FortiOS - Hardware Acceleration Guide

Version 6.4.9

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Change log

Date	Change description
January 4, 2023	Corrected information about NTurbo support and interface policies, see NTurbo offloads flow-based processing on page 29. New section: Tunneling protocols that can be offloaded by NP7 processors on page 35. Corrected the documented default values for many of the individual traffic types monitored by NP7 HPE, see NP7 HPE for individual traffic types on page 50.
October 24, 2022	Corrections to FortiGate-5001E and 5001E1 fast path architecture on page 218.
September 27, 2022	New information about NP7 DoS policy offloading limitations added to DoS policy hardware acceleration on page 46.
September 6, 2022	Added a disclaimer to CP9, CP9XLite, and CP9Lite capabilities on page 17.
August 11, 2022	Changes to the following sections: • FortiGate 4200F and 4201F fast path architecture on page 87. • FortiGate 4400F and 4401F fast path architecture on page 92. • hash-config {5-tuple | src-ip} on page 58. • Per-session accounting for offloaded NP6, NP6XLite, and NP6Lite sessions on page 128.
July 26, 2022	New section: NP6 HPE host protection engine on page 116.
July 20, 2022	Improvements to Configuring hyperscale TCP timeout profiles on page 64 and Configuring hyperscale UDP timeout profiles on page 65.
July 12, 2022	Fixes to NTurbo and IPSA on page 29 and IPSA offloads flow-based pattern matching on page 30. More information about NP7 traffic shaping added to NP7 traffic shaping on page 44.
May 6, 2022	Changes to config dsw-queue-dts-profile on page 74. Previous versions of this document incorrectly stated that NP6 processors support offloading DoS policy sessions. This has been corrected throughout the document as required.
April 26, 2022	FortiOS 6.4.9 document release. See What's new for FortiGates with NP7 processors for FortiOS 6.4.9 on page 15. New section: diagnose sys session list and no_ofld_reason field (NP7 session information) on page 77.
April 19, 2022	New sections: • Allowing offloaded IPsec packets that exceed the interface MTU on page 137. • FortiGate 400E Bypass fast path architecture on page 156. • diagnose sys session list no_ofld_reason field on page 146. Added information about NP6 processor support of DoS protection and offloading DoS policies. Changes to NP7 Host Protection Engine (HPE) on page 48.

Date	Change description
March 2, 2022	Renamed the section: Configuring NP7 queue protocol prioritization on page 70. New section Default NP7 queue protocol prioritization configuration on page 72. Correction to Disabling NP offloading for firewall policies on page 21 and Disabling nTurbo for firewall policies on page 30.
December 17, 2021	Corrected the default setting and added more information to vlan-lookup-cache {disable | enable} on page 62.
December 13, 2021	Updated the following sections to correct information about interface groups and to add information about splitting interfaces: • FortiGate 4200F and 4201F fast path architecture on page 87. • FortiGate 4400F and 4401F fast path architecture on page 92. Moved information about improving CPS performance to sections describing the following FortiGate models that support this feature: • FortiGate 1200D fast path architecture on page 171. • FortiGate 1500D fast path architecture on page 173. • FortiGate 1500DT fast path architecture on page 175. Removed information about older NP and CP processors and removed information about SP processors since older FortiGate models that include this hardware are not supported by FortiOS 6.4.
December 2, 2021	Corrections to FortiGate 80F, 81F, and 80F Bypass fast path architecture on page 225.
December 1, 2021	Changes to policy-offload-level {disable | dos-offload | full-offload} on page 58. Correction to Disabling NP offloading for firewall policies on page 21. New section Disabling nTurbo for firewall policies on page 30. Removed the incorrect section "Disabling CP offloading for firewall policies".
November 25, 2021	FortiOS 6.4.8 document release. See What's new for FortiGates with NP7 processors for FortiOS 6.4.8 on page 15.
September 17, 2021	More information added to NP6 session drift on page 133.
September 9, 2021	Added more information about the NP6XLite processor to Network processors (NP7, NP6, NP6XLite, and NP6Lite) on page 20 and NP6XLite processors on page 100. This content continues to be under development. If you have comments about it, contact techdoc@fortinet.com. Updates to the following sections: • FortiGate 1800F and 1801F fast path architecture on page 79. • FortiGate 2600F and 2601F fast path architecture on page 83. • FortiGate 4200F and 4201F fast path architecture on page 87. • FortiGate 4400F and 4401F fast path architecture on page 92.
September 3, 2021	New and improved content: • Re-wrote the information about the NP7 HPE, see NP7 Host Protection Engine (HPE) on page 48. • New section: NP acceleration, virtual clustering, and VLAN MAC addresses on page 22. • Fixes to NP6 session drift on page 133.

Date	Change description
	• Removed the information about CP9 support for a true random number generator and entropy source from CP9, CP9XLite, and CP9Lite capabilities on page 17.
August 5, 2021	Updated NTurbo offloads flow-based processing on page 29 to clarify that NTurbo also applies to IPsec VPN sessions. Corrected errors in the section FortiGate 100F and 101F fast path architecture on page 228.
July 9, 2021	FortiOS 6.4.6 document release. FortiOS 6.4.6 includes support for FortiGates with NP7 processors and for NP7 hyperscale firewall features. See What's new for FortiGates with NP7 processors for FortiOS 6.4.6 on page 15. Updated NP6 session fast path requirements on page 99 to list support for offloading UDP traffic with a destination port of 4500 (ESP-in-UDP traffic). New section: Offloading UDP-encapsulated ESP traffic on page 138. Added a note about NP6 processors not offloading sessions between two EMAC VLANs on NPU inter-VDOM link interfaces to Using VLANs to add more accelerated inter-VDOM link interfaces on page 112.
June 22, 2021	Corrected integrated switch fabric information in the following sections: • FortiGate 300E and 301E fast path architecture on page 152. • FortiGate 400E and 401E fast path architecture on page 154. • FortiGate 500E and 501E fast path architecture on page 160. • FortiGate 600E and 601E fast path architecture on page 161.
June 16, 2021	Added more information about bypass mode to: • FortiGate 800D fast path architecture on page 163. • FortiGate 2500E fast path architecture on page 182. • FortiGate 80F, 81F, and 80F Bypass fast path architecture on page 225.
April 12, 2021	Improved the information in Supporting IPsec anti-replay protection on page 114. Corrected the output of the `get hardware npu np6 port-list` command in FortiGate 3600E and 3601E fast path architecture on page 196.
March 1, 2021	Corrected the `get hardware npu np6 port-list` command output in FortiGate 1100E and 1101E fast path architecture on page 169. Updated the architecture sections for most E and F models to include more information about management/HA and data processing separation. For example, see the following: • FortiGate 400E and 401E fast path architecture on page 154. • FortiGate 1100E and 1101E fast path architecture on page 169. • FortiGate 3300E and 3301E fast path architecture on page 190 • FortiGate 200F and 201F fast path architecture on page 230. • FortiGate 200E and 201E fast path architecture on page 233.
December 18, 2020	New section: FortiGate 200F and 201F fast path architecture on page 230.

Date	Change description
December 10, 2020	New section: FortiGate 80F, 81F, and 80F Bypass fast path architecture on page 225. More information about NetFlow support added to sFlow and NetFlow and hardware acceleration on page 25. Corrected the `get hardware npu np6 port-list` command output in FortiGate 1100E and 1101E fast path architecture on page 169.
November 23, 2020	More information and corrections about SOC4 (NP6XLite and CP9XLite) and SOC3 (NP6Lite and CP9Lite). • Network processors (NP7, NP6, NP6XLite, and NP6Lite) on page 20. • NP6XLite processors on page 100. • NP6Lite processors on page 101. • Content processors (CP9, CP9XLite, CP9Lite) on page 17. • FortiGate 60F and 61F fast path architecture on page 224. • FortiGate 100F and 101F fast path architecture on page 228. • FortiGate 100E and 101E fast path architecture on page 232. • FortiGate 200E and 201E fast path architecture on page 233.
October 19, 2020	Added bypass interface information to FortiGate 800D fast path architecture on page 163. Minor improvements to the bypass interface information in FortiGate 2500E fast path architecture on page 182. Other misc. changes and fixes.
September 14, 2020	Improved information about how for NP7 and many more recent NP6 fast path architectures the HA interfaces are not connected to the NP7 or NP6 processors. Information about bypass mode added to FortiGate 2500E fast path architecture on page 182. Corrected the output of the `diagnose npu np6 port-list` command in FortiGate 3960E fast path architecture on page 212. Hardware architectures changed: • FortiGate 500E and 501E fast path architecture on page 160. • FortiGate 600E and 601E fast path architecture on page 161.
August 25, 2020	New section: FortiGate 100E and 101E fast path architecture on page 232. Added a note about NP6 processors and traffic shaping counters to NP6 processors and traffic shaping on page 102. Information about setting interface speeds added to FortiGate 3400E and 3401E fast path architecture on page 193 and FortiGate 3600E and 3601E fast path architecture on page 196.
August 21, 2020	Added NP6XLite content.
July 8, 2020	Corrected the `get hardware npu np6 port-list` output in FortiGate 3400E and 3401E fast path architecture on page 193. Added information about interface groups for the following models: • FortiGate 1100E and 1101E fast path architecture on page 169. • FortiGate 2200E and 2201E fast path architecture on page 179. • FortiGate 3400E and 3401E fast path architecture on page 193. • FortiGate 3600E and 3601E fast path architecture on page 196. Added a note about ESP in UDP sessions (UDP port 4500) not been offloaded by NP6 processors to NP6 session fast path requirements on page 99. Corrections to Dedicated management CPU on page 27.

Date	Change description
	Changes to Disabling NP6, NP6XLite, and NP6Lite hardware acceleration (fastpath) on page 104.
May 21, 2020	New sections: • FortiGate 1100E and 1101E fast path architecture on page 169. • FortiGate 2200E and 2201E fast path architecture on page 179. • FortiGate 3300E and 3301E fast path architecture on page 190.
April 3, 2020	Improvements to the information about the HPE in Configuring individual NP6 processors on page 124. New sections: • Adjusting NP6 HPE BGP, SLBC, and BFD priorities on page 121. • Eliminating dropped packets on LAG interfaces on page 110.
March 31, 2019	FortiOS 6.4 document release.

Hardware acceleration

Most FortiGate models have specialized acceleration hardware, (called Security Processing Units (SPUs)) that can offload resource intensive processing from main processing (CPU) resources. Most FortiGate units include specialized content processors (CPs) that accelerate a wide range of important security processes such as virus scanning, attack detection, encryption and decryption. (Only selected entry-level FortiGate models do not include a CP processor.) Many FortiGate models also contain network processors (NPs) that offload processing of high volume network traffic.

This document describes the Security Processing Unit (SPU) hardware that Fortinet builds into FortiGate devices to accelerate traffic through FortiGate units. Two types of SPUs are described:

- Content processors (CPs) that accelerate a wide range of security functions.
- Network processors (NPs and NPLites) that offload network traffic to specialized hardware that is optimized to provide high levels of network throughput.

Whats new

This section describes new hardware acceleration features for FortiOS 6.4 releases.

What's new for FortiGates with NP7 processors for FortiOS 6.4.9

This section lists the new NP7 features added to FortiOS 6.4.9. For new FortiOS 6.4.9 NP7 hyperscale firewall features, see the FortiOS 6.4.9 Hyperscale Firewall Guide.

- FortiOS 6.4.9 includes main branch support for FortiGates with NP7 processors and hyperscale firewall features (FortiGate-1800F, FortiGate-1801F, FortiGate-2600F, FortiGate-2601F, FortiGate-4200F, FortiGate-4201F, FortiGate-4400F, and FortiGate-4401F). Previous versions of FortiOS supported FortiGates with NP7 processors through special branch firmware builds.

What's new for FortiGates with NP7 processors for FortiOS 6.4.8

This section lists the new NP7 features added to FortiOS 6.4.8. For new FortiOS 6.4.8 NP7 hyperscale firewall features, see the FortiOS 6.4.8 Hyperscale Firewall Guide.

- The `config system npu` command includes a new `htx-icmp-csum-chk` option to block or allow NP7 processors to send ICMP packets with checksum errors to the CPU. See htx-icmp-csum-chk { drop | pass} on page 62.
- New option to enable or disable background NP7 SSE scanning for FortiGates with hyperscale firewall features enabled and configure some SSE scanning options. See config background-sse-scan on page 66.
- You can enable or disable hyperscale firewall per-policy accounting for all hyperscale traffic. See per-policy-accounting {disable | enable} on page 61.

What's new for FortiGates with NP7 processors for FortiOS 6.4.6

FortiOS 6.4.6 includes support for FortiGates with NP7 processors and for NP7 hyperscale firewall features. For information about NP7 processors, see:

- Network processors (NP7, NP6, NP6XLite, and NP6Lite) on page 20.
- NP7 acceleration on page 32.
- FortiGate NP7 architectures on page 79.

For information about NP7 hyperscale firewall features, see the FortiOS 6.4.6 Hyperscale Firewall Guide.

The following new features for FortiGates that include NP7 processors have been added to FortiOS 6.4.6.

- Re-designed NP7 HPE, see NP7 Host Protection Engine (HPE) on page 48.
- New `config system npu` options:

- tcp-rst-timeout <timeout> on page 59.
- napi-break-interval <interval> on page 59.
- vlan-lookup-cache {disable | enable} on page 62.
- htab-msg-queue {data | idle | dedicated} on page 62.
- htab-dedi-queue-nr <number-of-queues> on page 63.
- double-level-mcast-offload {disable | enable} on page 63.

The following new FortiOS 6.2.7 features are also available for FortiOS 6.4.6.

- You can improve overall performance by keeping accelerated VDOM link interfaces from consuming excessive NP7 bandwidth. See Bandwidth control for NPU accelerated VDOM link interfaces on page 37.
- When configuring a VLAN interface, you can set the maximum outgoing bandwidth that traffic over the VLAN interface can use. See Controlling the maximum outgoing VLAN bandwidth on page 37.
- FortiGates with NP7 processors now support synchronizing HA session sync packets to multiple CPUs, see Distributing HA session synchronization packets to multiple CPUs on page 47.
- You can now enable or disable hash table entry spread for NP7 processors, see hash-tbl-spread (disable | enable} on page 61.
- NP7 Host Protection Engine (HPE) enhancements, to prevent SYN_ACK reflection attacks and limit the maximum number of TCP FIN and RST packets. See NP7 Host Protection Engine (HPE) on page 48.

Content processors (CP9, CP9XLite, CP9Lite)

Most FortiGate models contain CP9 Security Processing Unit (SPU) Content Processors (CPs) that accelerate many common resource intensive security related processes. CP9s work at the system level with tasks being offloaded to them as determined by the main CPU. Current FortiGate units include CP9, CP9Lite, and CP9XLite processors. Capabilities of the CPs vary by model. Older CP versions include the CP4, CP5, CP6, and CP8.

CP9, CP9XLite, and CP9Lite capabilities

CP9, CP9XLite (found in SOC4), and CP9Lite (found in SOC3) content processors support mostly the same features, with a few exceptions noted below. The main difference between the processors is their capacity and throughput. For example, the CP9 has sixteen IPsec VPN engines while the CP9XLite has five and the CP9Lite has one. As a result, the CP9 can accelerate many more IPsec VPN sessions than the lite versions.

The CP9 content processor provides the following services:

FortiOS may not support all of the CP9 services listed below. For example, IPsec VPNs may not support some less commonly used proposals; such as AES-GMAC. For any FortiOS function, you can check the options available from the CLI to see the features that are supported. For example, when configuring an IPsec VPN phase one, you can use the CLI help with the `set proposal` option to see the list of supported proposals.

- Flow-based inspection (IPS and application control) pattern matching acceleration with over 10Gbps throughput
  - IPS pre-scan/pre-match offload
  - IPS signature correlation offload
  - Full match offload (CP9 only)
  - High throughput DFA-based deep packet inspection
- High performance VPN bulk data engine
  - IPsec and SSL/TLS protocol processor
  - DES/3DES/AES128/192/256 in accordance with FIPS46-3/FIPS81/FIPS197
  - MD5/SHA-1/SHA256/384/512-96/128/192/256 with RFC1321 and FIPS180
  - M S/KM Generation (Hash) (CP9 only)
  - HMAC in accordance with RFC2104/2403/2404 and FIPS198
  - ESN mode
  - GCM support for NSA "Suite B" (RFC6379/RFC6460) including GCM-128/256; GMAC-128/256
- Key exchange processor that supports high performance IKE and RSA computation
  - Public key exponentiation engine with hardware CRT support
  - Primary checking for RSA key generation
  - Handshake accelerator with automatic key material generation
  - Ring OSC entropy source
  - Elliptic curve cryptography ECC (P-256) support for NSA "Suite B" (CP9 only)
  - Sub public key engine (PKCE) to support up to 4096 bit operation directly (4k for DH and 8k for RSA with CRT)

- DLP fingerprint support
  - Configurable Two-Thresholds-Two-Divisors (TTTD) content chunking

CP8 capabilities

The CP8 content processor provides the following services:

- Flow-based inspection (IPS, application control etc.) pattern matching acceleration
- High performance VPN bulk data engine
  - IPsec and SSL/TLS protocol processor
  - DES/3DES/AES in accordance with FIPS46-3/FIPS81/FIPS197
  - ARC4 in compliance with RC4
  - MD5/SHA-1/SHA256 with RFC1321 and FIPS180
  - HMAC in accordance with RFC2104/2403/2404 and FIPS198
  - Key Exchange Processor support high performance IKE and RSA computation
  - Public key exponentiation engine with hardware CRT support
  - Primarily checking for RSA key generation
  - Handshake accelerator with automatic key material generation
  - Random Number generator compliance with ANSI X9.31
  - Sub public key engine (PKCE) supports up to DH 2048 bit (group 14)
- Message authentication module offers high performance cryptographic engine for calculating SHA256/SHA1/MD5 of data up to 4G bytes (used by many applications)
- PCI express Gen 2 four lanes interface
- Cascade Interface for chip expansion

Determining the content processor in your FortiGate unit

Use the `get hardware status` CLI command to determine which content processor your FortiGate unit contains. The output looks like this:

```
get hardware status
Model name: FortiGate-4201F
ASIC version: CP9
ASIC SRAM: 64M
CPU: Intel(R) Xeon(R) Gold 6248 CPU @ 2.50GHz
Number of CPUs: 80
RAM: 387740 MB
Compact Flash: 28738 MB /dev/sda
Hard disk: 1907729 MB /dev/nvme0n1
USB Flash: not available
Network Card chipset: Intel(R) Gigabit Ethernet Linux Driver (rev.0003)
Network Card chipset: FortiASIC NP7 Adapter (rev.)
Hardware Board ID: 000
```

The ASIC version line lists the content processor model number.

Viewing SSL acceleration status

You can view the status of SSL acceleration using the following command:

```
get vpn status ssl hw-acceleration-status
Acceleration hardware detected: kxp=on cipher=on
```

Where kxp means key exchange acceleration.

Network processors (NP7, NP6, NP6XLite, and NP6Lite)

FortiASIC network processors work at the interface level to accelerate traffic by offloading traffic from the main CPU. Current models contain NP7, NP6, NP6XLite, and NP6Lite network processors. Older FortiGate models include NP1 network processors (also known as FortiAccel, or FA2), NP2, NP4, and NP4Lite network processors.

The traffic that can be offloaded, maximum throughput, and number of network interfaces supported by each varies by processor model:

- NP7 supports offloading of most IPv4 and IPv6 traffic, IPsec VPN encryption (including Suite B), SSL VPN encryption, GTP traffic, CAPWAP traffic, VXLAN traffic, multicast traffic, and NAT session setup. On FortiGates licensed for hyperscale firewall support, NP7 offloads session setup, Carrier Grade NAT (CGN), hardware logging, HA hardware session synchronization, DoS protection, and data communication from the FortiGate CPU. The NP7 has a maximum throughput of 200 Gbps using 2 x 100 Gbps interfaces. For details about the NP7 processor, see NP7 acceleration on page 32 and for information about FortiGate models with NP7 processors, see FortiGate NP7 architectures on page 79. For information about hyperscale firewall functionality, see the Hyperscale Firewall Guide.
- NP6 supports offloading of most IPv4 and IPv6 traffic, IPsec VPN encryption, CAPWAP traffic, DoS protection, and multicast traffic. The NP6 has a maximum throughput of 40 Gbps using 4 x 10 Gbps XAUI or Quad Serial Gigabit Media Independent Interface (QSGMII) interfaces or 3 x 10 Gbps and 16 x 1 Gbps XAUI or QSGMII interfaces. For details about the NP6 processor, see NP6, NP6XLite, and NP6Lite acceleration on page 98 and for information about FortiGate models with NP6 processors, see FortiGate NP6 architectures on page 151.
- NP6XLite is a component of the Fortinet SOC4 and supports the same features as the NP6 but with slightly lower throughput. The NP6XLite also includes new features and improvements, such as the ability to offload AES128-GCM and AES256-GCM encryption for IPsec VPN traffic. The NP6XLite has a maximum throughput of 36 Gbps using 4x KR/USXGMII/QSGMII and 2x(1x) Reduced gigabit media-independent interface (RGMII) interfaces. For details about the NP6XLite processor, see NP6XLite processors on page 100 and for information about FortiGate models with NP6XLite processors, see FortiGate NP6XLite architectures on page 224.
- The NP6Lite is a component of the Fortinet SOC3 and is similar to the NP6 but with a lower throughput and some functional limitations (for example, the NP6Lite does not offload CAPWAP traffic). The NP6Lite has a maximum throughput of 10 Gbps using 2x QSGMII and 2x RGMII interfaces. For details about the NP6Lite processor, see NP6Lite processors on page 101 and for information about FortiGate models with NP6 processors, see FortiGate NP6Lite architectures on page 232.

Sessions that require proxy-based security features are not fast pathed and must be processed by the CPU. Sessions that require flow-based security features can be offloaded to NPx network processors if the FortiGate supports NTurbo.

Accelerated sessions on FortiView All Sessions page

When viewing sessions in the FortiView All Sessions console, NP6 or NP7 accelerated sessions are highlighted with an NP6 or NP7 icon. The tooltip for the icon includes the NP processor type and the total number of accelerated sessions.

You can also configure filtering to display FortiASIC sessions.

NP session offloading in HA active-active configuration

Network processors can improve network performance in active-active (load balancing) high availability (HA) configurations, even though traffic deviates from general offloading patterns, involving more than one network processor, each in a separate FortiGate unit. No additional offloading requirements apply.

Once the primary FortiGate unit's main processing resources send a session key to its network processor(s), network processor(s) on the primary unit can redirect any subsequent session traffic to other cluster members, reducing traffic redirection load on the primary unit's main processing resources.

As subordinate units receive redirected traffic, each network processor in the cluster assesses and processes session offloading independently from the primary unit. Session key states of each network processor are not part of synchronization traffic between HA members.

Configuring NP HMAC check offloading

Hash-based Message Authentication Code (HMAC) checks offloaded to network processors by default. You can enter the following command to disable this feature:

```
configure system global
   set ipsec-hmac-offload disable
end
```

Software switch interfaces and NP processors

FortiOS supports creating a software switch by grouping two or more FortiGate physical interfaces into a single virtual or software switch interface. All of the interfaces in this virtual switch act like interfaces in a hardware switch in that they all have the same IP address and can be connected to the same network. You create a software switch interface from the CLI using the command `config system switch-interface`.

The software switch is a bridge group of several interfaces, and the FortiGate CPU maintains the mac-port table for this bridge. As a result of this CPU involvement, traffic processed by a software switch interface is not offloaded to network processors.

Disabling NP offloading for firewall policies

Use the following options to disable NP offloading for specific security policies:

For IPv4 security policies.

```
config firewall policy
   edit 1
      set auto-asic-offload disable
   end
```

For IPv6 security policies.

```
config firewall policy6
   edit 1
      set auto-asic-offload disable
   end
```

For multicast security policies.

```
config firewall multicast-policy
   edit 1
      set auto-asic-offload disable
   end
```

Disabling NP offloading for individual IPsec VPN phase 1s

Use the following command to disable NP offloading for an interface-based IPsec VPN phase 1:

```
config vpn ipsec phase1-interface
   edit phase-1-name
      set npu-offload disable
end
```

Use the following command to disable NP offloading for a policy-based IPsec VPN phase 1:

```
config vpn ipsec phase1
   edit phase-1-name
      set npu-offload disable
   end
```

The `npu-offload` option is enabled by default.

NP acceleration, virtual clustering, and VLAN MAC addresses

In some configurations, when a FortiGate with NP7 or NP6 processors is operating with virtual clustering enabled, traffic cannot be offloaded by the NP7 or NP6 processors if the MAC address of the VLAN interface accepting the traffic is different from the MAC address of the physical interface that the VLAN interface has been added to. If you are running a configuration like this, traffic from the VLAN interface can be dropped by the NP7 or NP6 processors. If you notice traffic being dropped, you can disable NP offloading in the firewall policy that accepts the traffic to resolve the issue.

NP7 and NP6 offloading can still work in some network configurations when a VLAN and its physical interface have different MAC addresses. For example, offloading can still work as long as other network devices learn the FortiGate's MAC addresses from ARP. As well, offloading can work if the reply traffic destination MAC is the same as the MAC of the underlying interface.

Determining the network processors installed in your FortiGate

Use the following command to list the NP7 processors in your FortiGate unit:

```
diagnose npu np7 port-list
```

Use either of the following command to list the NP6 processors in your FortiGate unit:

```
get hardware npu np6 port-list
diagnose npu np6 port-list
```

Use the following command to list the NP6XLite processors in your FortiGate unit:

```
get hardware npu np6xlite port-list
```

Use either of the following commands to list the NP6Lite processors in your FortiGate unit:

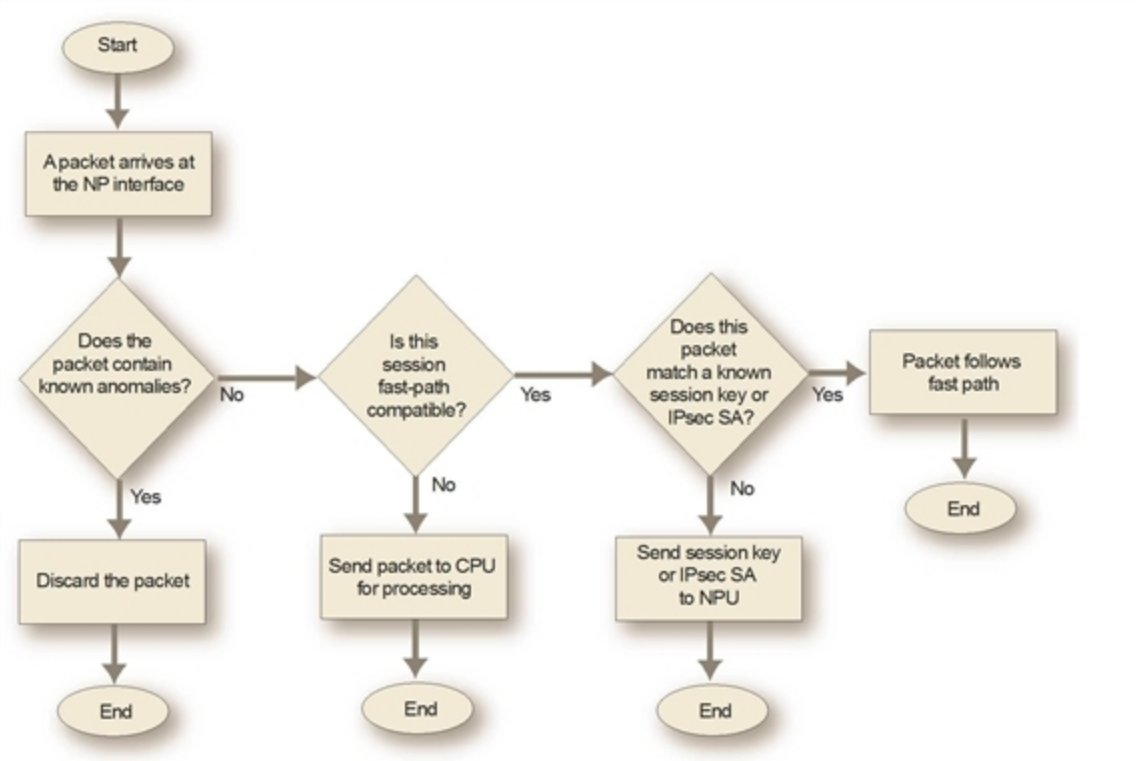
```
get hardware npu np6lite port-list
diagnose npu np6lite port-list
```

NP hardware acceleration alters packet flow

NP hardware acceleration generally alters packet flow as follows:

1. Packets initiating a session pass to the FortiGate unit's main processing resources (CPU).
2. The FortiGate unit assesses whether the session matches fast path (offload) requirements.
   To be suitable for offloading, traffic must possess only characteristics that can be processed by the fast path. The list of requirements depends on the processor, see NP7 session fast path requirements on page 33 or NP6 session fast path requirements on page 99.
   If the session can be fast pathed, the FortiGate unit sends the session key or IPsec security association (SA) and configured firewall processing action to the appropriate network processor.
3. Network processors continuously match packets arriving on their attached ports against the session keys and SAs they have received.
   - If a network processor's network interface is configured to perform hardware accelerated anomaly checks, the network processor drops or accepts packets that match the configured anomaly patterns. These checks are separate from and in advance of anomaly checks performed by IPS, which is not compatible with network processor offloading. See .
   - The network processor next checks for a matching session key or SA. If a matching session key or SA is found, and if the packet meets packet requirements, the network processor processes the packet according to the configured action and then sends the resulting packet. This is the actual offloading step. Performing this processing on the NP processor improves overall performance because the NP processor is optimized for this task. As well, overall FortiGate performance is improved because the CPU has fewer sessions to process.

NP network processor packet flow



- If a matching session key or SA is not found, or if the packet does not meet packet requirements, the packet cannot be offloaded. The network processor sends the data to the FortiGate unit's CPU, which processes the packet.

Encryption and decryption of IPsec traffic originating from the FortiGate can utilize network processor encryption capabilities.

Packet forwarding rates vary by the percentage of offloadable processing and the type of network processing required by your configuration, but are independent of frame size. For optimal traffic types, network throughput can equal wire speed.

NP7, NP6, NP6XLite, and NP6Lite traffic logging and monitoring

NP7, NP6, NP6XLite, and NP6Lite processors support per-session traffic and byte counters, Ethernet MIB matching, and reporting through messages resulting in traffic statistics and traffic log reporting.

- For information about NP6, NP6XLite, and NP6Lite per-session accounting, see Per-session accounting for offloaded NP6, NP6XLite, and NP6Lite sessions on page 128.
- For information about NP7 per-session accounting, see Per-session accounting for offloaded NP7 sessions on page 38.

sFlow and NetFlow and hardware acceleration

NP7, NP6, NP6XLite, and NP6Lite offloading is supported when you configure NetFlow for interfaces connected to NP7, NP6, NP6XLite, or NP6Lite processors. Offloading of other sessions is not affected by configuring NetFlow. Full NetFlow is supported through the information maintained in the firewall session.

Configuring sFlow on any interface disables all NP7, NP6, NP6XLite, or NP6Lite offloading for all traffic on that interface.

Checking that traffic is offloaded by NP processors

A number of diagnose commands can be used to verify that traffic is being offloaded.

Using the packet sniffer

Use the packet sniffer to verify that traffic is offloaded. Offloaded traffic is not picked up by the packet sniffer so if you are sending traffic through the FortiGate unit and it is not showing up on the packet sniffer you can conclude that it is offloaded.

```
diag sniffer packet port1 <option>
```

If you want the packet sniffer to be able to see offloaded traffic you can temporarily disable offloading the traffic, run the packet sniffer to view it and then re-enable offloading. As an example, you may want to sniff the traffic that is accepted by a specific firewall policy. You can edit the policy and set the `auto-asic-offload` option to `disable` to disable offloading this traffic.You can also disable offloading for IPsec VPN traffic, see Network processors (NP7, NP6, NP6XLite, and NP6Lite) on page 20.

Checking the firewall session offload tag

Use the `diagnose sys session list` command to display sessions. If the output for a session includes the `npu info` field you should see information about session being offloaded. If the output doesn't contain an `npu info` field then the session has not been offloaded.

```
diagnose sys session list
session info: proto=6 proto_state=01 duration=34 expire=3565 timeout=3600 flags=00000000
     sockflag=00000000 sockport=0 av_idx=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0 policy_dir=0 tunnel=/
state=may_dirty npu
statistic(bytes/packets/allow_err): org=295/3/1 reply=60/1/1 tuples=2
orgin->sink: org pre->post, reply pre->post dev=48->6/6->48 gwy=10.1.100.11/11.11.11.1
hook=pre dir=org act=noop 172.16.200.55:56453->10.1.100.11:80(0.0.0.0:0)
hook=post dir=reply act=noop 10.1.100.11:80->172.16.200.55:56453(0.0.0.0:0)
pos/(before,after) 0/(0,0), 0/(0,0)
misc=0 policy_id=1 id_policy_id=0 auth_info=0 chk_client_info=0 vd=4
```

```
serial=0000091c tos=ff/ff ips_view=0 app_list=0 app=0
dd_type=0 dd_mode=0
per_ip_bandwidth meter: addr=172.16.200.55, bps=393
npu_state=00000000
npu info: flag=0x81/0x81, offload=4/4, ips_offload=0/0, epid=1/23, ipid=23/1,
     vlan=32779/0
```

Verifying IPsec VPN traffic offloading

The following commands can be used to verify IPsec VPN traffic offloading to NP processors.

```
diagnose vpn ipsec status
NP1/NP2/NP4_0/sp_0_0:
     null: 0 0
     des: 0 0
      3des: 4075 4074
     aes: 0 0
     aria: 0 0
     seed: 0 0
     null: 0 0
      md5: 4075 4074
     sha1: 0 0
     sha256: 0 0
     sha384: 0 0
     sha512: 0 0
diagnose vpn tunnel list
list all ipsec tunnel in vd 3
------------------------------------------------------
name=p1-vdom1 ver=1 serial=5 11.11.11.1:0->11.11.11.2:0 lgwy=static tun=tunnel mode=auto
     bound_if=47
proxyid_num=1 child_num=0 refcnt=8 ilast=2 olast=2
stat: rxp=3076 txp=1667 rxb=4299623276 txb=66323
dpd: mode=active on=1 idle=5000ms retry=3 count=0 seqno=20
natt: mode=none draft=0 interval=0 remote_port=0
proxyid=p2-vdom1 proto=0 sa=1 ref=2 auto_negotiate=0 serial=1
src: 0:0.0.0.0/0.0.0.0:0
dst: 0:0.0.0.0/0.0.0.0:0
SA: ref=6 options=0000000e type=00 soft=0 mtu=1436 expire=1736 replaywin=2048 seqno=680
life: type=01 bytes=0/0 timeout=1748/1800
dec: spi=ae01010c esp=3des key=24 18e021bcace225347459189f292fbc2e4677563b07498a07
ah=md5 key=16 b4f44368741632b4e33e5f5b794253d3
enc: spi=ae01010d esp=3des key=24 42c94a8a2f72a44f9a3777f8e6aa3b24160b8af15f54a573
ah=md5 key=16 6214155f76b63a93345dcc9ec02d6415
dec:pkts/bytes=3073/4299621477, enc:pkts/bytes=1667/66375
 npu_flag=03 npu_rgwy=11.11.11.2 npu_lgwy=11.11.11.1 npu_selid=4
diagnose sys session list
session info: proto=6 proto_state=01 duration=34 expire=3565 timeout=3600 flags=00000000
     sockflag=00000000 sockport=0 av_idx=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0 policy_dir=0 tunnel=/p1-vdom2
state=re may_dirty npu
statistic(bytes/packets/allow_err): org=112/2/1 reply=112/2/1 tuples=2
orgin->sink: org pre->post, reply pre->post dev=57->7/7->57 gwy=10.1.100.11/11.11.11.1
hook=pre dir=org act=noop 172.16.200.55:35254->10.1.100.11:80(0.0.0.0:0)
```

```
hook=post dir=reply act=noop 10.1.100.11:80->172.16.200.55:35254(0.0.0.0:0)
pos/(before,after) 0/(0,0), 0/(0,0)
misc=0 policy_id=1 id_policy_id=0 auth_info=0 chk_client_info=0 vd=4
serial=00002d29 tos=ff/ff ips_view=0 app_list=0 app=0
dd_type=0 dd_mode=0
per_ip_bandwidth meter: addr=172.16.200.55, bps=260
npu_state=00000000
npu info: flag=0x81/0x82, offload=7/7, ips_offload=0/0, epid=1/3, ipid=3/1, vlan=32779/0
```

Dedicated management CPU

The GUI and CLI of FortiGate units with NP7 and NP6 processors may become unresponsive when the system is under heavy processing load because NP7 or NP6 interrupts overload the CPUs preventing CPU cycles from being used for management tasks. You can resolve this issue by using the following command to dedicate CPU core 0 to management tasks.

```
config system npu
   set dedicated-management-cpu enable
end
```

All management tasks are then processed by CPU 0. NP6 or NP7 interrupts that would normally be handed by CPU 0 are added to CPU 1, resulting in CPU 1 processes more interrupts. The `dedicated-management-cpu` option is disabled by default.

Preventing packet ordering problems

In some cases when FortiGate units with NP7, NP6, NP6XLite, or NP6Lite processors are under heavy load, the packets used in the TCP 3-way handshake of some sessions may be transmitted by the FortiGate in the wrong order resulting in the TCP sessions failing.

If you notice TCP sessions failing when a FortiGate with NP7, NP6, NP6XLite, or NP6ite processors is very busy you can enable `delay-tcp-npu-session` in the firewall policy receiving the traffic. This option resolves the problem by delaying the session to make sure that there is time for all of the handshake packets to reach the destination before the session begins transmitting data.

```
config firewall policy
   set delay-tcp-npu-session enable
end
```

Strict protocol header checking disables hardware acceleration

You can use the following command to cause the FortiGate to apply strict header checking to verify that a packet is part of a session that should be processed. Strict header checking includes verifying the layer-4 protocol header length, the IP header length, the IP version, the IP checksum, IP options, and verifying that ESP packets have the correct sequence number, SPI, and data length.If the packet fails header checking it is dropped by the FortiGate unit.

```
config system global
   set check-protocol-header strict
end
```

Enabling strict header checking disables all hardware acceleration. This includes NP, SP, and CP processing.

NTurbo and IPSA

You can use the following command to configure NTurbo and IPS Acceleration (IPSA) for firewall sessions that have flow-based security profiles. This includes firewall sessions with IPS, application control, CASI, flow-based antivirus, and flow-based web filtering.

```
config ips global
   set np-accel-mode {none | basic}
   set cp-accel-mode {none | basic | advanced}
end
```

`np-accel-mode` select the NTurbo mode.

`cp-accel-mode` select the IPSA mode.

NTurbo offloads flow-based processing

NTurbo offloads firewall sessions that include flow-based security profiles to NP7 or NP6 network processors. Without NTurbo, or with NTurbo disabled, all firewall sessions that include flow-based security profiles are processed by the FortiGate CPU. NTurbo can also offload DoS policy, access control list policy, and interface policy sessions. NTurbo can also offload IPsec sessions if the SA is offloadable (and it usually is).

NTurbo can only offload firewall sessions containing flow-based security profiles if the session could otherwise have been offloaded except for the presence of the flow-based security profiles. If something else prevents the session from being offloaded, NTurbo will not offload that session.

Firewall sessions that include proxy-based security profiles are never offloaded to network processors and are always processed by the FortiGate CPU.

NTurbo can offload DoS policy sessions (`config firewall DoS-policy` or `DoS-policy6`) and access control list policy sessions (`config firewall acl` or `acl6`). NTurbo can offload interface policy sessions (`config firewall interface-policy` or`interface-policy6`) as long as you don't enable any UTM features in the interface policy.

NTurbo creates a special data path to redirect traffic from the ingress interface to IPS, and from IPS to the egress interface. NTurbo allows firewall operations to be offloaded along this path, and still allows IPS to behave as a stage in the processing pipeline, reducing the workload on the FortiGate CPU and improving overall throughput.

NTurbo sessions still offload pattern matching and other processes to CP processors, just like normal flow-based sessions.

If NTurbo is supported by your FortiGate unit, you can use the following command to configure it:

```
config ips global
   set np-accel-mode {basic | none}
end
```

`basic` enables NTurbo and is the default setting for FortiGate models that support NTurbo. `none` disables NTurbo. If the `np-accel-mode` option is not available, then your FortiGate does not support NTurbo.

There are some special cases (listed below) where sessions may not be offloaded by NTurbo, even when NTurbo is explicitly enabled. In these cases, the sessions are handled by the FortiGate CPU.

- NP acceleration is disabled. For example, `auto-asic-offload` is disabled in the firewall policy configuration.
- The firewall policy includes proxy-based security profiles.
- The sessions require FortiOS session-helpers. For example, FTP sessions can not be offloaded to NP processors because FTP sessions use the FTP session helper.
- Tunneling is enabled. Any traffic to or from a tunneled interface (IPinIP, SSL VPN, GRE, CAPWAP, etc.) cannot be offloaded by NTurbo. (However, IPsec VPN sessions can be offloaded by NTurbo if the SA can be offloaded.)

Disabling nTurbo for firewall policies

If you want to disable nTurbo for test purposes or other reasons, you can do so in security policies. Here are some examples:

For IPv4 security policies.

```
config firewall policy
   edit 1
      set np-acceleration disable
   end
```

For IPv6 security policies.

```
config firewall policy6
   edit 1
      set np-acceleration disable
   end
```

For multicast security policies.

```
config firewall multicast-policy
   edit 1
      set np-acceleration disable
   end
```

IPSA offloads flow-based pattern matching

IPS Acceleration (IPSA) offloads enhanced pattern matching operations required for flow-based content processing to CP8 and CP9 Content Processors. IPSA offloads enhanced pattern matching for NTurbo firewall sessions and firewall sessions that are not offloaded to NP processors. When IPSA is turned on, flow-based pattern databases are compiled and downloaded to the content processors from the IPS engine and IPS database. Flow-based pattern matching requests are redirected to the CP hardware reducing the load on the FortiGate CPU and accelerating pattern matching.

IF IPSA is supported on your FortiGate, you can use the following command to configure it:

```
config ips global
   set cp-accel-mode {advanced | basic | none}
end
```

`basic` offloads basic pattern matching.

`advanced` offloads more types of pattern matching resulting in higher throughput than basic mode. `advanced` is only available on FortiGate models with two or more CP8s or one or more CP9s.

If the `cp-accel-mode` option is not available, then your FortiGate does not support IPSA.

On FortiGates with one CP8, the default `cp-accel-mode` is `basic`. Setting the mode to `advanced` does not change the types of pattern matching that are offloaded.

On FortiGates with two or more CP8s or one or more CP9s, the default `cp-accel-mode` is `advanced`. You can set the mode to `basic` to offload fewer types of pattern matching.

NP7 acceleration

NP7 network processors provide fastpath acceleration by offloading communication sessions from the FortiGate CPU. When the first packet of a new session is received by an interface connected to an NP7 processor, just like any session connecting with any FortiGate interface, the session is forwarded to the FortiGate CPU where it is matched with a security policy. If the session is accepted by a firewall policy and if the session can be offloaded its session key is copied to the NP7 processor that received the packet. All of the rest of the packets in the session are intercepted by the NP7 processor and fast-pathed to their destination without ever passing through the FortiGate CPU. The result is enhanced network performance provided by the NP7 processor plus the network processing load is removed from the CPU. In addition the NP7 processor can handle some CPU intensive tasks, like IPsec VPN encryption/decryption.

On FortiGates licensed for hyperscale firewall support, NP7 network processors provide fastpath acceleration by offloading session setup, Carrier Grade NAT (CGN), hardware logging, HA hardware session synchronization, DoS protection, and data communication from the FortiGate CPU. When the first packet of a new session is received by an interface connected to an NP7 processor, session and NAT setup takes place entirely on the NP7 policy and NAT engine without any involvement of the system bus or CPU, resulting in much higher connections per second. To support hardware session setup, the NP7 policy and NAT engine has a copy of the FortiGate policy, NAT, and routing tables. For information about hyperscale firewall functionality, see the Hyperscale Firewall Guide.

If the session is accepted by a firewall policy, and if the session can be offloaded, its session key is stored in the session table of the NP7 that received the session. All of the rest of the packets in the session are intercepted by the NP7 processor and fast-pathed out of the FortiGate unit to their destination. The result is enhanced connection per second (CPS) and network throughput performance provided by the NP7 processor plus the network processing load is removed from the CPU.

In addition, the NP7 processor can handle some CPU intensive tasks, like IPsec encryption/decryption.

In FortiGate with multiple NP7s, session keys (and IPsec SA keys) are stored in the memory of the NP7 processor that is connected to the interface that received the packet that started the session. All sessions are fast-pathed and accelerated, even if they exit the FortiGate unit through an interface connected to another NP7. There is no dependence on getting the right pair of interfaces since the offloading is done by the receiving NP7.

The key to making this possible is an Integrated Switch Fabric (ISF) that connects the NP7s and the FortiGate interfaces together. The ISF allows any interface connectivity with any NP7 on the same ISF. There are no special ingress and egress fast path requirements as long as traffic enters and exits on interfaces connected to the same ISF.

Each NP7 has a maximum throughput of 200 Gbps using two 100-Gigabit interfaces. Some FortiGates with NP7 processors also support creating NP7 port maps, allowing you to map data interfaces to specific NP7 100G interfaces. This feature allows you to control the balance traffic between the NP7 interfaces.

There is one limitation to keep in mind:

- The capacity of the NP7 processor. An individual NP7 processor can support up to 12 million sessions. This number is limited by the amount of memory the processor has. Once an NP7 processor hits its session limit, sessions that are over the limit are sent to the CPU. You can avoid this problem by as much as possible distributing incoming sessions evenly among multiple NP7 processors. To be able to do this you need to be aware of which interfaces connect to which NP7 processors and distribute incoming traffic accordingly.

NP7 session fast path requirements

NP7 processors can offload IPv4 and IPv6 traffic and NAT64 and NAT46 traffic as well as IPv4 and IPv6 versions of the following traffic types where appropriate:

- Link aggregation (LAG) (IEEE 802.3ad) traffic and traffic from static redundant interfaces (see Increasing NP6 offloading capacity using link aggregation groups (LAGs) on page 109Increasing NP7 offloading capacity using link aggregation groups (LAGs) on page 39).
- TCP, UDP, ICMP, SCTP, GTP-u, and RDP traffic.
- IPsec VPN traffic terminating on the FortiGate. NP7 processors also offload of IPsec encryption/decryption including:
  - Null, DES, 3DES, AES128, AES192, AES256, AES128-GCM, AES256-GCM, AES-GMAC128, AES-GMAC192, AES-GMAC256 encryption algorithms.
  - Null, MD5, SHA1, SHA256, SHA384, SHA512, HMAC-MD5, SHA2-256 and SHA2-512 authentication algorithms.
- IPsec traffic that passes through a FortiGate without being unencrypted.
- Anomaly-based intrusion prevention, checksum offload, and packet defragmentation.
- IPIP tunneling (also called IP in IP tunneling), SIT tunneling, and IPv6 tunneling.
- Multicast traffic (including Multicast over IPsec).
- CAPWAP and wireless bridge traffic tunnel encapsulation to enable line rate wireless forwarding from FortiAP devices.
- Virtual switch traffic including MAC management and forwarding, STP, and 802.1x.
- GTP.
- VXLAN.
- CAPWAP and VXLAN over IPsec.
- Fragmented packets (if the packet has been fragmented into two packets (see Reassembling and offloading fragmented packets on page 44).
- Traffic shaping and priority queuing including:
  - Shared and per IP traffic shaping.
  - Interface in bandwidth and out bandwidth traffic shaping.
- QoS.
- Syn proxying.
- DNS session helper.
- Inter-VDOM link traffic.
- Traffic over a loopback interface (including IPsec traffic terminated by the FortiGate). For information about using loopback interfaces, see the Fortinet KB article: Technical Tip : Configuring and using a loopback interface on a FortiGate.

Sessions that are offloaded must be fast path ready. For a session to be fast path ready it must meet the following criteria:

- Layer 2 type/length must be 0x0800 for IPv4 or 0x86dd for IPv6 (IEEE 802.1q VLAN specification is supported).
- Layer 3 protocol can be IPv4 or IPv6.
- Layer 4 protocol can be UDP, TCP, ICMP, or SCTP.
- In most cases, Layer 3 / Layer 4 header or content modification sessions that require a session helper can be offloaded.
- NTurbo sessions can be offloaded if they are accepted by firewall policies that include IPS, Application Control, CASI, flow-based antivirus, or flow-based web filtering.

Offloading application layer content modification is not supported. This means that sessions are not offloaded if they are accepted by firewall policies that include proxy-based virus scanning, proxy-based web filtering, DNS filtering, DLP, Anti-Spam, VoIP, ICAP, Web Application Firewall, or Proxy options.

If you disable anomaly checks by Intrusion Prevention (IPS), you can still enable hardware accelerated anomaly checks using the `fp-anomaly` field of the `config system interface` CLI command. See Configuring individual NP6 processors on page 124.

If a session is not fast path ready, the FortiGate will not send the session key or IPsec SA key to the NP7 processor. Without the session key, all session key lookup by a network processor for incoming packets of that session fails, causing all session packets to be sent to the main processing resources, and processed at normal speeds.

If a session is fast path ready, the FortiGate sends the session key or IPsec SA key to the network processor. Session key or IPsec SA key lookups then succeed for subsequent packets from the known session or IPsec SA.

Mixing fast path and non-fast path traffic

If packet requirements are not met, an individual packet will be processed by the FortiGate CPU regardless of whether other packets in the session are offloaded to the NP7.

Also, in some cases, a protocol's session(s) may receive a mixture of offloaded and non-offloaded processing. For example, VoIP control packets may not be offloaded but VoIP data packets (voice packets) may be offloaded.

Protocols that can be offloaded by NP7 processors

The following table lists the internet traffic protocols that can be offloaded by NP7 processors:

Protocol number	Keyword	Protocol
1	ICMP	Internet Control Message Protocol
4	IP-in-IP	IPv4 IP in IP encapsulation*
6	TCP	Transmission Control Protocol
17	UDP	User Datagram Protocol
27	RDP	Reliable Data Protocol
41	IPv6	IPv6 Encapsulation*
47	GRE	Generic Routing Encapsulation*
50	ESP	Encapsulating Security Payload*
97	ETHERIP or EoIP	Ethernet-within-IP Encapsulation, also called Ethernet over IP.
132	SCTP	Stream Control Transmission Protocol

* Tunneling protocols are offloaded in passthrough mode.

Tunneling protocols that can be offloaded by NP7 processors

The following table lists some internet tunneling protocols that can be offloaded by NP7 processors:

Keyword	Description	Protocol number
ESP used for IPsec VPN	IPSec VPN tunneling	50
IP-in-IP	IPv4 encapsulation	4
L2TP	Layer Two Tunneling Protocol	115
CAPWAP	Communication between wireless access points and wired LANs or between different wireless access points	N/A
VXLAN	VXLAN and VXLAN over IPsec. Provides secure communication between data centers over public networks.	N/A
GRE	Generic Routing Encapsulation	47
GTP	GPRS Tunneling protocol	N/A
IPv6 encapsulation	Tunnel to send IPv6 traffic over an IPv4 network.	41

Viewing your FortiGate NP7 processor configuration

Use the following command to view the NP7 processor hardware configuration of your FortiGate:

```
diagnose npu np7 port-list
```

For example, for the FortiGate 4200F or 4201F the output would be:

```
diagnose npu np7 port-list
Front Panel Port:
Name   Max_speed(Mbps) Dflt_speed(Mbps) NP_group        Switch_id SW_port_id SW_port_name
------ --------------- ---------------  ---------------- --------- ---------- ------------
port1  25000           10000            NP#0-3           0         37         xe10
port2  25000           10000            NP#0-3           0         38         xe11
port3  25000           10000            NP#0-3           0         39         xe12
port4  25000           10000            NP#0-3           0         40         xe13
port5  25000           10000            NP#0-3           0         41         xe14
port6  25000           10000            NP#0-3           0         42         xe15
port7  25000           10000            NP#0-3           0         43         xe16
port8  25000           10000            NP#0-3           0         44         xe17
port9  25000           10000            NP#0-3           0         45         xe18
port10 25000           10000            NP#0-3           0         46         xe19
port11 25000           10000            NP#0-3           0         47         xe20
port12 25000           10000            NP#0-3           0         48         xe21
port13 25000           10000            NP#0-3           0         49         xe22
port14 25000           10000            NP#0-3           0         50         xe23
port15 25000           10000            NP#0-3           0         51         xe24
```

```
port16 25000           10000           NP#0-3          0         52         xe25
port17 100000          100000          NP#0-3          0         57         ce5
port18 100000          100000          NP#0-3          0         53         ce4
port19 100000          100000          NP#0-3          0         67         ce7
port20 100000          100000          NP#0-3          0         61         ce6
port21 100000          100000          NP#0-3          0         75         ce9
port22 100000          100000          NP#0-3          0         71         ce8
port23 100000          100000          NP#0-3          0         83         ce11
port24 100000          100000          NP#0-3          0         79         ce10
------ --------------- ---------------  --------------- --------- ---------- ------------

NP Port:
Name   Switch_id SW_port_id SW_port_name
------ --------- ---------- ------------
np0_0  0         5          ce0
np0_1  0         9          ce1
np1_0  0         13         ce2
np1_1  0         17         ce3
np2_0  0         115        ce13
np2_1  0         111        ce12
np3_0  0         123        ce15
np3_1  0         119        ce14
------ --------- ---------- ------------
* Max_speed: Maximum speed, Dflt_speed: Default speed
* SW_port_id: Switch port ID, SW_port_name: Switch port name
```

For more example output for different FortiGate models, see FortiGate NP7 architectures on page 79.

You can also use the following command to view the features enabled or disabled on the NP7 processors in your FortiGate unit:

```
diagnose  npu np7 system-config
default_qos_type        : shaping (1)
max_sse_tmo             : 40 (seconds)
per_sess_accounting     : enabled-by-log (0)
sess_acct_intvl         : 5 (seconds)
mcast_sess_accounting   : tpe-based (0)
ip_assembly             : disabled
ip_assembly_min_tmo     : 64 (us)
ip_assembly_max_tmo     : 10000 (us)
```

NP7 performance optimized over KR links

The NP7 processor has a bandwidth capacity of 200-Gigabit. If all of the FortiGate front panel interfaces are operating at their maximum bandwidth, the NP7 processor would not be able to offload all the traffic. Traffic passes to each NP7 processor over two 100-Gigabit KR links that are numbered 0 and 1. With default configuration, these two 100G links operate as a LAG. Traffic coming from front panel interfaces are distributed evenly across the LAG.

Bandwidth control for NPU accelerated VDOM link interfaces

NP7 processors include a module called the Virtual Egress Processor (VEP) that processes all traffic that passes through NPU accelerated VDOM link interfaces, including interfaces that have been added to NPU accelerated VDOM link interfaces (for example VLANs).

VEP allows you to tune improve overall performance by keeping accelerated VDOM link interfaces from consuming excessive NP7 bandwidth. By default, VEP imposes the following maximum bandwidth allocations on NPU accelerated VDOM link interfaces:

- Maximum bandwidth supported across an NPU accelerated VDOM link with multiple sessions is 200Gbps.
- Maximum bandwidth supported across an NPU accelerated VDOM link with one session is 100Gbps.

You can use the following command to change the VEP mode:

```
diagnose npu np7 vep-mode {100G-2 | 100G | 50G-4 | 50G-2 | 50G}
```

`100G-2` the default VEP mode. Multiple session bandwidth limited to 200Gbps. Single session bandwidth limited to 100Gbps.

`100G` both multiple session and single-session bandwidth limited to 100Gbps.

`50G-4` multiple session bandwidth limited to 200Gbps. Single session bandwidth limited to 50Gbps.

`50G-2` multiple session bandwidth limited to 100Gbps. Single session bandwidth limited to 50Gbps.

`50G` multiple session bandwidth limited to 50Gbps. Single session bandwidth limited to 50Gbps.

After using this command to select a VEP mode, you must manually restart the FortiGate for the new VEP mode to take affect.

The VEP mode is applied per NP7 processor. If your FortiGate has multiple NP7 processors, they will all operate in the same VEP mode.

Controlling the maximum outgoing VLAN bandwidth

When configuring a VLAN interface, you can use the `outbandwidth` option to set the maximum outgoing bandwidth that traffic over the VLAN interface can use.

```
config system interface
   edit "vlan11-vdom1"
      set vdom "vdom1"
      ...
      set outbandwidth <max-bandwidth>
      ...
      set interface "npu0_vlink0"
      set vlanid 11
   end
```

`<max-bandwidth>` set the maximum outgoing bandwidth in kbps for the VLAN interface. The default is 0 which means no maximum. The range is 0 to 100000000 kbps.

Controlling outgoing VLAN bandwidth can be useful for limiting the amount of bandwidth used by a VLAN interface added to an NPU accelerated VDOM link interface. The NP7 virtual egress processor (VEP) controls the amount of bandwidth that can be used by NPU accelerated VDOM link interfaces. If you are experiencing VEP over subscription

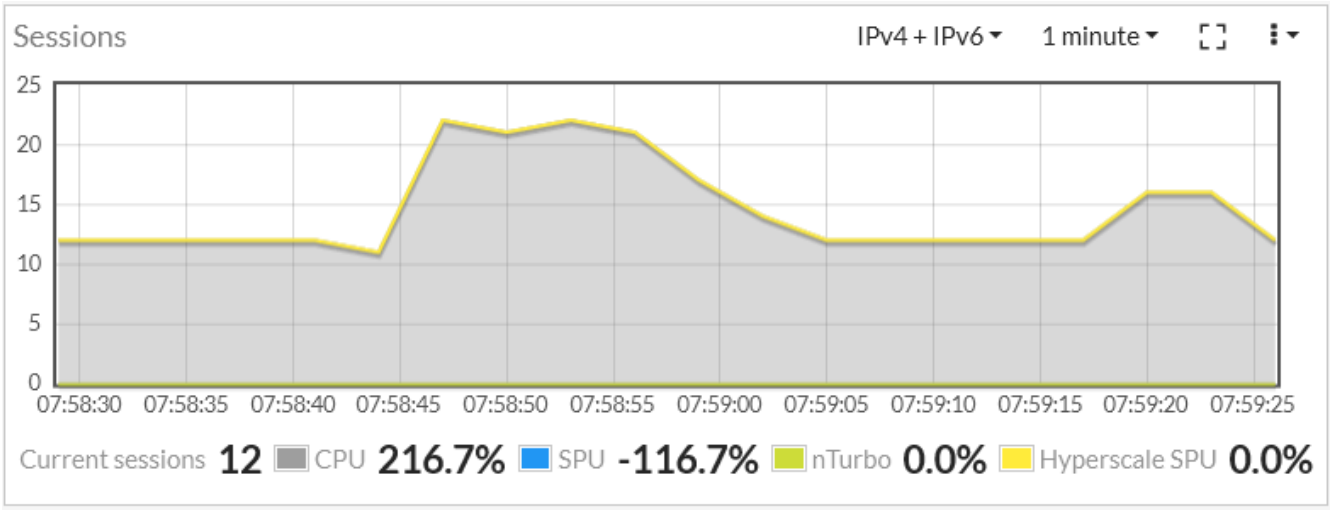
issues due to the amount of traffic passing through VLAN interfaces added to NPU accelerated VDOM link interfaces, you can use the VLAN interface `outbandwidth` option to control the amount of traffic that can pass through the VLAN interface. For more information about VEP, see Bandwidth control for NPU accelerated VDOM link interfaces on page 37.

Per-session accounting for offloaded NP7 sessions

Per-session accounting is an NP7 hardware logging feature that allows the FortiGate to report the correct bytes/pkt numbers per session for sessions offloaded to an NP7 processor. This information appears in traffic log messages as well as in FortiView. The following example shows the Sessions dashboard widget tracking SPU and nTurbo sessions. **Current sessions** shows the total number of sessions, **CPU** shows the percent of sessions handled by the CPU, **SPU** shows the percentage of these sessions that are SPU sessions, and **Nturbo** shows the percentage that are nTurbo sessions.

If your FortiGate is licensed for hyperscale firewall features, the Sessions widget also includes **Hyperscale**, which shows the percentage of the sessions set up by NP7 processors using hardware session setup. For information about hyperscale firewall functionality, see the Hyperscale Firewall Guide.

You can also enable per-session accounting separately for TCP multicast sessions.



Enabling per-session accounting

You configure per-session accounting for the FortiGate, all NP7s in the FortiGate have the same per-session accounting configuration. Use the following command to enable per-session accounting:

```
config system npu
   set per-session-accounting { disable | enable | traffic-log-only}
end
```

`disable` turns off per-session accounting.

`enable` enables per-session accounting for all traffic offloaded by the NP7 processor.

`traffic-log-only` (the default) turns on NP7 per-session accounting for traffic accepted by firewall policies that have traffic logging enabled.

Enabling per-session accounting can affect NP7 offloading performance.

Enabling multicast per-session accounting

You can use the following command to configure multicast per-session accounting:

```
config system npu
   set mcast-session-accounting {tpe-based | session-based | disable}
end
```

`tpe-based` (the default) enables TPE-based multicast session accounting. TPE is the NP7 accounting and traffic shaping module. In most cases, if you want multicast session accounting, you should select `tpe-based` for optimal performance and reliability. This setting may be incompatible with some traffic. If problems such as packet order issues occur, you can disable multicast session accounting or select `session-based` multicast accounting.

`session-based` enables session-based multicast session accounting.

`disable` disables multicast session accounting.

Generally speaking, session-based accounting has better performance than TPE-based when there are high number of multicast sessions (on the order of 7,000 sessions, depending on network and other conditions).

TPE-based accounting, generally can have better performance when there are a fewer multicast sessions with very high throughput.

Per-session accounting can affect offloading performance. So you should only enable per-session accounting if you need the accounting information.

Enabling per-session accounting does not provide traffic flow data for sFlow or NetFlow.

Changing the per-session accounting interval

Use the following command to configure how often NP7 processors send per-session accounting log messages

```
config system npu
   set session-acct-interval <interval>
end
```

The default is to send session accounting log messages every 5 seconds and the range is 1 to 10 seconds. Increase the interval to reduce bandwidth usage.

Increasing NP7 offloading capacity using link aggregation groups (LAGs)

NP7 processors can offload sessions received by interfaces in link aggregation groups (LAGs) (IEEE 802.3ad). A 802.3ad Link Aggregation and it's management protocol, Link Aggregation Control Protocol (LACP) LAG combines more than one physical interface into a group of interfaces that functions like a single interface with a higher capacity than a single physical interface. NP7 processors use CRC16 hashing to distribute sessions to the interfaces in the LAG. For

example, you could use a LAG if you want to offload sessions on a 100 Gbps link by adding four 25-Gbps interfaces to the same LAG.

All offloaded traffic types are supported by LAGs. Just like with normal interfaces, traffic accepted by a LAG is offloaded by the NP7 processor connected to the interfaces in the LAG that receive the traffic to be offloaded. If all interfaces in a LAG are connected to the same NP7 processor, traffic received by that LAG is offloaded by that NP7 processor. The amount of traffic that can be offloaded is limited by the capacity of the NP7 processor.

If a FortiGate has two or more NP7 processors connected by an integrated switch fabric (ISF), you can use LAGs to increase offloading by sharing the traffic load across multiple NP7 processors. You do this by adding physical interfaces connected to different NP7 processors to the same LAG.

Adding a second NP7 processor to a LAG effectively doubles the offloading capacity of the LAG. Adding a third further increases offloading. The actual increase in offloading capacity may not actually be doubled by adding a second NP7 or tripled by adding a third. Traffic and load conditions and other factors may limit the actual offloading result.

The increase in offloading capacity offered by LAGs and multiple NP7s is supported by the integrated switch fabric (ISF) that allows multiple NP7 processors to share session information.

There is also the following limitation to LAG NP7 offloading support for IPsec VPN:

- Because the encrypted traffic for one IPsec VPN tunnel has the same 5-tuple, the traffic from one tunnel can only can be balanced to one interface in a LAG. This limits the maximum throughput for one IPsec VPN tunnel in an NP7 LAG group to 100Gbps (since each NP7 is connected to the ISF using two 100Gbps interfaces).

NP7 processors and redundant interfaces

NP7 processors can offload sessions received by interfaces that are part of a redundant interface. You can combine two or more physical interfaces into a redundant interface to provide link redundancy. Redundant interfaces ensure connectivity if one physical interface, or the equipment on that interface, fails. In a redundant interface, traffic travels over one interface at a time. This differs from an aggregated interface where traffic is distributed over all of the interfaces in the group.

All offloaded traffic types are supported by redundant interfaces. Just like with normal interfaces, traffic accepted by a redundant interface is offloaded by the NP7 processor connected to the interfaces in the redundant interface.

If all interfaces in a redundant interface are connected to the same NP7 processor, traffic received by that redundant interface is offloaded by that NP7 processor. The amount of traffic that can be offloaded is limited by the capacity of the NP7 processor.

If a FortiGate has two or more NP7 processors connected by an integrated switch fabric (ISF), you can create redundant interfaces that include physical interfaces connected to different NP7 processors. However, with a redundant interface, only one of the physical interfaces is processing traffic at any given time. So you cannot use redundant interfaces to increase performance in the same way as you can with aggregate interfaces.

The ability to add redundant interfaces connected to multiple NP7s is supported by the integrated switch fabric (ISF) that allows multiple NP7 processors to share session information.

Configuring inter-VDOM link acceleration with NP7 processors

FortiGates with NP7 processors include NPU VDOM links that can be used to accelerate inter-VDOM traffic. One NPU VDOM link and two NPU VDOM link interfaces are available for each NP7 processor.

For example, the FortiGate-4200F includes four NP7 processors (npu0 to npu3) and eight NPU VDOM link interfaces:

- npu0_vlink0
- npu0_vlink1
- npu1_vlink0
- npu1_vlink1
- npu2_vlink0
- npu2_vlink1
- npu3_vlink0
- npu3_vlink1

While the FortiGate-1800F includes one NP7 processor (npu0) and two NPU VDOM link interfaces:

- npu0_vlink0
- npu0_vlink1

These interfaces are visible from the GUI and CLI when VDOMs are enabled. Use the following CLI command to display the FortiGate-4200F NPU VDOM link interfaces:

```
get system interface | grep vlink
== [ npu0_vlink0 ]
name: npu0_vlink0   mode: static    ip: 0.0.0.0 0.0.0.0   status: up    netbios-forward:
disable    type: physical   netflow-sampler: disable    sflow-sampler: disable    scan-
botnet-connections: disable    src-check: enable    mtu-override: disable    wccp: disable
 drop-overlapped-fragment: disable    drop-fragment: disable
== [ npu0_vlink1 ]
name: npu0_vlink1   mode: static    ip: 0.0.0.0 0.0.0.0   status: up    netbios-forward:
disable    type: physical   netflow-sampler: disable    sflow-sampler: disable    scan-
botnet-connections: disable    src-check: enable    mtu-override: disable    wccp: disable
 drop-overlapped-fragment: disable    drop-fragment: disable
...
```

By default the NPU VDOM link interfaces are assigned to the root VDOM. To use these interfaces to accelerate inter-VDOM traffic, assign each interface to the VDOMs that you want to offload traffic between. For example, if you have added a VDOM named New-VDOM, you can go to **System > Network > Interfaces**, edit the **npu0_vlink1** interface, and set the **Virtual Domain** to **New-VDOM**. This results in an accelerated inter-VDOM link between root and New-VDOM. You can also do this from the CLI:

```
config system interface
  edit npu0_vlink1
    set vdom New-VDOM
end
```

See Hyperscale firewall inter-VDOM link acceleration for information about how to set up inter-VDOM links if hyperscale firewall support is enabled.

Using VLANs to add more accelerated inter-VDOM links

You can add VLAN interfaces to the NPU VDOM link interfaces to create inter-VDOM links between more VDOMs. For the links to work, the VLAN interfaces must be added to the same NPU VDOM link interface, must be on the same subnet, and must have the same VLAN ID.

For example, to accelerate inter-VDOM traffic between VDOMs named Marketing and Engineering using VLANs with VLAN ID 100, go to **System > Network > Interfaces** and select **Create New** to create the VLAN interface associated with the Marketing VDOM:

Name	Marketing-link
Type	VLAN
Interface	npu0_vlink0
VLAN ID	100
Virtual Domain	Marketing
IP/Network Mask	172.20.120.12/24

Create the VLAN associated with Engineering VDOM:

Name	Engineering-link
Type	VLAN
Interface	npu0_vlink1
VLAN ID	100
Virtual Domain	Engineering
IP/Network Mask	172.20.120.22/24

Or do the same from the CLI:

```
config system interface
   edit Marketing-link
      set vdom Marketing
      set ip 172.20.120.12/24
      set interface npu0_vlink0
      set vlanid 100
   next
   edit Engineering-link
      set vdom Engineering
      set ip 172.20.120.22/24
      set interface npu0_vlink1
      set vlanid 100
   end
```

Confirm that the traffic is accelerated

Use the following diagnose commands to obtain the interface index of NP7 inter-VDOM link interfaces and then correlate them with the session entries to verify that sessions through these inter-VDOM links are offloaded. In the following

example, traffic was flowing between new accelerated inter-VDOM links and physical interfaces port1 and port2.

```
diagnose ip address list
IP=172.31.17.76->172.31.17.76/255.255.252.0 index=5 devname=port1
IP=10.74.1.76->10.74.1.76/255.255.252.0 index=6 devname=port2
IP=172.20.120.12->172.20.120.12/255.255.255.0 index=55 devname=IVL-VLAN1_ROOT
IP=172.20.120.22->172.20.120.22/255.255.255.0 index=56 devname=IVL-VLAN1_VDOM1

diagnose sys session list
session info: proto=1 proto_state=00 duration=282 expire=24 timeout=0 session info:
     proto=1 proto_state=00 duration=124 expire=59 timeout=0 flags=00000000
     sockflag=00000000 sockport=0 av_idx=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0 policy_dir=0 tunnel=/
state=may_dirty npu
statistic(bytes/packets/allow_err): org=180/3/1 reply=120/2/1 tuples=2
orgin->sink: org pre->post, reply pre->post dev=55->5/5->55
     gwy=172.31.19.254/172.20.120.22
hook=post dir=org act=snat 10.74.2.87:768->10.2.2.2:8(172.31.17.76:62464)
hook=pre dir=reply act=dnat 10.2.2.2:62464->172.31.17.76:0(10.74.2.87:768)
misc=0 policy_id=4 id_policy_id=0 auth_info=0 chk_client_info=0 vd=0
serial=0000004e tos=ff/ff ips_view=0 app_list=0 app=0
dd_type=0 dd_mode=0
per_ip_bandwidth meter: addr=10.74.2.87, bps=880
npu_state=00000000
npu info: flag=0x81/0x81, offload=9/9, ips_offload=0/0, epid=160/218, ipid=218/160,
     vlan=32769/0


session info: proto=1 proto_state=00 duration=124 expire=20 timeout=0 flags=00000000
     sockflag=00000000 sockport=0 av_idx=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0 policy_dir=0 tunnel=/
state=may_dirty npu
statistic(bytes/packets/allow_err): org=180/3/1 reply=120/2/1 tuples=2
orgin->sink: org pre->post, reply pre->post dev=6->56/56->6 gwy=172.20.120.12/10.74.2.87
hook=pre dir=org act=noop 10.74.2.87:768->10.2.2.2:8(0.0.0.0:0)
hook=post dir=reply act=noop 10.2.2.2:768->10.74.2.87:0(0.0.0.0:0)
misc=0 policy_id=3 id_policy_id=0 auth_info=0 chk_client_info=0 vd=1
serial=0000004d tos=ff/ff ips_view=0 app_list=0 app=0
dd_type=0 dd_mode=0
per_ip_bandwidth meter: addr=10.74.2.87, bps=880
npu_state=00000000
npu info: flag=0x81/0x81, offload=9/9, ips_offload=0/0, epid=219/161, ipid=161/219,
     vlan=0/32769
total session 2
```

Reassembling and offloading fragmented packets

NP7 processors support reassembling and offloading fragmented IPv4 and IPv6 packets. The NP7 processor uses defrag/reassembly (DFR) to re-assemble fragmented packets. The NP7 can re-assemble and offload packets that have been fragmented into two packets (1 header and 1 packet fragment). Traffic that has been fragmented into more that two packets is handled by the CPU.

Reassembling and offloading fragmented packets is disabled by default and all fragmented packets are handled by the CPU. If your system is processing relative large amounts of fragmented packets, you can use the following command to improve performance by reassembling and offloading them using NP7 processors:

```
config system npu
   config ip-reassembly
      set status {disable | enable}
      set min_timeout <micro-seconds>
      set max_timeout <micro-seconds>
   end
```

Where:

`status`, enable or disable IP reassembly. IP reassembly is disabled by default.

`min_timeout` is the minimum timeout value for IP reassembly in the range 5 to 600,000,000 µs (micro seconds). The default min-timeout is 64 µs.

`max_timeout` is the maximum timeout value for IP reassembly 5 to 600,000,000 µs. The default max-timeout is 1000 µs.

The timeouts are quite sensitive and may require tuning to get best performance depending on your network and FortiGate configuration and traffic mix.

The CLI help uses `us` to represent µs or micro seconds.

NP7 traffic shaping

By default, if you configure traffic shaping for a FortiGate with NP7 processors, traffic shaping is applied to offloaded traffic by applying traffic shaping with policing.

You can use the following command to configure NP7 processors to switch between traffic shaping with policing and traffic shaping with queuing:

```
config system npu
   set default-qos-type {policing | shaping}
end
```

`policing`, (the default) NP7 processors apply traffic shaping with policing using the NP7 accounting and traffic shaping module (called theTPE module). When traffic exceeds configured traffic shaping bandwidth limits, traffic is dropped.

`shaping`, enable traffic shaping with queuing using the NP7 Queuing based Traffic Management (QTM) module. Traffic shaping with queuing schedules traffic in queues by implementing variations of a round robin algorithm. When traffic

exceeds configured traffic shaping bandwidth limits, traffic is delayed for transport until bandwidth frees up. Traffic may be dropped if the queues are full. In most cases, traffic shaping with queuing will be more stable and will also improve performance for traffic shaping applied by NP7 processors.

The FortiGate restarts after changing the QoS type.

Traffic shaping with queuing using the NP7 QTM module is not compatible with carrier-grade NAT and hyperscale firewall features. If you enable the hyperscale firewall license you cannot set `default-qos-type` to `shaping`.

Disabling offloading IPsec Diffie-Hellman key exchange

You can use the following command to disable using ASIC offloading to accelerate IPsec Diffie-Hellman key exchange for IPsec ESP traffic. By default hardware offloading is used. For debugging purposes or other reasons you may want this function to be processed by software.

Use the following command to disable using ASIC offloading for IPsec Diffie-Hellman key exchange:

```
config system global
   set ipsec-asic-offload disable
end
```

Access control lists (ACLs)

Access Control Lists (ACLs) use NP7 offloading to drop IPv4 or IPv6 packets at the physical network interface before the packets are analyzed by the CPU. On a busy appliance this can really help the performance.

The ACL feature is available only on FortiGates with NP7-accelerated interfaces. ACL checking is one of the first things that happens to the packet and checking is done by the NP7 processor. The result is very efficient protection that does not use CPU or memory resources.

Use the following command to configure IPv4 ACL lists:

```
config firewall acl
   edit 0
      set status enable
      set interface <interface-name>
      set srcaddr <firewall-address>
      set dstaddr <firewall-address>
      set service <firewall-service>
   end
```

Use the following command to configure IPv6 ACL lists:

```
config firewall acl6
   edit 0
      set status enable
      set interface <interface-name>
      set srcaddr <firewall-address6>
      set dstaddr <firewall-address6>
      set service <firewall-service>
```

```
   end
```

Where:

`<interface-name>` is the interface on which to apply the ACL. There is a hardware limitation that needs to be taken into account. The ACL is a Layer 2 function and is offloaded to the ISF hardware, therefore no CPU resources are used in the processing of the ACL. It is handled by the inside switch chip which can do hardware acceleration, increasing the performance of the FortiGate. The ACL function is only supported on switch fabric driven interfaces.

`<firewall-address> <firewall-address6>` can be any of the address types used by the FortiGate, including address ranges. The traffic is blocked not on an either or basis of these addresses but the combination of the two, so that they both have to be correct for the traffic to be denied. To block all of the traffic from a specific address all you have to do is make the destination address `ALL`.

Because the blocking takes place at the interface based on the information in the packet header and before any processing such as NAT can take place, a slightly different approach may be required. For instance, if you are trying to protect a VIP which has an external address of x.x.x.x and is forwarded to an internal address of y.y.y.y, the destination address that should be used is x.x.x.x, because that is the address that will be in the packet's header when it hits the incoming interface.

`<firewall-service>` the firewall service to block. Use `ALL` to block all services.

DoS policy hardware acceleration

DoS policy hardware acceleration offloads processing required for IPv4 and IPv6 DoS policies, interface policies, and access control list (ACL) policies to NP7 processors.

Use the following command to configure DoS policy offloading:

```
config system npu
   set policy-offload-level {dos-offload | full-offload}
      config dos-options
         set npu-dos-meter-mode {global | local}
         set npu-dos-tpe-mode {disable | enable}
      end
```

`policy-offload-level` can be set to `dos-offload` or `full-offload` to support DoS policy hardware acceleration. `full-offload` is only available if your FortiGate is licensed for hyperscale firewall support.

`npu-dos-meter-mode` select `global` (the default) to configure DoS metering across all NP7 processors. Select `local` to configure metering per NP7 processor.

DoS metering controls how the threshold for each configured anomaly is distributed among NP7 processors. For example, for a FortiGate with four NP7 processors and the `tcp_syn_flood` anomaly threshold set to 400. If `npu-dos-meter-mode` is set to `global`, the threshold of 400 is divided between the NP7 processors and the `tcp_syn_flood` threshold would be set to 100 for each NP7 (for a total threshold of 400 for the FortiGate). If `npu-dos-meter-mode` is set to `local`, then each NP7 would have a threshold of 400 (for a total threshold of 1600 for a FortiGate with four NP7 processors).

`npu-dos-tpe-mode` select `enable` (the default) to insert the dos meter ID into the session table. Select `disable` if you don't want to insert the DoS meter into the session table. If set to enable, UDP_FLOOD and ICMP_FLOOD DoS protection applies to offloaded sessions. If set to disable, UDP_FLOOD and ICMP_FLOOD DoS protection will not apply to offloaded sessions.

NP7 DoS offloading does not offload processing for all DoS policy anomalies. The following table shows that some anomaly sessions are offloaded to NP7 processors and some are handled by the CPU. In addition, when `full-offload` is enabled, more types of anomaly processing are handled by NP7 processors than when `dos-offload` is selected.

NP7 processors offload DoS sessions differently depending on the policy offload level:

DoS policy anomaly	dos-offload selected	full-offload selected
tcp_syn_flood	NP7	NP7
tcp_port_scan	NP7	NP7
tcp_src_session	NP7	NP7
tcp_dst_session	NP7	NP7
udp_flood	NP7	NP7
udp_scan	CPU	NP7
udp_src_session	CPU	NP7
udp_dst_session	CPU	NP7
icmp_flood	NP7	NP7
icmp_sweep	CPU	CPU
icmp_src_session	CPU	CPU
icmp_dst_session	CPU	CPU
ip_src_session	TCP sessions are offloaded to NP7 processors. Other sessions are handled by the CPU.	TCP and UDP sessions are offloaded to NP7 processors. Other sessions are handled by the CPU.
ip_dst_session	TCP sessions are offloaded to NP7 processors. Other sessions are handled by the CPU.	TCP and UDP sessions are offloaded to NP7 processors. Other sessions are handled by the CPU.
sctp_flood	CPU, because the NP7 processor can only send sctp-init packets to MSE	CPU
sctp_scan	CPU	CPU
sctp_src_session	CPU	CPU
sctp_dst_session	CPU	CPU

Distributing HA session synchronization packets to multiple CPUs

FortiGates with NP7 processors support using the following command to synchronize HA session sync packets to multiple CPUs:

```
config system ha
```

```
   set sync-packet-balance {disable | enable}
end
```

If your FortiGate with NP7 processors is processing a large number of HA session sync packets, enabling `sync-packet-balance` can improve performance if you have enabled the `session-sync-dev` option of your HA configuration. Enabling `sync-packet-balance` can also improve performance if you are using HA or AUX interfaces for session sync traffic.

NP7 Host Protection Engine (HPE)

The NP7 host protection engine (HPE) uses NP7 processors to protect the FortiGate CPU from excessive amounts of ingress traffic, which typically occurs during DDoS attacks or network problems (for example an ARP flood due to a network loop). You can use the HPE to prevent ingress traffic received on data interfaces connected to NP7 processors from overloading the FortiGate CPU.

You configure the HPE by enabling it and setting traffic thresholds. The HPE then acts like a traffic shaper, dropping packets that exceed the configured traffic thresholds. You can enable HPE monitoring to record log messages when the HPE drops packets. You can also run the HPE with monitoring enabled but without dropping packets. Using these tools you can monitor HPE activity and set HPE threshold values that are low enough to protect the CPU and high enough to not impact legitimate traffic.

The HPE does not affect offloaded traffic, just CPU traffic. The HPE is not as granular as DoS policies and should be used as a first level of protection.

DoS policies can be used as a second level of protection. NP7 processors support offloading DoS policies. For information about DoS policies, see DoS protection.

You can use the following command to configure the HPE.

```
config system npu
   config hpe
      set enable-shaper {disable | enable}
      set all-protocol <packets-per-second>
      set tcpsyn-max <packets-per-second>
      set tcpsyn-ack-max <packets-per-second>
      set tcpfin-rst-max <packets-per-second>
      set tcp-max <packets-per-second>
      set udp-max <packets-per-second>
      set icmp-max <packets-per-second>
      set sctp-max <packets-per-second>
      set esp-max <packets-per-second>
      set ip-frag-max <packets-per-second>
      set ip-others-max <packets-per-second>
      set arp-max <packets-per-second>
      set l2-others-max <packets-per-second>
      set high-priority <packets-per-second>
   end
```

NP7 HPE recommended configuration

The optimal way to set up the NP7 HPE is to set the `all-protocol` option to a maximum packet rate threshold that protects the FortiGate CPU from excessive traffic. If `all-protocol`is set to a value other than 0, the number of host

packets received for all traffic of all packet types that the HPE shapes is controlled by the `all-protocol` threshold. By default `all-protocol` is set to 400000. This default threshold is designed to work well for most FortiGates and most networks.

You can use HPE monitoring to verify how many packets the HPE is actually dropping and adjust the `all-protocol` threshold. See Monitoring NP7 HPE activity on page 53. You can also use the `diagnose npu np7 monitor-hpe` command to monitor HPE activity without dropping packets. See Monitor HPE activity without dropping packets on page 53.

If you set `all-protocol` to 0, you can configure thresholds for individual traffic types, see NP7 HPE for individual traffic types on page 50.

The HPE also includes an overflow option for high-priority traffic, see NP7 HPE and high priority traffic on page 51.

NP7 HPE packet flow and host queues

The NP7 HPE configuration is applied to all NP7 processors in the FortiGate. Each NP7 processor has multiple host queues and each HPE packets-per-second setting is applied separately to each host queue. The actual amount of traffic allowed by an HPE threshold depends on the number of host queues that the NP7 processor has. You can use the following command to see the number of host queues of the NP7 processors in your FortiGate.

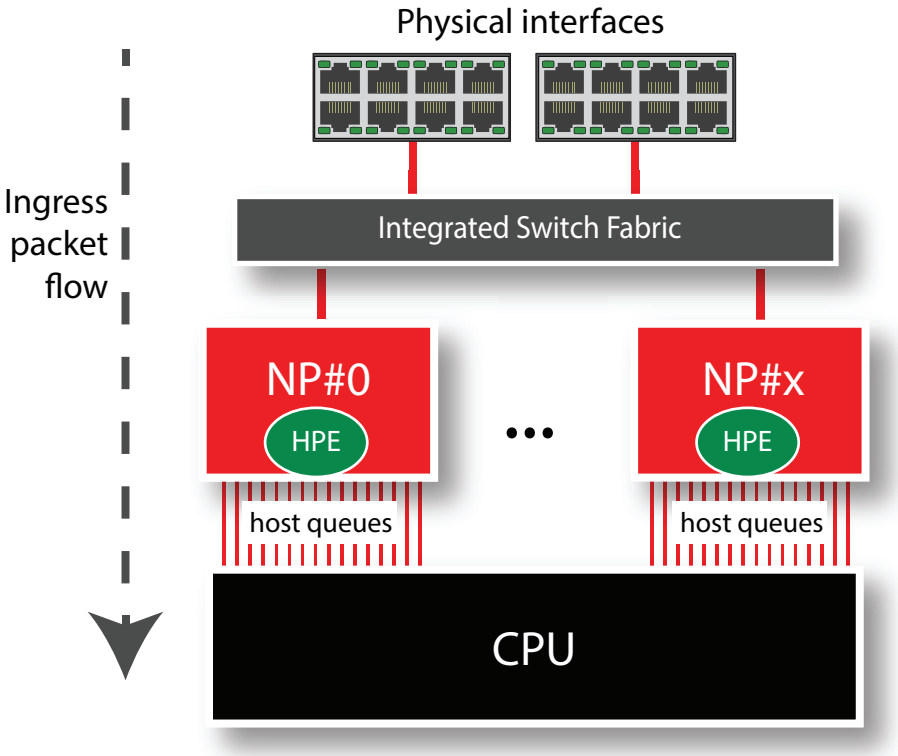
For example, for a FortiGate-1800F, the following command output shows that the number of host queues is 16 (`hif->nr_ring:16`).

```
diagnose npu np7 hpe | grep ring
PE HW pkt_credit:29632 , tsref_inv:20000, tsref_gap:32, hpe_refskip:0 , hif->nr_ring:16
```

Based on the number of host queues, you can calculate the total number of packets per second allowed for a given HPE threshold. Some examples:

- The FortiGate-1800F has one NP7 processor and all front panel data interfaces are connected to this NP7 processor over the integrated switch fabric. The default `all-protocol` setting of 400000 limits the total number of host packets per second that the FortiGate-1800F can process to 400000 x 16 = 6,400,000 host packets per second.
- The FortiGate-4400F has six NP7 processors and each NP7 processor has 40 host queues. All front panel data interfaces are connected to all NP7 processors over the integrated switch fabric. The default `all-protocol` setting of 400000 limits the total number of host packets per second that the FortiGate-4400F can process to 400000 x 40 x 6 = 96,000,000 host packets per second.
- If `all-protocol` is set to 0, the limits applied by individual HPE options are also calculated in the same way. For example, the FortiGate-4200F has four NP7 processors and each NP7 processor has 40 host queues. All front panel data interfaces are connected to all NP7 processors over the integrated switch fabric. If `all-protocol` is set to 0, the default `tcpsyn-ack-max` setting of 40000 limits the of total number of TCP SYN_ACK host packets per second that the FortiGate-4200F can process to 40000 x 40 x 4 = 6,400,000 TCP SYN_ACK host packets per second.

HPE packet flow with multiple NP7 processors



NP7 HPE for individual traffic types

If you want to set different maximum packet rates for different packet types, you can disable `all-protocol` by setting it 0. When you do this, the NP7 HPE supports setting individual limits for the following traffic types:

- TCP SYN
- TCP SYN_ACK
- TCP FIN and RST
- TCP
- UDP
- ICMP
- SCTP
- ESP
- Fragmented IP packets
- Other types of IP packets
- ARP
- Other layer-2 packets that are not ARP packets

The following table lists and describes the HPE options for individual traffic types.

Option	Description	Default
tcpsyn-max	Limit the maximum number of TCP SYN packets received per second per host queue. The range is 1000 to 40000000 pps.	40000
tcpsyn-ack-max	Prevent SYN_ACK reflection attacks by limiting the number of TCP SYN_ACK packets received per second per host queue. The range is 1000 to 40000000 pps. TCP SYN_ACK reflection attacks consist of an attacker sending large amounts of SYN_ACK packets without first sending SYN packets. These attacks can cause high CPU usage because the firewall assumes that these SYN_ACK packets are the first packets in a session, so the packets are processed by the CPU instead of the NP7 processors. The range is 1000 to 40000000 pps.	40000
tcpfin-rst-max	Limit the maximum number of TCP FIN and RST packets received per second per host queue. The range is 1000 to 40000000 pps.	40000
tcp-max	Limit the maximum number of TCP packets received per second per host queue that are not filtered by tcpsyn-max, tcpsyn-ack-max, or tcpfin-rst-max. The range is 1000 to 40000000 pps.	40000
udp-max	Limit the maximum number of UDP packets received per second per host queue. The range is 1000 to 40000000 pps.	40000
icmp-max	Limit the maximum number of ICMP packets received per second per host queue. The range is 1000 to 40000000 pps.	5000
sctp-max	Limit the maximum number of SCTP packets received per second per host queue. The range is 1000 to 40000000 pps.	5000
esp-max	Limit the maximum number of ESP packets received per second per host queue. The range is 1000 to 40000000 pps.	5000
ip-frag-max	Limit the maximum number of fragmented IP packets received per second per host queue. The range is 1000 to 40000000 pps.	5000
ip-others-max	Limit the maximum number of other types of IP packets received per second per host queue. Other packet types are IP packets that cannot be set with other HPE options. The range is 1000 to 40000000 pps.	5000
arp-max	Limit the maximum number of ARP packets received per second per host queue. The range is 1000 to 40000000 pps.	5000
l2-others-max	Limit the maximum number of other layer-2 packets that are not ARP packets received per second per host queue. The range is 1000 to 40000000 pps. This option limits HA heartbeat, HA session sync, LACP/802.3ad, FortiSwitch heartbeat, and wireless-controller CAPWAP packets.	5000

NP7 HPE and high priority traffic

The NP7 HPE high-priority option allows you to set a maximum overflow limit for high-priority traffic. The range is 1000 to 40000000 packets per second per host queue. The default high-priority setting is 40000.

By default, the high-priority overflow is applied to the following types of traffic that are treated as high-priority by the NP7 processor:

- HA heartbeat
- LACP/802.3ad
- OSPF
- BGP
- IKE
- SLBC
- BFD

The `high-priority` setting adds an overflow for high priority traffic, causing the HPE to allow more of these high priority packets.

The overflow is added to the maximum number of packets allowed by the HPE based on other HPE settings. For example, by default, the HPE limits IKE traffic to `all-protocol` + `pri-type-max` pps, which works out to 400000 + 40000 = 440,000 packets per second per host queue.

The protocols that are considered high-priority by the HPE are defined by the configuration of the following command:

```
config system npu
   config np-queues
end
```

You can use this command to add or remove high-priority traffic types. For more information, see Configuring NP7 queue protocol prioritization on page 70.

Adjusting NP7 HPE BGP, SLBC, and BFD priorities

Use the following command to adjust the priority of BGP, SLBC, and BFD traffic to control whether the NP7 HPE treats these traffic types as high-priority traffic

```
config system npu
   config priority-protocol
      set bgp {disable | enable}
      set slbc {disable | enable}
      set bfd {disable | enable}
   end
```

By default, all options are set to `enable` and BGP, SLBC, and BFD packets are treated by the HPE as high priority traffic subject to high-priority overflow. In some cases, the overflow can allow excessive amounts of BGP, SLBC, and BFD host traffic that can cause problems such as route flapping and CPU spikes. If you encounter this problem, or for other reasons you can use this command to set BGP, SLBC, or BFD traffic to low priority, bypassing the HPE `high-prioity` overflow. For example, if your FortiGate is not processing one or more of these traffic types, you can set them to low priority to limit the amount of the selected type of packets allowed by the HPE.

Changing these traffic types to low priority can cause problems if your FortiGate is actively processing traffic. Fortinet recommends that you make changes with this command during a maintenance window and then monitor your system to make sure its working properly once it gets busy again.

Monitoring NP7 HPE activity

You can use the following command to generate event log messages when the NP7 HPE blocks packets:

```
config monitoring npu-hpe
   set status {disable | enable}
   set interval <interval>
   set multipliers <m1>, <m2>, ... <m12>
end
```

`status` enable or disable HPE status monitoring.

`interval` HPE status check interval in seconds. The range is 1 to 60 seconds. The default interval is 1 second.

`multipliers` set 12 multipliers to control how often an event log message is generated for each HPE packet type in the following order:

- `tcpsyn-max` default 4
- `tcpsyn-ack-max` default 4
- `tcpfin-rst-max` default 4
- `tcp-max` default 4
- `udp-max` default 8
- `icmp-max` default 8
- `sctp-max` default 8
- `esp-max` default 8
- `ip-frag-max` default 8
- `ip-others-max` default 8
- `arp-max` default 8
- `l2-others-max` default 8

An event log is generated after every (`interval x multiplier`) seconds for each HPE option when drops occur for that HPE type. Increase the interval or individual multipliers to generate fewer event log messages.

An attack log message is generated after every (4 x `multiplier`) continuous event logs.

Example HPE monitoring configuration

```
config monitoring npu-hpe
   set status enable
   set interval 2
   set multipliers 3 2 2 2 4 4 4 4 4 4 4 4
end
```

Monitor HPE activity without dropping packets

If you have enabled monitoring using the `config monitoring npu-hpe` command, you can use the following command to monitor HPE activity without causing the HPE to drop packets. This can be useful when testing HPE, allowing you to see how many packets the HPE would be dropping without actually affecting traffic.

```
diagnose npu np7 monitor-hpe {disable | enable}
```

This command is disabled by default. If you enable it, the HPE will not drop packets, but, if monitoring is enabled, will create log messages for packets that would have been dropped.

Since this is a diagnose command, monitoring the HPE without dropping packets will be disabled when the FortiGate restarts.

Sample HPE event log messages

```
date=2021-01-13 time=16:00:01 eventtime=1610582401563369503 tz="-0800"
logid="0100034418" type="event" subtype="system" level="warning" vd="root" logdesc="NP7
HPE is dropping packets" msg="NPU HPE module is stop dropping packet types of:udp in
NP7_0."
```

```
date=2021-01-13 time=16:00:00 eventtime=1610582400562601540 tz="-0800"
logid="0100034418" type="event" subtype="system" level="warning" vd="root" logdesc="NP7
HPE is dropping packets" msg="NPU HPE module is likely dropping packets of one or more
of these types:udp in NP7_0."
```

```
date=2021-01-13 time=15:59:59 eventtime=1610582399558325686 tz="-0800"
logid="0100034419" type="event" subtype="system" level="critical" vd="root"
logdesc="NP7 HPE under a packets flood" msg="NPU HPE module is likely under attack
of:udp in NP7_0."
```

Displaying NP7 HPE configuration and status information

You can use the following diagnose command to display NP7 HPE configuration and status information for one of the NP7 processors in your FortiGate.

```
diagnose npu np7 hpe 2

[NP7_2]
Queue  Type          NPU-min    NPU-max    CFG-min(pps) CFG-max(pps) Pkt-credit
0      high-priority39731      39731      40000        40000        0
0      TCP-syn       39731      39731      40000        40000        0
0      TCP-synack    39731      39731      40000        40000        0
0      TCP-finrst    39731      39731      40000        40000        0
0      TCP           39731      39731      40000        40000        0
0      UDP           39731      39731      40000        40000        0
0      ICMP          19865      19865      20000        20000        0
0      SCTP          19865      19865      20000        20000        0
0      ESP           19865      19865      20000        20000        0
0      IP-Frag       19865      19865      20000        20000        0
0      IP_others     19865      19865      20000        20000        0
0      ARP           19865      19865      20000        20000        0
0      l2_others     19865      19865      20000        20000        0
0      all-protocol  39731      39731      40000        40000        0
------------------------------------------------------------------------------
HPE HW pkt_credit:11080 , tsref_inv:50000, tsref_gap:32, hpe_refskip:0 , hif->nr_ring:40

Note:
 NPU-min and NPU-max: The register reading of max and min value for each queue in NPU.
 CFG-min(pps): the setting value of hpe configuration in CLI command and
```

```
                it is packet per second rate limit for each host rx queue of NPU.
CFG-max(pps): The value is CFG-min of hpe configuration in CLI command.
```

Configuring NP7 processors

You can use the `config system npu` command to configure a wide range of settings for each of the NP7 processors in your FortiGate, including adjusting session accounting and session timeouts. As well you can set anomaly checking for IPv4 and IPv6 traffic.

You can also enable and adjust Host Protection Engine (HPE) settings to protect networks from DoS attacks by categorizing incoming packets based on packet rate and processing cost and applying packet shaping to packets that can cause DoS attacks.

The settings that you configure for an NP7 processor with the `config system npu` command apply to traffic processed by all interfaces connected to that NP7 processor. This includes the physical interfaces connected to the NP7 processor as well as all VLAN interfaces, IPsec interfaces, LAGs, and so on associated with the physical interfaces connected to the NP7 processor.

Some of the following options are only available if your FortiGate is licensed for hyperscale firewall features.

```
config system npu
   set dedicated-management-cpu {disable | enable}
   set ipsec-ob-np-sel {RR | packet | hash}
   set policy-offload-level {disable | dos-offload | full-offload}
   set hash-config {5-tuple | scr-ip}
   set pba-eim {disallow | allow}
   set ippool-overload-low <threshold>
   set ippool-overload-high <threshold>
   set dse-timeout <seconds>
   set tcp-rst-timeout <timeout>
   set napi-break-interval <interval>
   set capwap-offload {disable | enable}
   set default-qos-type {policing | shaping}
   set gtp-support {disable | enable}
   set per-session-accounting {disable | enable | traffic-log-only}
   set per-policy-accounting {disable | enable}
   set session-acct-interval <seconds>
   set max-session-timeout <seconds>
   set hash-tbl-spread {disable | enable}
   set htx-icmp-csum-chk {drop | pass}
   set vlan-lookup-cache {disable | enable}
   set htab-msg-queue {data | idle | dedicated}
   set htab-dedi-queue-nr <number-of-queues>
   set mcast-session-accounting {tpe-based | session-based | disable}
   set inbound-dscp-copy-port <interface> [<interface> ...]
   set ip-fragment-offload {disable | enable}
   set double-level-mcast-offload {disable | enable}
      config port-npu-map
         edit <interface-name>
            set npu-group-index <index>
      config port-path-option
         set ports-using-npu {ha1 ha2 aux1 aux2}
      config dos-options
         set npu-dos-meter-mode {global | local}
```

```
      set npu-dos-tpe-mode {disable | enable}
   config tcp-timeout-profile
      edit {5 | 6 | 7 | ... | 47}
         set tcp-idle <seconds>
         set fin-wait <seconds>
         set close-wait <seconds>
         set time-wait <seconds>
         set syn-sent <seconds>
         set syn-wait <seconds>
   config udp-timeout-profile {5 | 6 | 7 | ... | 63}
      edit {5 | 6 | 7 | ... | 63}
         set udp-idle <seconds>
   config hpe
      set tcpsyn-max <packets-per-second>
      set tcp-max <packets-per-second>
      set udp-max <packets-per-second>
      set icmp-max <packets-per-second>
      set sctp-max <packets-per-second>
      set esp-max <packets-per-second>
      set ip-frag-max <packets-per-second>
      set ip-others-max <packets-per-second>
      set arp-max <packets-per-second>
      set l2-others-max <packets-per-second>
      set pri-type-max <packets-per-second>
      set enable-shaper {disable | enable}
   config priority-protocol
      set bgp {disable | enable}
      set slbc {disable | enable}
      set bfd {disable | enable}
   config fp-anomaly
      set tcp-syn-fin {allow | drop | trap-to-host}
      set tcp-fin-noack {allow | drop | trap-to-host}
      set tcp-fin-only {allow | drop | trap-to-host}
      set tcp-no-flag {allow | drop | trap-to-host}
      set tcp-syn-data {allow | drop | trap-to-host}
      set tcp-winnuke {allow | drop | trap-to-host}
      set tcp-land {allow | drop | trap-to-host}
      set udp-land {allow | drop | trap-to-host}
      set icmp-land {allow | drop | trap-to-host}
      set icmp-frag {allow | drop | trap-to-host}
      set ipv4-land {allow | drop | trap-to-host}
      set ipv4-proto-err {allow | drop | trap-to-host}
      set ipv4-unknopt {allow | drop | trap-to-host}
      set ipv4-optrr {allow | drop | trap-to-host}
      set ipv4-optssrr {allow | drop | trap-to-host}
      set ipv4-optlsrr {allow | drop | trap-to-host}
      set ipv4-optstream {allow | drop | trap-to-host}
      set ipv4-optsecurity {allow | drop | trap-to-host}
      set ipv4-opttimestamp {allow | drop | trap-to-host}
      set ipv4-csum-err {drop | trap-to-host}
      set tcp-csum-err {drop | trap-to-host}
      set udp-csum-err {drop | trap-to-host}
      set icmp-csum-err {drop | trap-to-host}
      set ipv6-land {allow | drop | trap-to-host}
      set ipv6-proto-err {allow | drop | trap-to-host}
      set ipv6-unknopt {allow | drop | trap-to-host}
      set ipv6-saddr-err {allow | drop | trap-to-host}
```

```
      set ipv6-daddr-err {allow | drop | trap-to-host}
      set ipv6-optralert {allow | drop | trap-to-host}
      set ipv6-optjumbo {allow | drop | trap-to-host}
      set ipv6-opttunnel {allow | drop | trap-to-host}
      set ipv6-opthomeaddr {allow | drop | trap-to-host}
      set ipv6-optnsap {allow | drop | trap-to-host}
      set ipv6-optendpid {allow | drop | trap-to-host}
      set ipv6-optinvld {allow | drop | trap-to-host}
   config ip-reassembly
      set min_timeout <micro-seconds>
      set max_timeout <micro-seconds>
      set status {disable | enable}
   config dsw-dts-profile
      edit <profile-id>
         set min-limit <limit>
         set step <number>
         set action {wait | drop | drop_tmr_0 | drop_tmr_1 | enque | enque_0 | enque_1 }
   config dsw-queue-dts-profile
      edit <profile-name>
         set iport <iport>
         set oport <oport>
         set profile-id <profile-id>
         set queue-select <queue-id>
   config np-queues
      config profile
         edit <profile-id>
            set type {cos | dscp}
            set weight <weight>
            set {cos0 | cos1 | ... | cos7} {queue0 | queue1 | ... | queue7}
            set {dscp0 | dscp1 | ... | dscp63} {queue0 | queue1 | ... | queue7}
         end
      config ethernet-type
         edit <ethernet-type-name>
            set type <ethertype>
            set queue <queue>
            set weight <weight>
      config ip-protocol
         edit <protocol-name>
            set protocol <ip-protocol-number>
            set queue <queue>
            set weight <weight>
      config ip-service
         edit <service-name>
            set protocol <ip-protocol-number>
            set sport <port-number>
            set dport <port-number>
            set queue <queue>
            set weight <weight>
      config scheduler
         edit <schedule-name>
            set mode {none | priority | round-robin}
```

dedicated-management-cpu {disable | enable}

Enable dedicating CPU 0 for management tasks. See Dedicated management CPU on page 27. Disabled by default.

ipsec-ob-np-sel {RR | packet | hash}

For future use.

policy-offload-level {disable | dos-offload | full-offload}

Set the global policy offload level for your FortiGate.

`disable` is the default setting for FortiGate with NP7 processors. Hyperscale firewall features are disabled. Offloading DoS policy sessions to NP7 processors is disabled. All sessions are initiated by the CPU. Sessions that can be offloaded are sent to NP7 processors.

`dos-offload` offload DoS policy sessions to NP7 processors. All other sessions are initiated by the CPU. Sessions that can be offloaded are sent to NP7 processors.

`full-offload` only available if your FortiGate is licensed for hyperscale firewall features. Select this option to enable hyperscale firewall features. For information about hyperscale firewall functionality, see the Hyperscale Firewall Guide. DoS policy sessions are also offloaded to NP7 processors. All other sessions are initiated by the CPU. Sessions that can be offloaded are sent to NP7 processors.

If you have enabled hyperscale firewall features, when you create a hyperscale firewall VDOM you must use the following command to enable hyperscale firewall features for that VDOM.

```
config system settings
   set policy-offload-level full-offload
end
```

The following options are available for this command:

`disable` disable hyperscale firewall features and disable offloading DoS policy sessions to NP7 processors for this VDOM. All sessions are initiated by the CPU. Sessions that can be offloaded are sent to NP7 processors. This is the default setting.

`dos-offload` offload DoS policy sessions to NP7 processors for this VDOM. All other sessions are initiated by the CPU. Sessions that can be offloaded are sent to NP7 processors.

`full-offload` enable hyperscale firewall features for the current hyperscale firewall VDOM. This option is only available if the FortiGate is licensed for hyperscale firewall features. DoS policy sessions are also offloaded to NP7 processors. All other sessions are initiated by the CPU. Sessions that can be offloaded are sent to NP7 processors.

For more information about NP7 DoS policy hardware acceleration, see DoS policy hardware acceleration on page 46.

hash-config {5-tuple | src-ip}

On FortiGates with multiple NP7processors, you can use the following command to configure how the internal switch fabric (ISF) distributes sessions to the NP7 processors.

```
config system global
   config system npu
      set hash-config {5-tuple | src-ip}
   end
```

Changing the `hash-config` causes the FortiGate to restart.

`5-tuple`, the default. To distribute sessions, a hash is created for each session based on the session's source and destination IP address, IP protocol, and source and destination TCP/UDP port. In most cases `5-tuple` distribution provides the best performance.

`src-ip`, sessions are distributed by source IP address. All sessions from a source IP address are processed by the same NP7 processor.

Changing the `hash-config` also affects hyperscale firewall CGNAT functionality, see How the NP7 hash-config affects CGNAT.

Setting `hash-config` to `src-ip` is required to offload traffic that requires session helpers or application layer gateways (ALGs) (for example, FTP, TFTP, SIP, MGCP, H.323, PPTP, L2TP, ICMP Error/IP-options, PMAP, TNS, DCE-RPC, RAS, and RSH).

On a FortiGae with hyperscale firewall features enabled, session helper and ALG traffic should be processed by normal VDOMs and not by hyperscale firewall VDOMs. Traffic that requires session helpers or ALGs is not compatible with hyperscale firewall functionality since the initial packets of a new session must be processed by the CPU. As well, some traffic that requires ALGs, for example SIP traffic, also requires a security profile and security profiles are not compatible with hyperscale firewall functionality.

Session helper and ALG traffic can be partially offloaded by NP7 processors. For example, SIP setup sessions are processed by the CPU, but the RTP and RTCP sessions that result from SIP setup sessions can be accelerated by NP7 processors.

ippool-overload-low <threshold>

Set the low IP pool overload threshold. The threshold range is 100 to 2000 and the default threshold is 150.

ippool-overload-high <threshold>

Set the high IP pool overload threshold. The threshold range is 100 to 2000 and the default threshold is 200.

dse-timeout <seconds>

Set the DSE timeout. Range is 0 to 3600 seconds. The default is 10 seconds.

tcp-rst-timeout <timeout>

The NP7 TCP reset (RST) timeout in seconds. The range is 0-16777215. The default timeout is 5 seconds. This timeout is optimal in most cases, especially when hyperscale firewall is enabled. A timeout of 0 means no time out.

napi-break-interval <interval>

Set the new API (NAPI) break interval. The range is 0 to 65535. The default interval is 0.

capwap-offload {disable | enable}

Enable/disable offloading managed FortiAP and FortiLink CAPWAP sessions to the NP7 processor. Enabled by default.

NP7 CAPWAP offloading compatibility

To be compatible with NP7 CAPWAP offloading, FortiAP E and F models should be upgraded to the following firmware versions:

- FortiAP (F models): version 6.4.7, 7.0.1, and later.
- FortiAP-S and FortiAP-W2 (E models): version 6.4.7, 7.0.1, and later.
- FortiAP-U (EV and F models): version 6.2.2 and later.
- FortiAP-C (FAP-C24JE): version 5.4.3 and later.

NP7 CAPWAP offloading is not compatible with FortiAP models that cannot be upgraded to the versions mentioned above and is also not compatible with FortiAP B, C, CR, or D models.

You can work around this issue by disabling CAPWAP offloading and then restarting your FortiGate.

default-qos-type {policing | shaping}

Set the QoS type used by the NP7 for traffic shaping. The FortiGate restarts after changing this setting. See NP7 traffic shaping on page 44.

gtp-support {disable | enable}

Enable or disable enhanced NP7 support for FortiOS Carrier GTP features. For more information, see Improving NP6 GTP performance.

```
config system npu
   set gtp-support enable
end
```

per-session-accounting {disable | enable | traffic-log-only}

Disable NP7 per-session accounting or enable it and control how it works.

```
config system npu
   set per-session-accounting {disable | enable | traffic-log-only}
end
```

Where:

`enable` enables per-session accounting for all traffic offloaded by the NP7 processor.

`disable` turns off per-session accounting.

`traffic-log-only` (the default) turns on NP7 per-session accounting for traffic accepted by firewall policies that have traffic logging enabled.

Enabling per-session accounting can affect NP7 offloading performance.

For more information, see Per-session accounting for offloaded NP7 sessions on page 38.

per-policy-accounting {disable | enable}

Per-policy accounting records hit counts for packets accepted or denied by hyperscale firewall policies and makes this information available from the firewall policy GUI and from the CLI.

Per-policy accounting for hyperscale firewall policies can reduce hyperscale firewall performance.You can use the following command to enable or disable hyperscale firewall per-policy accounting for all hyperscale traffic:

```
config system npu
   set per-policy-accounting {disable | enable}
end
```

Per-policy accounting is disabled by default. When per-policy accounting is enabled, you can see hyperscale firewall policy hit counts on the GUI and CLI. If you disable per-policy-accouting for hyperscale firewall traffic, FortiOS will not collect hit count information for traffic accepted or denied by hyperscale firewall policies.

Enabling or disabling per-policy accounting deletes all current sessions, disrupting traffic. Changing the per-policy accounting configuration should only be done during a quiet period.

session-acct-interval <seconds>

Change the session accounting update interval. The default is to send an update every 5 seconds. The range is 1 to 10 seconds.

For more information, see Changing the per-session accounting interval on page 39.

max-session-timeout <seconds>

Change the maximum time interval for refreshing NPU-offloaded sessions. The default refresh time is 40 seconds. The range is 10 to 1000 seconds.

To free up NP7 memory you can reduce this session timeout so that inactive sessions are removed from the session table more often. However, if your NP7 is processing sessions with long lifetimes, you can increase the max-session-timeout to reduce how often the system checks for and removes inactive sessions,

hash-tbl-spread (disable | enable}

You can use the following command to enable or disable hash table entry spread for NP7 processors.

```
config system npu
   set hash-tbl-spread (disable | enable}
end
```

`hash-table-spread` is enabled by default. In most cases `hash-table-spread` should be enabled.

The following diagnose commands have been added to allow monitoring VLAN + LAG accounting when `hash-tble-spread` is enabled:

```
diagnose npu np7 sse-tpe-accounting {enable|disable}
diagnose npu np7 vlan-accounting {enable | disable}
```

vlan-lookup-cache {disable | enable}

You can use the following command to enable or disable VLAN lookup (SPV/TPV) caching. Enable this option to optimize performance of offloaded traffic passing through VLAN interfaces.

```
config system npu
   set vlan-lookup-cache {disable | enable}
end
```

This option is enabled by default. If your FortiGate with NP7 processors is offloading traffic passing through VLANs, VLAN lookup caching should be enabled for optimal performance.

Enabling or disabling `vlan-lookup-cache` requires a system restart. You should only change this setting during a maintenance window or quiet period.

htx-icmp-csum-chk { drop | pass}

You can use the following command to configure NP7 processors to send ICMP packets with checksum errors to the CPU:

```
config system npu
   config fp-anomaly
      set icmp-csum-err trap-to-host
   end
```

You might set up this configuration if you have configured a DoS firewall policy that includes ICMP DoS protection.

In addition to the above configuration, you can use the following command to block or allow NP7 processors to send ICMP packets with checksum errors to the CPU:

```
config system npu
   set htx-icmp-csum-chk {drop | pass}
end
```

`drop` block ICMP packets with checksum errors. This is the default setting.

`pass` forward ICMP packets with checksum errors to the CPU.

htab-msg-queue {data | idle | dedicated}

Set the hash table message queue mode. You can use this option to alleviate performance bottlenecks that may occur when hash table messages use up all of the available hyperscale NP7 data queues.

You can use the following commands to get the hash table message count and rate.

```
diagnose npu np7 msg htab-stats {all| chip-id}
diagnose npu np7 msg htab-rate {all| chip-id}
```

You can use the following command to show MSWM information:

```
diagnose npu np7 mswm
```

You can use the following command to show Session Search Engine (SSE) drop counters:

```
diagnose npu np7 dce-sse-drop 0 v
```

You can use the following command to show command counters:

```
diagnose npu np7 cmd
```

The following `htab-msg-queue` options are available:

- `data` (the default) use all available data queues.
- `idle` if you notice the data queues are all in use, you can select this option to use idle queues for hash table messages.
- `dedicated` use between 1 to 8 of the highest number data queues. Use the option `htab-dedi-queue-nr` to set the number of data queues to use. See htab-dedi-queue-nr <number-of-queues> on page 63.

htab-dedi-queue-nr <number-of-queues>

If you are using dedicated queues for hash table messages for hyperscale firewall sessions, you can set the number of queues to use. The range is 1 to 8 queues. The default is 4 queues.

Use dedicated queues by setting `htab-msg-queue` to| `dedicated`. See htab-msg-queue {data | idle | dedicated} on page 62.

mcast-session-accounting {tpe-based | session-based | disable}

Use this option to configure multicast session accounting.

Where:

`tpe-based` (the default) enables TPE-based multicast session accounting.

`session-based` enables session-based multicast session accounting.

`disable` disables multicast session accounting.

For more information, see Enabling multicast per-session accounting on page 39.

inbound-dscp-copy-port <interface> [<interface>...]

Configure one or more interfaces to support the DSCP copy feature. This feature copies the DSCP value from the ESP header to the inner IP Header for incoming packets. This feature can be used in situations where the network is expecting a DSCP value in the inner IP header but the traffic has the DSCP value in the ESP header.

double-level-mcast-offload {disable | enable}

Enable to support NP7 offloading for more than 256 destinations for multicast replication. By default this option is disabled and NP7 processors support up to 256 destinations for multicast replication. You can enable this option to effectively double the number.

config port-npu-map

Use the following command to configure NPU port mapping:

```
config system npu
   config port-npu-map
      edit <interface-name>
         set npu-group-index <index>
      end
```

You can use the port map to assign data interfaces to NP7 links.

See individual NP7 architectures in FortiGate NP7 architectures on page 79 for details for individual FortiGate models.

config port-path-option

If your FortiGate is licensed for hyperscale firewall features, you can use the following command to select interfaces to use for hardware logging and HA hardware session synchronization:

```
config system npu
   config port-path-option
      set ports-using-npu {ha1 ha2 aux1 aux2}
   end
```

Changing the `port-path-option` configuration restarts the FortiGate, temporarily interrupting traffic. If you have two FortiGates in an FGCP HA cluster, you should remove the backup FortiGate from the cluster, change the `port-path-option` configuration on both FortiGates, and then after they restart, add the backup FortiGate back to the cluster.

For more information about hardware logging, see Optimizing hardware logging performance using AUX interfaces. For more information about HA hardware session synchronization, see Optimizing HA hardware session synchronization performance.

config dos-options

Us the following command to configure some NP7 DoS protection settings:

```
config system npu
   config dos-options
      set npu-dos-meter-mode {global | local}
      set npu-dos-tpe-mode {disable | enable}
   end
```

For more information, see DoS policy hardware acceleration on page 46.

Configuring hyperscale TCP timeout profiles

If your FortiGate is licensed for hyperscale firewall features, you can use the following command to create one or more TCP timeout profiles. Once you have created TCP timeout profiles, in a firewall policy in a hyperscale firewall VDOM, you can use the `tcp-timeout-pid` firewall policy option to select a TCP timeout profile to apply to traffic accepted by the hyperscale firewall policy.

```
config system npu
   config tcp-timeout-profile
      edit {6 | 7 | 8 | ... | 47}
         set tcp-idle <seconds>
         set fin-wait <seconds>
         set close-wait <seconds>
         set time-wait <seconds>
         set syn-sent <seconds>
         set syn-wait <seconds>
      end
```

`tcp-idle` TCP idle timeout in seconds. Range 1 to 86400, default 3600.

`fin-wait` fin-wait timeout in seconds. Range 1 to 86400, default 120.

`close-wait` close-wait timeout in seconds. Range 1 to 86400, default 120.

`time-wait` time-wait timeout in seconds. Range 1 to 300, default 1.

`syn-sent` syn-sent timeout in seconds. Range 1 to 86400, default 10.

`syn-wait` syn-wait timeout in seconds. Range 1 to 86400, default 10.

For example, use the following command to create TCP timeout profile number 10:

```
config global
   config system npu
      config tcp-timeout-profile
         edit 10
            set tcp-idle 10
            set fin-wait 20
            set close-wait 10
            set time-wait 5
         end
```

Use the following command to apply TCP timeout profile number 10 to a hyperscale firewall policy:

```
config vdom
   edit <hyperscale-firewall-vdom-name>
      config firewall policy
         edit 1
            set action accept
            set policy-offload enable
            ...
            set tcp-timout-pid 10
            ...
         end
```

Configuring hyperscale UDP timeout profiles

If your FortiGate is licensed for hyperscale firewall features, you can use the following command to create one or more UDP timeout profiles. Once you have created UDP timeout profiles, in a firewall policy in a hyperscale firewall VDOM, you can use the `udp-timeout-pid` firewall policy option to select a UDP timeout profile to apply to traffic accepted by the hyperscale firewall policy.

```
config system npu
   config udp-timeout-profile
      edit {8 | 9 | 10 | ... | 63}
         set udp-idle <seconds>
```

```
      end
```

`udp-idle` UDP idle timeout in seconds. Range 1 to 86400, default 180.

For example, use the following command to create UDP timeout profile number 45:

```
config global
   config system npu
      config udp-timeout-profile
         edit 45
            set udp-idle <seconds>
         end
```

Use the following command to apply UDP timeout profile number 45 to a hyperscale firewall policy:

```
config vdom
   edit <hyperscale-firewall-vdom-name>
      config firewall policy
         edit 1
            set action accept
            set policy-offload enable
            ...
            set udp-timout-pid 45
            ...
         end
```

config background-sse-scan

To support reporting accurate UDP session statistics, normal UDP session synchronization is disabled for FortiGates with hyperscale firewall features enabled and background Session Search Engine (SSE) scanning is used to keep UDP sessions synchronized.

Background SSE scanning uses the CPU instead of the NP7 processors and can cause CPU spikes; however, these spikes should not usually affect overall performance. You can use the following command to adjust background SSE scanning behavior:

```
config system npu
   config background-sse-scan
      set scan {disable | enable}
      set stats-update-interval <interval>
      set udp-keepalive-interval <interval>
   end
```

`scan` enable or disable background SSE scanning. This option is enabled by default. If disabled, UDP O-session and R-session synchronization is enabled so UDP sessions will remain synchronized. However, the statistics reported by traffic logging for UDP O-sessions will be incorrect.

`stats-update-interval` statistics update interval in seconds. The range is 300 to 1073741823 seconds and the default update interval is 300 seconds. You can increase the statistics update interval to reduce how often the CPU is used for SSE background scanning.

`udp-keepalive-interval` UDP keepalive interval in seconds. The range is 90 to 1073741823 seconds and the default keepalive interval is 90 seconds. The 90 second keepalive interval is recommended because the default UDP session timeout is 180 seconds. If you increase the keepalive interval, some UDP sessions may be dropped prematurely.

config fp-anomaly

Use the following command to configure the NP7 traffic anomaly protection:

```
config system npu
   config fp-anomaly
      set tcp-syn-fin {allow | drop | trap-to-host}
      set tcp-fin-noack {allow | drop | trap-to-host}
      set tcp-fin-only {allow | drop | trap-to-host}
      set tcp-no-flag {allow | drop | trap-to-host}
      set tcp-syn-data {allow | drop | trap-to-host}
      set tcp-winnuke {allow | drop | trap-to-host}
      set tcp-land {allow | drop | trap-to-host}
      set udp-land {allow | drop | trap-to-host}
      set icmp-land {allow | drop | trap-to-host}
      set icmp-frag {allow | drop | trap-to-host}
      set ipv4-land {allow | drop | trap-to-host}
      set ipv4-proto-err {allow | drop | trap-to-host}
      set ipv4-unknopt {allow | drop | trap-to-host}
      set ipv4-optrr {allow | drop | trap-to-host}
      set ipv4-optssrr {allow | drop | trap-to-host}
      set ipv4-optlsrr {allow | drop | trap-to-host}
      set ipv4-optstream {allow | drop | trap-to-host}
      set ipv4-optsecurity {allow | drop | trap-to-host}
      set ipv4-opttimestamp {allow | drop | trap-to-host}
      set ipv4-csum-err {drop | trap-to-host}
      set tcp-csum-err {drop | trap-to-host}
      set udp-csum-err {drop | trap-to-host}
      set icmp-csum-err {drop | trap-to-host}
      set ipv6-land {allow | drop | trap-to-host}
      set ipv6-proto-err {allow | drop | trap-to-host}
      set ipv6-unknopt {allow | drop | trap-to-host}
      set ipv6-saddr-err {allow | drop | trap-to-host}
      set ipv6-daddr-err {allow | drop | trap-to-host}
      set ipv6-optralert {allow | drop | trap-to-host}
      set ipv6-optjumbo {allow | drop | trap-to-host}
      set ipv6-opttunnel {allow | drop | trap-to-host}
      set ipv6-opthomeaddr {allow | drop | trap-to-host}
      set ipv6-optnsap {allow | drop | trap-to-host}
      set ipv6-optendpid {allow | drop | trap-to-host}
      set ipv6-optinvld {allow | drop | trap-to-host}
   end
```

In most cases you can configure the NP7 processor to allow or drop the packets associated with an attack or forward the packets that are associated with the attack to FortiOS (called `trap-to-host`). Selecting `trap-to-host` turns off NP7 anomaly protection for that anomaly.

If you select `trap-to-host` for an anomaly protection option, you can use a DoS policy to configure anomaly protection for that anomaly. If you set the `policy-offload-level` NPU setting to `dos-offload`, DoS policy anomaly protection is offloaded to the NP7.

Command	Description	Default
`tcp-syn-fin {allow | drop | trap-to-host}`	Detects TCP SYN flood SYN/FIN flag set anomalies.	allow

Command	Description	Default
`tcp-fin-noack {allow | drop | trap-to-host}`	Detects TCP SYN flood with FIN flag set without ACK setting anomalies.	trap-to-host
`tcp-fin-only {allow | drop | trap-to-host}`	Detects TCP SYN flood with only FIN flag set anomalies.	trap-to-host
`tcp-no-flag {allow | drop | trap-to-host}`	Detects TCP SYN flood with no flag set anomalies.	allow
`tcp-syn-data {allow | drop | trap-to-host}`	Detects TCP SYN flood packets with data anomalies.	allow
`tcp-winnuke {allow | drop | trap-to-host}`	Detects TCP WinNuke anomalies.	trap-to-host
`tcp-land {allow | drop | trap-to-host}`	Detects TCP land anomalies.	trap-to-host
`udp-land {allow | drop | trap-to-host}`	Detects UDP land anomalies.	trap-to-host
`icmp-land {allow | drop | trap-to-host}`	Detects ICMP land anomalies.	trap-to-host
`icmp-frag {allow | drop | trap-to-host}`	Detects Layer 3 fragmented packets that could be part of a layer 4 ICMP anomalies.	allow
`ipv4-land {allow | drop | trap-to-host}`	Detects IPv4 land anomalies.	trap-to-host
`ipv4-proto-err {allow | drop | trap-to-host}`	Detects invalid layer 4 protocol anomalies. For information about the error codes that are produced by setting this option to `drop`, see NP6 anomaly error codes.	trap-to-host
`ipv4-unknopt {allow | drop | trap-to-host}`	Detects unknown option anomalies.	trap-to-host
`ipv4-optrr {allow | drop | trap-to-host}`	Detects IPv4 with record route option anomalies.	trap-to-host
`ipv4-optssrr {allow | drop | trap-to-host}`	Detects IPv4 with strict source record route option anomalies.	trap-to-host
`ipv4-optlsrr {allow | drop | trap-to-host}`	Detects IPv4 with loose source record route option anomalies.	trap-to-host
`ipv4-optstream {allow | drop | trap-to-host}`	Detects stream option anomalies.	trap-to-host
`ipv4-optsecurity {allow | drop | trap-to-host}`	Detects security option anomalies.	trap-to-host
`ipv4-opttimestamp {allow | drop | trap-to-host}`	Detects timestamp option anomalies.	trap-to-host

Command	Description	Default
`ipv4-csum-err {drop | trap-to-host}`	Detects IPv4 checksum errors.	drop
`tcp-csum-err {drop | trap-to-host}`	Detects TCP checksum errors.	drop
`udp-csum-err {drop | trap-to-host}`	Detects UDP checksum errors.	drop
`icmp-csum-err {drop | trap-to-host}`	Detects ICMP checksum errors. T he `config system npu` command includes a new `htx-icmp-csum-chk` option to block or allow NP7 processors to send ICMP packets with checksum errors to the CPU. See htx-icmp-csum-chk { drop | pass} on page 62.	drop
`ipv6-land {allow | drop | trap-to-host}`	Detects IPv6 land anomalies	trap-to-host
`ipv6-unknopt {allow | drop | trap-to-host}`	Detects unknown option anomalies.	trap-to-host
`ipv6-saddr-err {allow | drop | trap-to-host}`	Detects source address as multicast anomalies.	trap-to-host
`ipv6-daddr-err {allow | drop | trap-to-host}`	Detects destination address as unspecified or loopback address anomalies.	trap-to-host
`ipv6-optralert {allow | drop | trap-to-host}`	Detects router alert option anomalies.	trap-to-host
`ipv6-optjumbo {allow | drop | trap-to-host}`	Detects jumbo options anomalies.	trap-to-host
`ipv6-opttunnel {allow | drop | trap-to-host}`	Detects tunnel encapsulation limit option anomalies.	trap-to-host
`ipv6-opthomeaddr {allow | drop | trap-to-host}`	Detects home address option anomalies.	trap-to-host
`ipv6-optnsap {allow | drop | trap-to-host}`	Detects network service access point address option anomalies.	trap-to-host
`ipv6-optendpid {allow | drop | trap-to-host}`	Detects end point identification anomalies.	trap-to-host
`ipv6-optinvld {allow | drop | trap-to-host}`	Detects invalid option anomalies.	trap-to-host

config ip-reassembly

Use the following command to enable IP reassembly, which configures the NP7 processor to reassemble fragmented IP packets:

```
config system npu
   config ip-reassembly
```

```
      set min_timeout <micro-seconds>
      set max_timeout <micro-seconds>
      set status {disable | enable}
   end
```

For more information, see Reassembling and offloading fragmented packets on page 44.

config dsw-dts-profile

Configure NP7 DSW DTS profiles.

```
config system npu
   config dsw-dts-profile
      edit <profile-id>
         set min-limit <limit>
         set step <number>
         set action {wait | drop | drop_tmr_0 | drop_tmr_1 | enque | enque_0 | enque_1 }
      end
```

`min-limit` NP7 DSW DTS profile min-limt. Range 32 to 2048, 1 is a special value, default 0.

`step` NP7 DSW DTS profile step. Range 0 to 64, default 0.

`action` set the NP7 DSW DTS profile action to one of the following:

- `wait` the default, DSW DTS profile WAIT indefinitely.
- `drop` DSW DTS profile DROP immediately.
- `drop_tmr_0` DSW DTS profile DROP after interval #0 time-out.
- `drop_tmr_1` DSW DTS profile DROP after interval #1 time-out.
- `enque` DSW DTS profile ENQUE immediately.
- `enque_0` DSW DTS profile ENQUE after interval #0 time-out.
- `enque_1` DSW DTS profile ENQUE after interval #1 time-out.

Configuring NP7 queue protocol prioritization

Use the following command to configure NP7 HPE high-priority traffic types. Traffic types matched by the configuration of this command are assumed to be high-priority traffic types by the HPE. The default configuration includes most common types of traffic that might be considered to be high-priority traffic for most networks. You can add and remove traffic types if required for your network.

```
config system npu
   config np-queues
      config profile
         edit <profile-id>
            set type {cos | dscp}
            set weight <weight>
            set {cos0 | cos1 | ... | cos7} {queue0 | queue1 | ... | queue7}
            set {dscp0 | dscp1 | ... | dscp63} {queue0 | queue1 | ... | queue7}
         end
      config ethernet-type
         edit <ethernet-type-name>
            set type <ethertype>
            set queue <queue>
            set weight <weight>
```

```
      end
   config ip-protocol
      edit <protocol-name>
         set protocol <ip-protocol-number>
         set queue <queue>
         set weight <weight>
      end
   config ip-service
      edit <service-name>
         set protocol <ip-protocol-number>
         set sport <port-number>
         set dport <port-number>
         set queue <queue>
         set weight <weight>
      end
   config scheduler
      edit <schedule-name>
         set mode {none | priority | round-robin}
      end
```

`config profile` configure NP7 class profiles.

- `type` the profile type. Select `cos` (the default) for VLAN priority or `dscp` for IP differentiated services code point (DSCP) priority.
- `weight` set a weight for the profile. Range 0 to 15, default 6.
- `cos0` to `cos7` if type is set to `cos`, select a queue number (`queue1` to `queue7`) for each CoS. By default, each CoS is assigned a queue with the corresponding number. For example, `cos1` is assigned `queue1`, `cos2` is assigned `queue2` and so on.
- `dscp0` to `dscp63` if `type` is set to `dscp`, select a queue number (`queue1` to `queue7`) for each DSCP.

`config ethernet-type` configure NP7 QoS settings for different ethernet types. The default configuration includes the following ethernet types: ARP, HA-SESSYNC, HA-DEF, HC-DEF, L2EP-DEF, and LACP. You can edit these pre-configured ethernet types to change the `queue` and `weight`. You can also add new ethernet types.

- `type` the ethertype number of the ethernet type to be configured. For example, for ARP `type` would be 806 (and not 0x0806).
- `queue` the queue number. Range 0 to 11, the default when you create a new ethernet type is 0.
- `weight` the class weight for the ethernet type in the range of 0 to 15, the default weight is 15.

`config ip-protocol` configure NP7 QoS settings for different IP protocols. The default configuration includes these pre-configured IP protocols: OSPF, IGMP, and ICMP. You can edit these pre-configured IP protocols to change the `queue` and `weight`. You can also add new IP protocols.

- `protocol` the protocol number of the IP protocol to be configured.
- `queue` the queue number. Range 0 to 11, the default when you create a new IP protocol is 0.
- `weight` the class weight for the IP protocol in the range of 0 to 15, the default weight is 14.

`config ip-service` configure NP7 QoS settings for different IP services. The default configuration includes these pre-configured IP services: IKE, BGP, BFD-single-hop, BFD-multiple-hop, SLBC-management, SLBC-1, and SLBC-2. You can edit these pre-configured IP services to change the `queue` and `weight`. You can also add new IP services.

- `protocol` the protocol number of the IP service to be configured.
- `sport` the source port number used by the service.
- `dport` the destination port number used by the service.

- `queue` the queue number. Range 0 to 11, the default when you create a new IP service is 0.
- `weight` the class weight for the IP service in the range of 0 to 15, the default weight is 13.

`config scheduler` configure NP7 QoS schedules.

- `mode` the scheduler mode. Can be `none`, `priority`, or `round-robin`.

Default NP7 queue protocol prioritization configuration

Default NP7 queue protocol prioritization configuration

The default NP queue priority configuration should result in optimal performance in most cases. An empty or incorrect NP queue priority configuration can affect performance or cause traffic disruptions. In the case of a hyperscale firewall VDOM, an empty NP queue priority configuration could cause BGP flapping or traffic interruptions when a lot of IP traffic and/or non-SYN TCP traffic is sent to the CPU.

After upgrading your FortiGate with NP7 processors, you should verify that the NP queue priority configuration is either your intended configuration or matches the default configuration shown below. If you are upgrading from a FortiOS version that does not support the NP queue priority feature, the NP queue priority configuration after the firmware upgrade could be empty or incorrect.

Here is the default NP queue priority configuration:

```
config system npu
    config np-queues
        config ethernet-type
            edit "ARP"
                set type 806
                set queue 9
            next
            edit "HA-SESSYNC"
                set type 8892
                set queue 11
            next
            edit "HA-DEF"
                set type 8890
                set queue 11
            next
            edit "HC-DEF"
                set type 8891
                set queue 11
            next
            edit "L2EP-DEF"
                set type 8893
                set queue 11
            next
            edit "LACP"
                set type 8809
                set queue 9
            next
        end
        config ip-protocol
            edit "OSPF"
```

```
            set protocol 89
            set queue 11
        next
        edit "IGMP"
            set protocol 2
            set queue 11
        next
        edit "ICMP"
            set protocol 1
            set queue 3
        next
    end
    config ip-service
        edit "IKE"
            set protocol 17
            set sport 500
            set dport 500
            set queue 11
        next
        edit "BGP"
            set protocol 6
            set sport 179
            set dport 179
            set queue 9
        next
        edit "BFD-single-hop"
            set protocol 17
            set sport 3784
            set dport 3784
            set queue 11
        next
        edit "BFD-multiple-hop"
            set protocol 17
            set sport 4784
            set dport 4784
            set queue 11
        next
        edit "SLBC-management"
            set protocol 17
            set dport 720
            set queue 11
        next
        edit "SLBC-1"
            set protocol 17
            set sport 11133
            set dport 11133
            set queue 11
        next
        edit "SLBC-2"
            set protocol 17
            set sport 65435
            set dport 65435
            set queue 11
        end
```

config dsw-queue-dts-profile

Create NP7 DSW Queue DTS profiles.

```
config system npu
   config dsw-queue-dts-profile
      edit <profile-name>
         set iport <iport>
         set oport <oport>
         set profile-id <profile-id>
         set queue-select <queue-id>
      end
```

`iport` select a NP7 DSW DTS in port from the list of available ports, default `eif0`.

`oport` select a NP7 DSW DTS out port from the list of available ports, default `eif0`.

`profile-id` an NP7 DSW DTS profile ID, range 1 to 32, default 0.

`queue-select` an NP7 DSW DTS queue ID. Range <0> to <4095>, default 0 resets the queue to default.

When this command was first added with FortiOS 6.4.6, the `iport` and `oport` options were all uppercase. However, for 6.4.8 they were converted to lower case. This change was missed in the upgrade code, so your configuration of this command may be lost after upgrading to 6.4.9.

Changing NP7 TCP session setup

You can use the following command to cause the NP7 processor to push TCP sessions to the SYN state instead of SYN/ACK to guarantee the right order when establishing TCP connection.

```
config system global
   set early-tcp-npu-session {disable | enable}
end
```

This option is disabled by default and NP7 session setup includes the normal SYN/ACK step.

NP7 diagnose commands

This section describes some `diagnose` commands you can use to display useful information about NP7 processors and bout sessions processed by NP7 processors.

diagnose npu np7 (display NP7 information)

You can use the `diagnose npu np7` command to display NP7 information.

In the following syntax:

- <np7-id> is the NP7 identifier, if your FortiGate has one NP7 the np-id is 0.
- For some of the commands, you can specify an <action>. <action> is optional and can be:
  - {0 | b | brief} Show non-zero counters.
  - {1| v | verbose} Show all the counters.
  - {2 | c | clear} Clear counters.

Command	Description
cgmac-stats <np7-id> [<action>]	Show or clear TX, RX, and Error counters.
dce-drop-all <np7-id> [<action>]	Show or clear all drop counters.
dce-eif-drop <np7-id> [<action>]	Show or clear Ingress Header Processing (IHP) drop counters for the EIF module.
dce-htx-drop <np7-id> [<action>]	Show or clear IHP drop counters for the Host TX (HTX) module.
dce-ipti-drop <np7-id> [<action>]	Show or clear IHP drop counters for the IP Tunnel Inbound (IPTI) module.
dce-l2ti-drop <np7-id> [<action>]	Show or clear IHP drop counters for the L2 Tunnel Inbound (HTX) module.
dce-dfr-drop <np7-id> [<action>]	Show or clear IHP drop counters for the Reassembly (DFR) module.
dce-xhp-drop <np7-id> [<action>]	Show or clear IHP drop counters for the Extensible Header Processing (XHP) module.
dce-l2p-drop <np7-id> [<action>]	Show or clear IHP drop counters for the L2P ingress/egress processing module.
dce-hif-drop <np7-id> [<action>]	Show or clear IHP drop counters for the Host Interface (HIF).
dce-ipsec-drop <np7-id> [<action>]	Show or clear IPsec drop counters.
dsw-drop-all <np7-id> [<action>]	Show or clear DSW drop counters.
dsw-drop-by-src <np7-id> [<action>]	Show or clear DSW drop counters by source modules.
dsw-drop-by-dst <np7-id> [<action>]	Show or clear DSW drop counters by destination modules.
dsw-ingress-stats <np7-id> [<action>]	Show or clear engine counter statistics for DSW ingress modules.
dsw-egress-stats <np7-id> [<action>]	Show or clear counter statistics for DSW egress modules based on queue index.
hif-stats <np7-id>	Show or clear Host Interface (HIF) statistic for each TX and RX host queue.

Command	Description
`[<action>]`	
`pdq <np7-id>`	Show counters of packet and byte count for active modules.
`pba <np7-id>`	Show Packet Buffer Allocator (PBA) information. PBA is a key indicator for determining the current state of the NP7. If normal and current `pba`, `dba`, and `hba` are different when no traffic is flowing, then `!!!Leak!!!` will appear at the bottom, indicating a potential NP7 issue.
`pmon <np7-id> [<action>]`	Show or clear process monitor data that shows the processor load each NP7 software module is using.

`port-list <np7-id>`	Show the FortiGate interfaces, the NP7 that each interface is connected to, and the port to NPU port mapping configuration. You can configure NPU port mapping using the following command:
	`config system npu`
	`config port-npu-map`
	`edit <interface-name>`
	`set npu-group-index {0 | 1 | 2}`
	`end`

`sse-cmd-stats <np7-id> [<action>]`	Show or clear Session Search Engine (SSE) command statistics, which show the number of sessions for various operations.
`sse-stats <np7-id>`	Show NP7 session statistics, including the following: `entcnt` total number of valid sessions. `inssuc` number of successfully inserted sessions. `insfail` number of sessions that fail to be inserted. `updsucc` total number of session update that have been successfully executed. `delsucc` number of sessions that have been deleted successfully. `delfail` number of sessions that fail to be deleted due to no matching session found. `depfail` OFT max chain depth reached fail count. Should remain zero. `srhsucc` number of sessions successfully searched (search hit). `srhfail` number of sessions whose search failed (search miss). `agesucc` total number of successful session removal by aging. `chdepth` Maximum OFT chain depth allowed. `phtbase` Lower 32 bits of PHT base address. `phtsize` PHT size. `oftbase` Lower 32 bits of OFT base address. `oftsize` Size of overflow table. `oftfcnt` OFT free bucket count.
`system-config`	Show the current NP7 configuration. Most of the configuration is set by the `config system npu` command.

Command	Description
`register <np7-id> [<blocks> list]`	Show NP7 registers. Optionally specify a <block> to show registers for a specific block. For example: `diagnose npu np7 register 0 sse* list.`
`ddr-info <np7-id>`	Show DDR size and debug information.
`ddr-access {disable | enable} <np7-id>`	Enable or disable DDR access of sub-modules.
`ddr-test <np7-id> <channel> <start-hex> <size-hex> <pattern-src> <pattern>`	Run DDR memory testing. Where: `<channel>` is the DDR channel to test and can be 0, 1, 2, 3, 4, or 5. `<start-hex>` and <end-hex> define the range of memory addresses for which to run the test in hexadecimal format. `<size-hex>` is the size of the memory in hexadecimal format. `<pattern>` can be `0` walkone, `1` walkzero, `2` incremental, and `3` random.
`trng-read <np7-id> <size>`	Display a true random number generated by the NP7 true random number generator.
`trng-frequency <np7-id>`	Show true random number generator frequency information.
`debug-cgmac <options>`	Show NP7 debug information. Enter `diagnose npu np7 debug-cgmac ?` to view the available `<options>`.
`hpe <np7-id>`	Show HPE host queue type shaping statistics.
`ipl <options>`	Show IPL information. Enter `diagnose npu np7 ipl -h` for a list of options.

diagnose sys session list and no_ofld_reason field (NP7 session information)

The `diagnose sys session list` and `diagnose sys session6 list` commands list all of the current IPv4 or IPv6 sessions being processed by the FortiGate. For each session the command output includes an `npu info` line that displays NPx offloading information for the session. If a session is not offloaded, the command output includes a `no_ofld_reason` line that indicates why the session was not offloaded.

The `no_ofld_reason` field appears in the output of the `diagnose sys session list` or `diagnose sys sessions6 list` command to indicate why the session wasn't offloaded by an NP6 processor. The field appears for sessions that normally would be offloaded but for some reason can't currently be offloaded. The following table lists and explains some of the reasons that a session could not be offloaded. Note that more than one of these reasons can appear in the `no_ofld_reason` field for a single session.

no_ofld_reason	Description
`dirty`	Because of a configuration change to routing, firewall policies, interfaces, ARP tables, or other configuration, the session needs to be revalidated by FortiOS. Traffic may still be processed by the session, but it will not be offloaded until the session has been revalidated.
`local`	The session is a local-in or local-out session that can't be offloaded. Examples

no_ofld_reason	Description
	include management sessions, SSL VPN sessions accessing an SSL VPN portal, explicit proxy sessions, and so on.
disabled-by-policy	The firewall policy option auto-asic-offload is disabled in the firewall policy that accepted the session. This reason can also appear if one or more of the interfaces handling the session are software switch interfaces.
non-npu-intf	The incoming or outgoing interface handling the sessions is not an NP6-accelerated interface or is part of a software switch. This reason may also appear if when the config system npu option fastpath is disabled.
npu-flag-off	The session is not offloaded because of hardware or software limitations. For example, the session could be using EMAC VLAN interfaces or the session could be for a protocol or service for which offloading is not supported. For example, before NP6 processors supported offloading IPv6 tunnel sessions, npu-flag-off would appear in the no_ofld_reason field for IPv6 tunnel sessions.
redir-to-ips	Normally this session is expected to be offloaded to the NP6 processor by the IPS, but for some reason the session cannot be offloaded. May be caused by a bug. The no_ofld_reason field may contain more information.
denied-by-nturbo	A session being processed by the IPS that could normally be offloaded is not supported by nTurbo. May be caused by a bug. Can be paired with redir-to-ips.
block-by-ips	A session being processed by the IPS that could normally be offloaded is blocked. May be caused by a bug. Can be paired with redir-to-ips.
redir-to-av	Flow-based antivirus is preventing offloading of this session.
sflow	sFlow is enabled for one or both of the interfaces handling the session. sFlow periodic traffic sampling that can only be done by the CPU.
mac-host-check	Device identification has not yet identified the device communicating with the FortiGate using this session. Once the device has been identified the session may be offloaded.
offload-denied	Usually this reason appears if the session is being handled by a session helper and sessions handled by this session helper can't be offloaded.
not-established	A TCP session is not in its established state (proto_state=01).

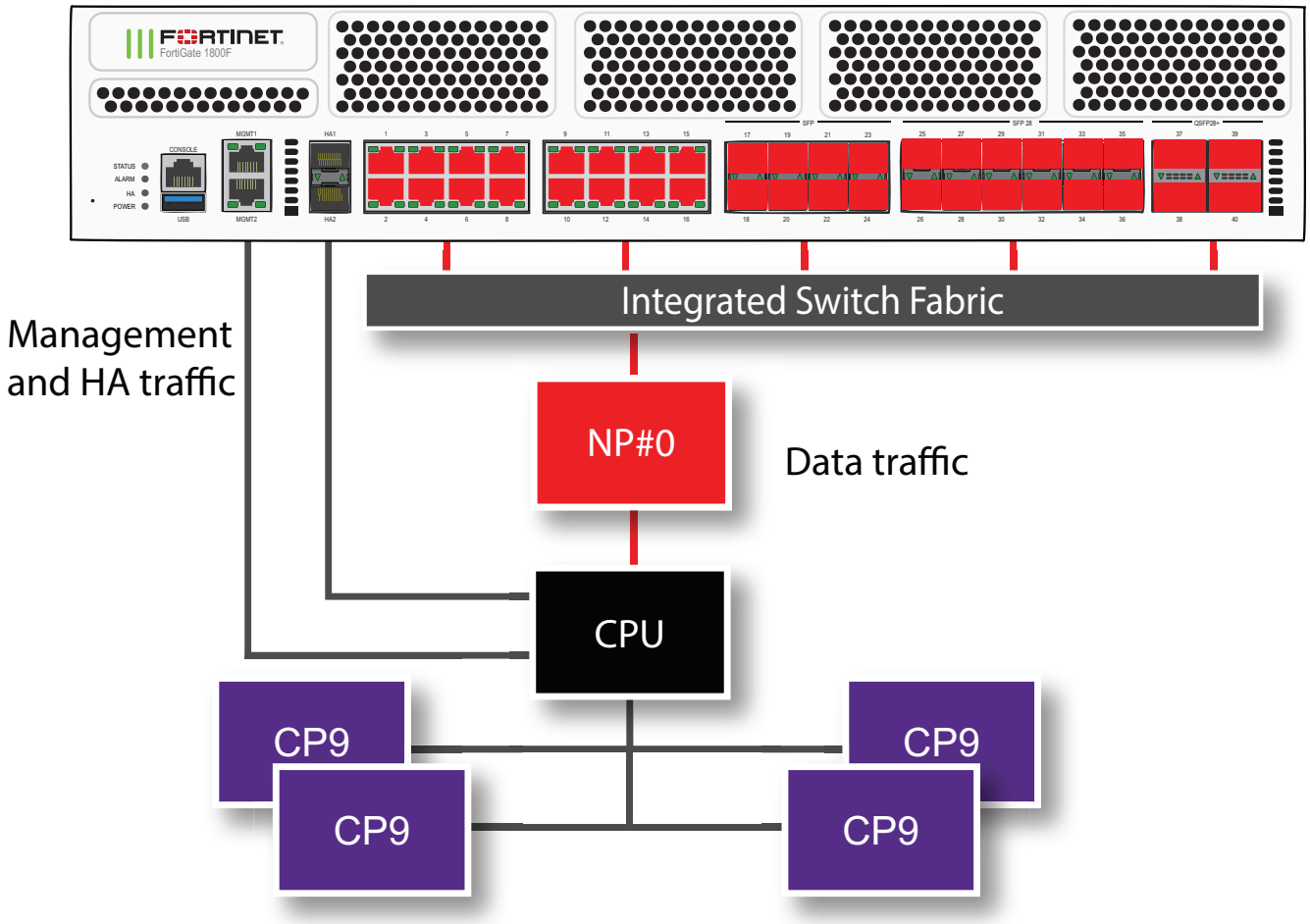
FortiGate NP7 architectures

This chapter shows the NP7 architecture for FortiGate models that include NP7 processors.

FortiGate 1800F and 1801F fast path architecture

The FortiGate 1800F and 1801F models feature the following front panel interfaces:

- Two 1 GigE RJ45 (MGMT1 and MGMT2), not connected to the NP7 processor.
- Two 10 GigE SFP+ (HA1 and HA2), not connected to the NP7 processor.
- Sixteen 10/100/1000BASE-T RJ45 (1 to 16).
- Eight 1 GigE SFP (17 to 24).
- Twelve 10/25 GigE SFP+/SFP28 (25 to 36), interface groups: 25 - 28, 29 - 32, and 33 - 36.
- Four 40 GigE QSFP+ (37 to 40).



The FortiGate 1800F and 1801F each include one NP7 processor. All front panel data interfaces and the NP7 processor connect to the integrated switch fabric (ISF). All data traffic passes from the data interfaces through the ISF to the NP7 processor. All supported traffic passing between any two data interfaces can be offloaded by the NP7 processor. Data traffic processed by the CPU takes a dedicated data path through the ISF and the NP7 processor to the CPU.

The MGMT interfaces are not connected to the NP7 processor. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. You can also dedicate separate CPU resources for management traffic to further isolate management processing from data processing (see Dedicated management CPU on page 27).

The HA interfaces are also not connected to the NP7 processor. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing.

The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following command to display the FortiGate 1800F or 1801F NP7 configuration. The command output shows a single NP7 named NP#0 is connected to all interfaces. This interface to NP7 mapping is also shown in the diagram above.

```
diagnose npu np7 port-list
name   max_speed(Mbps) np_group        switch_id sw_port_id sw_port_name
------ --------------- --------------- --------- ---------- ------------
port1  1000            NP#0            0         3          ge1
port2  1000            NP#0            0         2          ge0
port3  1000            NP#0            0         5          ge3
port4  1000            NP#0            0         4          ge2
port5  1000            NP#0            0         7          ge5
port6  1000            NP#0            0         6          ge4
port7  1000            NP#0            0         9          ge7
port8  1000            NP#0            0         8          ge6
port9  1000            NP#0            0         11         ge9
port10 1000            NP#0            0         10         ge8
port11 1000            NP#0            0         13         ge11
port12 1000            NP#0            0         12         ge10
port13 1000            NP#0            0         15         ge13
port14 1000            NP#0            0         14         ge12
port15 1000            NP#0            0         17         ge15
port16 1000            NP#0            0         16         ge14
port17 1000            NP#0            0         18         ge16
port18 1000            NP#0            0         19         ge17
port19 1000            NP#0            0         20         ge18
port20 1000            NP#0            0         21         ge19
port21 1000            NP#0            0         22         ge20
port22 1000            NP#0            0         23         ge21
port23 1000            NP#0            0         24         ge22
port24 1000            NP#0            0         25         ge23
port25 25000           NP#0            1         15         xe14
port26 25000           NP#0            1         16         xe15
port27 25000           NP#0            1         13         xe12
port28 25000           NP#0            1         14         xe13
port29 25000           NP#0            1         19         xe18
port30 25000           NP#0            1         20         xe19
port31 25000           NP#0            1         17         xe16
port32 25000           NP#0            1         18         xe17
port33 25000           NP#0            1         23         xe22
port34 25000           NP#0            1         24         xe23
port35 25000           NP#0            1         21         xe20
```

```
port36 25000           NP#0            1          22          xe21
port37 40000           NP#0            1          29          xe25
port38 40000           NP#0            1          25          xe24
port39 40000           NP#0            1          33          xe26
port40 40000           NP#0            1          37          xe27
NP PORTS:
name   switch_id sw_port_id sw_port_name
------ --------- ---------- ------------
np0_0  1         41         ce0
np0_1  1         45         ce1
```

The command output also shows the maximum speeds of each interface. Also, interfaces 1 to 24 are connected to one switch and interfaces 25 to 40 are connected to another switch. Both of these switches make up the internal switch fabric, which connects the interfaces to the NP7 processor, the CPU, and the four CP9 processors.

The NP7 processor has a bandwidth capacity of 200 Gigabits. You can see from the command output that if all interfaces were operating at their maximum bandwidth the NP7 processor would not be able to offload all the traffic.

The FortiGate-1800F and 1801F can be licensed for hyperscale firewall support, see the Hyperscale Firewall Guide.

Interface groups and changing data interface speeds

FortiGate-1800F and 1801F front panel data interfaces 25 to 36 are divided into the following groups:

- port25 - port28
- port29 - port32
- port33 - port36

All of the interfaces in a group operate at the same speed. Changing the speed of an interface changes the speeds of all of the interfaces in the same group. For example, if you change the speed of port26 from 10Gbps to 25Gbps the speeds of port25 to port28 are also changed to 25Gbps.

Another example, the default speed of the port25 to port36 interfaces is 10Gbps. If you want to install 25GigE transceivers in port29 to port36 to convert all of these data interfaces to connect to 25Gbps networks, you can enter the following from the CLI:

```
config system interface
   edit port29
      set speed 25000full
   next
   edit port33
      set speed 25000full
   end
```

Every time you change a data interface speed, when you enter the `end` command, the CLI confirms the range of interfaces affected by the change. For example, if you change the speed of port29 the following message appears:

```
config system interface
   edit port29
      set speed 25000full
   end
port29-port32 speed will be changed to 25000full due to hardware limit.
Do you want to continue? (y/n)
```

Configuring NPU port mapping

You can use the following command to configure FortiGate-1800F and 1801F NPU port mapping:

```
config system npu
   config port-npu-map
      edit <interface-name>
         set npu-group-index <index>
      end
```

You can use the port map to assign data interfaces to NP7 links.

Each NP7 has two 100-Gigabit KR links, numbered 0 and 1. Traffic passes to the NP7 over these links. By default the two links operate as a LAG that distributes sessions to the NP7 processor. You can configure the NPU port map to assign interfaces to use one or the other of the NP7 links instead of sending sessions over the LAG.

`<index>` varies depending on the NP7 processors available in your FortGate.

For the FortiGate-1800F `<index>` can be 0, 1, or 2:

- `0`, assign the interface to `NP#0`, the default, the interface is connected to the LAG. Traffic from the interface is distributed to both links.
- `1`, assign the interface to `NP#0-link0`, to connect the interface to NP7 link 0. Traffic from the interface is set to link 0.
- `2`, assign the interface to `NP#0-link1`, to connect the interface to NP7 link 1. Traffic from the interface is set to link 1.

For example, use the following syntax to assign the FortiGate-1800F front panel 40Gigabit interfaces 37 and 38 to NP#0-link0 and interfaces 39 and 40 to NP#0-link 1. The resulting configuration splits traffic from the 40Gigabit interfaces between the two NP7 links:

```
config system npu
   config port-npu-map
      edit port37
         set npu-group-index 1
      next
      edit port38
         set npu-group-index 1
      next
      edit port39
         set npu-group-index 2
      next
      edit port40
         set npu-group-index 2
      end
   end
```

You can use the `diagnose npu np7 port-list` command to see the current NPU port map configuration. While the FortiGate-1800F or 1801F is processing traffic, you can use the `diagnose npu np7 cgmac-stats <npu-id>` command to show how traffic is distributed to the NP7 links.

For example, after making the changes described in the example, the `np_group` column of the `diagnose npu np7 port-list` command output for port37 to port40 shows the new mapping:

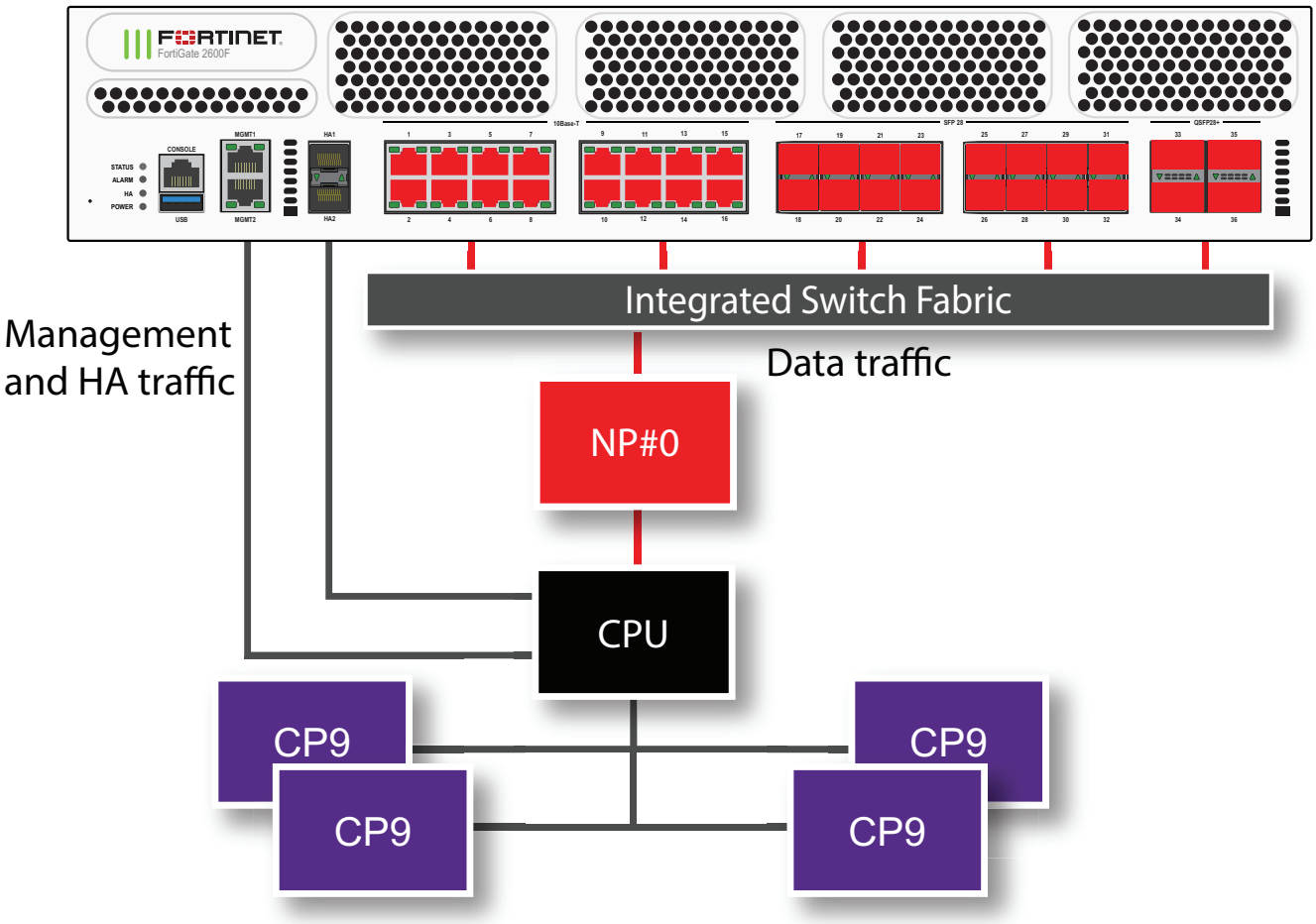
```
diagnose npu np7 port-list
name   max_speed(Mbps) np_group        switch_id sw_port_id sw_port_name
------ --------------- --------------- --------- ---------- ------------
.
```

```
.
.
port37 40000           NP#0-link0      1          29          xe25
port38 40000           NP#0-link0      1          25          xe24
port39 40000           NP#0-link1      1          33          xe26
port40 40000           NP#0-link1      1          37          xe27
```

FortiGate 2600F and 2601F fast path architecture

The FortiGate 2600F and 2601F models feature the following front panel interfaces:

- Two 1 GigE RJ45 (MGMT1 and MGMT2, not connected to the NP7 processors)
- Two 10 GigE SFP+ (HA1 and HA2, not connected to the NP7 processor)
- Sixteen 10 GigE RJ45 (1 to 16)
- Sixteen 10/25 GigE SFP+/SFP28 (17 to 32), interface groups: 17 - 20, 21 - 24, 25 - 28, and 29 - 32
- Four 100/40 GigE QSFP28/QSFP+ (33 to 36)



The FortiGate 2600F and 2601F each include one NP7 processor. All front panel data interfaces and the NP7 processor connect to the integrated switch fabric (ISF). All data traffic passes from the data interfaces through the ISF to the NP7

processor. All supported traffic passing between any two data interfaces can be offloaded by the NP7 processor. Data traffic processed by the CPU takes a dedicated data path through the ISF and the NP7 processor to the CPU.

The MGMT interfaces are not connected to the NP7 processor. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. You can also dedicate separate CPU resources for management traffic to further isolate management processing from data processing (see Dedicated management CPU on page 27).

The HA interfaces are also not connected to the NP7 processor. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing.

The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following command to display the FortiGate 2600F or 2601F NP7 configuration. The command output shows a single NP7 named NP#0 is connected to all interfaces. This interface to NP7 mapping is also shown in the diagram above.

```
diagnose npu np7 port-list
Front Panel Port:
Name     Max_speed(Mbps) Dflt_speed(Mbps) NP_group        Switch_id SW_port_id SW_port_name
-------- --------------- ---------------  --------------- --------- ---------- ------------
port1    10000           10000            NP#0            0         54         ge4
port2    10000           10000            NP#0            0         53         ge3
port3    10000           10000            NP#0            0         56         ge6
port4    10000           10000            NP#0            0         55         ge5
port5    10000           10000            NP#0            0         58         ge7
port6    10000           10000            NP#0            0         57         xe25
port7    10000           10000            NP#0            0         60         ge9
port8    10000           10000            NP#0            0         59         ge8
port9    10000           10000            NP#0            0         7          xe6
port10   10000           10000            NP#0            0         8          xe7
port11   10000           10000            NP#0            0         5          xe4
port12   10000           10000            NP#0            0         6          xe5
port13   10000           10000            NP#0            0         11         ge1
port14   10000           10000            NP#0            0         12         ge2
port15   10000           10000            NP#0            0         9          ge0
port16   10000           10000            NP#0            0         10         xe8
port17   25000           10000            NP#0            0         15         xe11
port18   25000           10000            NP#0            0         16         xe12
port19   25000           10000            NP#0            0         13         xe9
port20   25000           10000            NP#0            0         14         xe10
port21   25000           10000            NP#0            0         19         xe15
port22   25000           10000            NP#0            0         20         xe16
port23   25000           10000            NP#0            0         17         xe13
port24   25000           10000            NP#0            0         18         xe14
port25   25000           10000            NP#0            0         23         xe19
port26   25000           10000            NP#0            0         24         xe20
port27   25000           10000            NP#0            0         21         xe17
port28   25000           10000            NP#0            0         22         xe18
port29   25000           10000            NP#0            0         27         xe23
port30   25000           10000            NP#0            0         28         xe24
port31   25000           10000            NP#0            0         25         xe21
port32   25000           10000            NP#0            0         26         xe22
port33   100000          100000           NP#0            0         33         ce1
port34   100000          100000           NP#0            0         29         ce0
port35   100000          100000           NP#0            0         37         ce2
port36   100000          100000           NP#0            0         41         ce3
```

```
-------- --------------- ---------------  --------------- --------- ---------- ------------

NP Port:
Name   Switch_id SW_port_id SW_port_name
------ --------- ---------- ------------
np0_0  0         45         ce4
np0_1  0         49         ce5
------ --------- ---------- ------------
* Max_speed: Maximum speed, Dflt_speed: Default speed
* SW_port_id: Switch port ID, SW_port_name: Switch port name
```

The command output also shows the maximum and default speeds of each interface.

The NP7 processor has a bandwidth capacity of 200 Gigabits. You can see from the command output that if all interfaces were operating at their maximum bandwidth the NP7 processor would not be able to offload all the traffic.

The NP7 processor has a bandwidth capacity of 200 Gigabits. You can see from the command output that if all interfaces were operating at their maximum bandwidth the NP7 processor would not be able to offload all the traffic.

The FortiGate-2600F and 2601F can be licensed for hyperscale firewall support, see the Hyperscale Firewall Guide.

Interface groups and changing data interface speeds

FortiGate-2600F and 2601F front panel data interfaces 17 to 32 are divided into the following groups:

- port17 - port20
- port21 - port24
- port25 - port28
- port29 - port32

All of the interfaces in a group operate at the same speed. Changing the speed of an interface changes the speeds of all of the interfaces in the same group. For example, if you change the speed of port26 from 10Gbps to 25Gbps, the speeds of port25 to port28 are also changed to 25Gbps.

Another example, the default speed of the port25 to port32 interfaces is 10Gbps. If you want to install 25GigE transceivers in port25 to port32 to convert all of these data interfaces to connect to 25Gbps networks, you can enter the following from the CLI:

```
config system interface
   edit port25
      set speed 25000full
   next
   edit port29
      set speed 25000full
   end
```

Every time you change a data interface speed, when you enter the `end` command, the CLI confirms the range of interfaces affected by the change. For example, if you change the speed of port29 the following message appears:

```
config system interface
   edit port29
      set speed 25000full
   end
port29-port32 speed will be changed to 25000full due to hardware limit.
Do you want to continue? (y/n)
```

Configuring NPU port mapping

You can use the following command to configure FortiGate-2600F and 2601F NPU port mapping:

```
config system npu
   config port-npu-map
      edit <interface-name>
         set npu-group-index <index>
      end
```

You can use the port map to assign data interfaces to NP7 links.

Each NP7 has two 100-Gigabit KR links, numbered 0 and 1. Traffic passes to the NP7 over these links. By default the two links operate as a LAG that distributes sessions to the NP7 processor. You can configure the NPU port map to assign interfaces to use one or the other of the NP7 links instead of sending sessions over the LAG.

`<index>` varies depending on the NP7 processors available in your FortGate.

For the FortiGate-2600F `<index>` can be 0, 1, or 2:

- `0`, assign the interface to `NP#0`, the default, the interface is connected to the LAG. Traffic from the interface is distributed to both links.
- `1`, assign the interface to `NP#0-link0`, to connect the interface to NP7 link 0. Traffic from the interface is set to link 0.
- `2`, assign the interface to `NP#0-link1`, to connect the interface to NP7 link 1. Traffic from the interface is set to link 1.

For example, use the following syntax to assign the FortiGate-2600F front panel 100Gigabit interfaces 33 and 34 to NP#0-link0 and interfaces 35 and 36 to NP#0-link1. The resulting configuration splits traffic from the 40Gigabit interfaces between the two NP7 links:

```
config system npu
   config port-npu-map
      edit port33
         set npu-group-index 1
      next
      edit port34
         set npu-group-index 1
      next
      edit port35
         set npu-group-index 2
      next
      edit port36
         set npu-group-index 2
      end
   end
```

You can use the `diagnose npu np7 port-list` command to see the current NPU port map configuration. While the FortiGate-2600F or 2601F is processing traffic, you can use the `diagnose npu np7 cgmac-stats <npu-id>` command to show how traffic is distributed to the NP7 links.

For example, after making the changes described in the example, the `np_group` column of the `diagnose npu np7 port-list` command output for port33 to port36 shows the new mapping:

```
diagnose npu np7 port-list
Front Panel Port:
Name     Max_speed(Mbps) Dflt_speed(Mbps) NP_group        Switch_id SW_port_id SW_port_name
-------- --------------- ---------------  --------------- --------- ---------- ------------
```

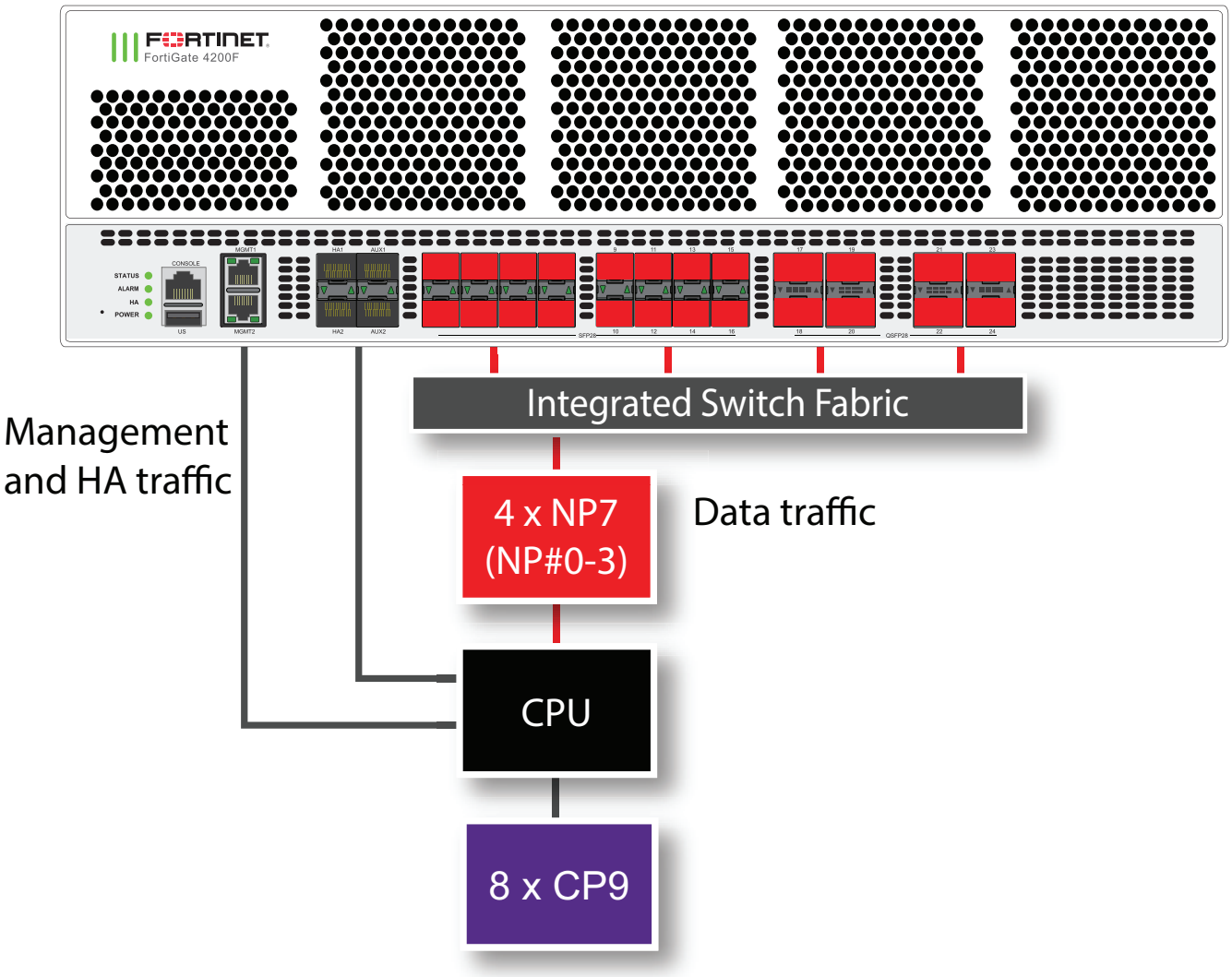
```
.
.
.
port33   100000          100000          NP#0-link0      0         33         ce1
port34   100000          100000          NP#0-link0      0         29         ce0
port35   100000          100000          NP#0-link1      0         37         ce2
port36   100000          100000          NP#0-link1      0         41         ce3
```

FortiGate 4200F and 4201F fast path architecture

The FortiGate 4200F and 4201F each include four NP7 processors (NP#0, NP#1, NP#2, and NP#3). All front panel data interfaces (1 to 24) connect to the NP7 processors over the integrated switch fabric. So all supported traffic passing between any two data interfaces can be offloaded.

The FortiGate 4200F and 4201F models feature the following front panel interfaces:

- Two 1 GigE (MGMT1 and MGMT2, not connected to the NP7 processors).
- Four 10/25 GigE SFP28 (HA1, HA2 , AUX1, and AUX2 not connected to the NP7 processors) interface group: HA1, HA2, AUX1, and AUX2.
- Sixteen 10/25 GigE SFP28 (1 to 16), interface groups: 1 - 4, 5 - 8, 9 - 12, 13 - 16.
- Eight 40/100 GigE QSFP28 (17 to 24). Each of these interfaces can be split into four 1/10/25 GigE SFP28 interfaces.



The FortiGate 4200F and 4201F each include four NP7 processors. All front panel data interfaces and the NP7 processors connect to the integrated switch fabric (ISF). All data traffic passes from the data interfaces through the ISF to the NP7 processors. All supported traffic passing between any two data interfaces can be offloaded by the NP7 processors. Data traffic processed by the CPU takes a dedicated data path through the ISF and an NP7 processor to the CPU.

The MGMT interfaces are not connected to the NP7 processors. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. You can also dedicate separate CPU resources for management traffic to further isolate management processing from data processing (see Dedicated management CPU on page 27).

The HA interfaces are also not connected to the NP7 processors. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing.

The AUX interfaces are also not connected to the NP7 processors. Fortinet recommends using these interfaces for HA session synchronization.

The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following command to display the FortiGate 4200F and 4201F NP7 configuration. The command output shows a that all four NP7s are connected to all interfaces.

```
diagnose npu np7 port-list
Front Panel Port:
Name   Max_speed(Mbps) Dflt_speed(Mbps) NP_group        Switch_id SW_port_id SW_port_name
------ --------------- ---------------  --------------- --------- ---------- ------------
port1  25000           10000            NP#0-3          0         37         xe10
port2  25000           10000            NP#0-3          0         38         xe11
port3  25000           10000            NP#0-3          0         39         xe12
port4  25000           10000            NP#0-3          0         40         xe13
port5  25000           10000            NP#0-3          0         41         xe14
port6  25000           10000            NP#0-3          0         42         xe15
port7  25000           10000            NP#0-3          0         43         xe16
port8  25000           10000            NP#0-3          0         44         xe17
port9  25000           10000            NP#0-3          0         45         xe18
port10 25000           10000            NP#0-3          0         46         xe19
port11 25000           10000            NP#0-3          0         47         xe20
port12 25000           10000            NP#0-3          0         48         xe21
port13 25000           10000            NP#0-3          0         49         xe22
port14 25000           10000            NP#0-3          0         50         xe23
port15 25000           10000            NP#0-3          0         51         xe24
port16 25000           10000            NP#0-3          0         52         xe25
port17 100000          100000           NP#0-3          0         57         ce5
port18 100000          100000           NP#0-3          0         53         ce4
port19 100000          100000           NP#0-3          0         67         ce7
port20 100000          100000           NP#0-3          0         61         ce6
port21 100000          100000           NP#0-3          0         75         ce9
port22 100000          100000           NP#0-3          0         71         ce8
port23 100000          100000           NP#0-3          0         83         ce11
port24 100000          100000           NP#0-3          0         79         ce10
------ --------------- ---------------  --------------- --------- ---------- ------------

NP Port:
Name   Switch_id SW_port_id SW_port_name
------ --------- ---------- ------------
np0_0  0         5          ce0
np0_1  0         9          ce1
np1_0  0         13         ce2
np1_1  0         17         ce3
np2_0  0         115        ce13
np2_1  0         111        ce12
np3_0  0         123        ce15
np3_1  0         119        ce14
------ --------- ---------- ------------
* Max_speed: Maximum speed, Dflt_speed: Default speed
* SW_port_id: Switch port ID, SW_port_name: Switch port name
```

The command output also shows the maximum and default speeds of each interface.

The integrated switch fabric distributes sessions from the data interfaces to the NP7 processors. The four NP7 processors have a bandwidth capacity of 200Gigabit x 4 = 800 Gigabit. If all interfaces were operating at their maximum bandwidth, the NP7 processors would not be able to offload all the traffic. You can use NPU port mapping to control how sessions are distributed to NP7 processors.

You can add LAGs to improve performance. For details, see Increasing NP7 offloading capacity using link aggregation groups (LAGs) on page 39.

The FortiGate-4200F and 4201F can be licensed for hyperscale firewall support, see the Hyperscale Firewall Guide.

Interface groups and changing data interface speeds

FortiGate-4200F and 4201F front panel data interfaces are divided into the following groups:

- ha1, ha2, aux1, and aux2
- port1 - port4
- port5 - port8
- port9 - port12
- port13 - port16

All of the interfaces in a group operate at the same speed. Changing the speed of an interface changes the speeds of all of the interfaces in the same group. For example, if you want to install 25GigE transceivers in port1 to port8 to convert all of these data interfaces to connect to 25Gbps networks, you can enter the following from the CLI:

```
config system interface
   edit port1
      set speed 25000full
   next
   edit port5
      set speed 25000full
   end
```

Every time you change a data interface speed, when you enter the `end` command, the CLI confirms the range of interfaces affected by the change. For example, if you change the speed of port5, the following message appears:

```
config system interface
   edit port5
      set speed 25000full
   end
port5-port8 speed will be changed to 25000full due to hardware limit.
Do you want to continue? (y/n)
```

Splitting the port17 to port24 interfaces

You can use the following command to split each FortiGate 4200F or 4201F 17 to 24 (port17 to port24) 40/100 GigE QSFP28 interface into four 1/10/25 GigE SFP28 interfaces. For example, to split interfaces 19 and 23 (port19 and port23), enter the following command:

```
config system global
   set split-port port19 port23
end
```

The FortiGate 4200F or 4201F reboots and when it starts up:

- The port19 interface has been replaced by four SFP28 interfaces named port19/1 to port19/4.
- The port23 interface has been replaced by four SFP28 interfaces named port23/1 to port23/4.

By default, the speed of each split interface is set to `10000full` (10GigE). These interfaces can operate as 25GigE, 10GigE, or 1GigE interfaces depending on the transceivers and breakout cables. You can use the `config system interface` command to change the speeds of the split interfaces.

If you set the speed of one of the split interfaces to `25000full` (25GigE), all of the interfaces are changed to operate at this speed (no restart required). If the split interfaces are set to `25000full` and you change the speed of one of them to `10000full` (10GigE) they are all changed to `10000full` (no restart required). When the interfaces are operating at `10000full`, you can change the speeds of individual interfaces to operate at `1000full` (1GigE).

Configuring NPU port mapping

The default FortiGate-4200F and 4201F port mapping configuration results in sessions passing from front panel data interfaces to the integrated switch fabric. The integrated switch fabric distributes these sessions among the NP7 processors. Each NP7 processor is connected to the switch fabric with a LAG that consists of two 100-Gigabit CAUI-4 interfaces. The integrated switch fabric distributes sessions to the LAGs and each LAG distributes sessions between the two interfaces connected to the NP7 processor.

You can use NPU port mapping to override how data network interface sessions are distributed to each NP7 processor. For example, you can sent up NPU port mapping to send all traffic from a front panel data interface to a specific NP7 processor LAG or even to just one of the interfaces in that LAG.

Use the following command to configure NPU port mapping:

```
config system npu
   config port-npu-map
      edit <interface-name>
         set npu-group-index <index>
      end
```

`<interface-name>` the name of a front panel data interface.

`<index>` select different values of `<index>` to change how sessions from the selected front panel data interface are handled by the integrated switch fabric. The list of available `<index>` options depends on the NP7 configuration of your FortGate. For the FortiGate-4200F or 4201F `<index>` can be 0 to 16. Use the ? to see the effect of each `<index>` value.

Here are some examples of `<index>` values for the FortiGate-4200F and 4201F:

- `0`, assign the front panel data interface to `NP#0-3`, the default. Sessions from the front panel data interface are distributed among all four NP7 LAGs.
- `1`, assign the front panel data interface to the LAG connected to `NP#0`. Sessions from the front panel data interface are sent to the LAG connected to NP#0.
- `7`, assign the front panel data interface to `NP#2-3`. Sessions from the front panel data interface are distributed between the LAGs connected to NP#2 and NP#3.
- `10`, assign the front panel data interface to `NP#0_0`. Sessions from the front panel data interface are sent to `np0_0`, which is one of the interfaces connected to NP#0.

For example, use the following syntax to assign the FortiGate-4200F port21 and port22 interfaces to NP#2 and port23 and port24 interfaces to NP#3:

```
config system npu
   config port-npu-map
      edit port21
         set npu-group-index 3
      next
      edit port22
         set npu-group-index 3
      next
      edit port23
         set npu-group-index 4
      next
      edit port24
         set npu-group-index 4
      end
   end
```

You can use the `diagnose npu np7 port-list` command to see the current NPU port map configuration. While the FortiGate-4200F or 4201F is processing traffic, you can use the `diagnose npu np7 cgmac-stats <npu-id>` command to show how traffic is distributed to the NP7 links.

For example, after making the changes described in the example, the `NP_group` column of the `diagnose npu np7 port-list` command output for port21 to port 24 shows the new mapping:

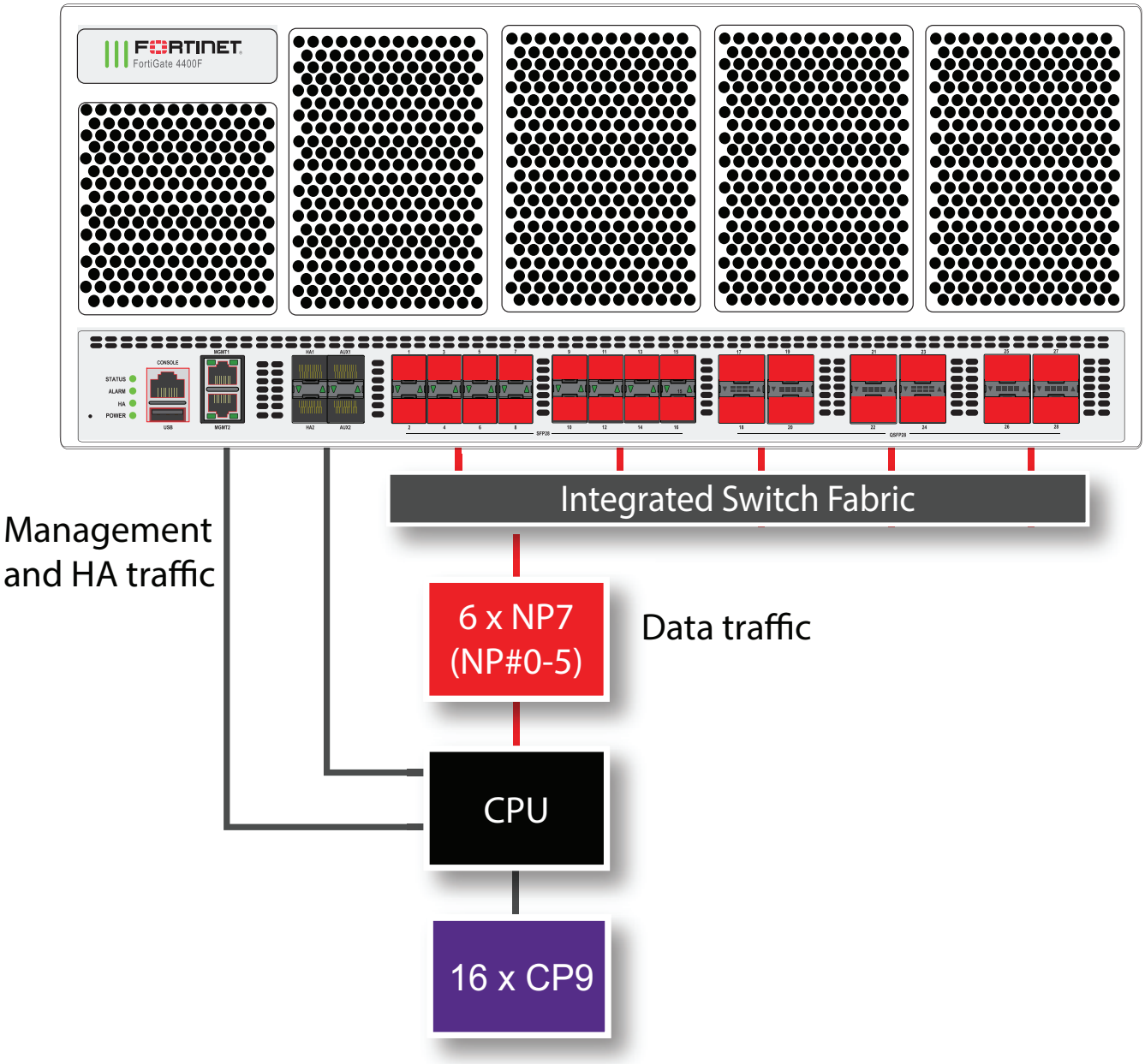
```
diagnose npu np7 port-list
Front Panel Port:
Name   Max_speed(Mbps) Dflt_speed(Mbps) NP_group        Switch_id SW_port_id SW_port_name
------ --------------- ---------------  --------------- --------- ---------- ------------
.
.
.
port21 100000          100000           NP#2            0         75         ce9
port22 100000          100000           NP#2            0         71         ce8
port23 100000          100000           NP#3            0         83         ce11
port24 100000          100000           NP#3            0         79         ce10
------ --------------- ---------------  --------------- --------- ---------- ------------
```

FortiGate 4400F and 4401F fast path architecture

The FortiGate 4400F and 4401F each include six NP7 processors (NP#0, NP#1, NP#2, NP#3, NP#4, and NP#5). All front panel data interfaces (1 to 28) connect to the NP7 processors over the integrated switch fabric. So all supported traffic passing between any two data interfaces can be offloaded.

The FortiGate 4400F and 4401F models feature the following front panel interfaces:

- Two 1GigE RJ45 Copper (MGMT1 and MGMT2, not connected to the NP7 processors).
- Four 10/25 GigE SFP28 (HA1, HA2 , AUX1, and AUX2 not connected to the NP7 processors) interface group: HA1, HA2, AUX1, and AUX2.
- Sixteen 10/25 GigE SFP28 (1 to 16), interface groups: 1 - 4, 5 - 8, 9 - 12, 13 - 16.
- Twelve 40/100 GigE QSFP28 (17 to 28). Each of these interfaces can be split into four 1/10/25 GigE SFP28 interfaces.



The FortiGate 4400F and 4401F each include six NP7 processors. All front panel data interfaces and the NP7 processors connect to the integrated switch fabric (ISF). All data traffic passes from the data interfaces through the ISF to the NP7 processors. All supported traffic passing between any two data interfaces can be offloaded by the NP7 processors. Data traffic processed by the CPU takes a dedicated data path through the ISF and an NP7 processor to the CPU.

The MGMT interfaces are not connected to the NP7 processors. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. You can also dedicate separate CPU resources for management traffic to further isolate management processing from data processing (see Dedicated management CPU on page 27).

The HA interfaces are also not connected to the NP7 processors. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing.

The AUX interfaces are also not connected to the NP7 processors. Fortinet recommends using these interfaces for HA session synchronization.

The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following command to display the FortiGate 4400F and 4401F NP7 configuration. The command output shows that all six np7s are connected to all interfaces.

```
diagnose npu np7 port-list
Front Panel Port:
Name     Max_speed(Mbps) Dflt_speed(Mbps) NP_group        Switch_id SW_port_id SW_port_name
-------- --------------- ---------------  --------------- --------- ---------- ------------
port1    25000           10000            NP#0-5          0         37         xe12
port2    25000           10000            NP#0-5          0         38         xe13
port3    25000           10000            NP#0-5          0         39         xe14
port4    25000           10000            NP#0-5          0         40         xe15
port5    25000           10000            NP#0-5          0         41         xe16
port6    25000           10000            NP#0-5          0         42         xe17
port7    25000           10000            NP#0-5          0         43         xe18
port8    25000           10000            NP#0-5          0         44         xe19
port9    25000           10000            NP#0-5          0         45         xe20
port10   25000           10000            NP#0-5          0         46         xe21
port11   25000           10000            NP#0-5          0         47         xe22
port12   25000           10000            NP#0-5          0         48         xe23
port13   25000           10000            NP#0-5          0         49         xe24
port14   25000           10000            NP#0-5          0         50         xe25
port15   25000           10000            NP#0-5          0         51         xe26
port16   25000           10000            NP#0-5          0         52         xe27
port17   100000          100000           NP#0-5          0         57         ce7
port18   100000          100000           NP#0-5          0         53         ce6
port19   100000          100000           NP#0-5          0         67         ce9
port20   100000          100000           NP#0-5          0         61         ce8
port21   100000          100000           NP#0-5          0         75         ce11
port22   100000          100000           NP#0-5          0         71         ce10
port23   100000          100000           NP#0-5          0         83         ce13
port24   100000          100000           NP#0-5          0         79         ce12
port25   100000          100000           NP#0-5          0         91         ce15
port26   100000          100000           NP#0-5          0         87         ce14
port27   100000          100000           NP#0-5          0         99         ce17
port28   100000          100000           NP#0-5          0         95         ce16
-------- --------------- ---------------  --------------- --------- ---------- ------------

NP Port:
Name   Switch_id SW_port_id SW_port_name
------ --------- ---------- ------------
np0_0  0         5          ce0
np0_1  0         9          ce1
np1_0  0         13         ce2
np1_1  0         17         ce3
np2_0  0         21         ce4
np2_1  0         25         ce5
np3_0  0         115        ce21
np3_1  0         111        ce20
np4_0  0         107        ce19
np4_1  0         103        ce18
np5_0  0         123        ce23
np5_1  0         119        ce22
------ --------- ---------- ------------
* Max_speed: Maximum speed, Dflt_speed: Default speed
* SW_port_id: Switch port ID, SW_port_name: Switch port name
```

The command output also shows the maximum and default speeds of each interface.

The integrated switch fabric distributes sessions from the data interfaces to the NP7 processors. The six NP7 processors have a bandwidth capacity of 200Gigabit x 6 = 1200 Gigabit. If all interfaces were operating at their maximum bandwidth, the NP7 processors would not be able to offload all the traffic. You can use NPU port mapping to control how sessions are distributed to NP7 processors.

You can add LAGs to improve performance. For details, see Increasing NP7 offloading capacity using link aggregation groups (LAGs) on page 39.

The FortiGate-4400F and 4401F can be licensed for hyperscale firewall support, see the Hyperscale Firewall Guide.

Interface groups and changing data interface speeds

FortiGate-4400F and 4401F front panel data interfaces are divided into the following groups:

- ha1, ha2, aux1, and aux2
- port1 - port4
- port5 - port8
- port9 - port12
- port13 - port16

All of the interfaces in a group operate at the same speed. Changing the speed of an interface changes the speeds of all of the interfaces in the same group. For example, if you want to install 25GigE transceivers in port1 to port8 to convert all of these data interfaces to connect to 25Gbps networks, you can enter the following from the CLI:

```
config system interface
   edit port1
      set speed 25000full
   next
   edit port5
      set speed 25000full
   end
```

Every time you change a data interface speed, when you enter the `end` command, the CLI confirms the range of interfaces affected by the change. For example, if you change the speed of port5, the following message appears:

```
config system interface
   edit port5
      set speed 25000full
   end
port5-port8 speed will be changed to 25000full due to hardware limit.
Do you want to continue? (y/n)
```

Splitting the port17 to port28 interfaces

You can use the following command to split each FortiGate 4400F or 4401F 17 to 28 (port17 to port28) 40/100 GigE QSFP28 interface into four 10/25 GigE SFP28 interfaces. For example, to split interfaces 19 and 26 (port19 and port26), enter the following command:

```
config system global
   set split-port port19 port26
end
```

The FortiGate 4400F or 4401F reboots and when it starts up:

- The port19 interface has been replaced by four SFP28 interfaces named port19/1 to port19/4.
- The port26 interface has been replaced by four SFP28 interfaces named port26/1 to port26/4.

By default, the speed of each split interface is set to `10000full` (10GigE). These interfaces can operate as 25GigE, 10GigE, or 1GigE interfaces depending on the transceivers and breakout cables. You can use the `config system interface` command to change the speeds of the split interfaces.

If you set the speed of one of the split interfaces to `25000full` (25GigE), all of the interfaces are changed to operate at this speed (no restart required). If the split interfaces are set to `25000full` and you change the speed of one of them to `10000full` (10GigE) they are all changed to `10000full` (no restart required). When the interfaces are operating at `10000full`, you can change the speeds of individual interfaces to operate at `1000full` (1GigE).

Configuring NPU port mapping

The default FortiGate-4400F and 4401F port mapping configuration results in sessions passing from front panel data interfaces to the integrated switch fabric. The integrated switch fabric distributes these sessions among the NP7 processors. Each NP7 processor is connected to the switch fabric with a LAG that consists of two 100-Gigabit CAUI-4 interfaces. The integrated switch fabric distributes sessions to the LAGs and each LAG distributes sessions between the two interfaces connected to the NP7 processor.

You can use NPU port mapping to override how data network interface sessions are distributed to each NP7 processor. For example, you can sent up NPU port mapping to send all traffic from a front panel data interface to a specific NP7 processor LAG or even to just one of the interfaces in that LAG.

Use the following command to configure NPU port mapping:

```
config system npu
   config port-npu-map
      edit <interface-name>
         set npu-group-index <index>
      end
```

`<interface-name>` the name of a front panel data interface.

`<index>` select different values of `<index>` to change how sessions from the selected front panel data interface are handled by the integrated switch fabric. The list of available `<index>` options depends on the NP7 configuration of your FortGate. For the FortiGate-4400F or 4401F `<index>` can be 0 to 24. Use the ? to see the effect of each `<index>` value.

Here are some examples of `<index>` values for the FortiGate-4400F and 4401F:

- `0`, assign the front panel data interface to `NP#0-5`, the default. Sessions from the front panel data interface are distributed among all six NP7 LAGs.
- `1`, assign the front panel data interface to the LAG connected to `NP#0`. Sessions from the front panel data interface are sent to the LAG connected to NP#0.
- `8`, assign the front panel data interface to `NP#2-3`. Sessions from the front panel data interface are distributed between the LAGs connected to NP#2 and NP#3.
- `17`, assign the front panel data interface to `NP#2-link0`. Sessions from the front panel data interface are sent to `np2_link0`, which is one of the interfaces connected to NP#2.

For example, use the following syntax to assign the FortiGate-4400F interfaces 25 and 26 to NP7#4 and interfaces 27 and 28 to NP7#5:

```
config system npu
   config port-npu-map
      edit port25
```

```
        set npu-group-index 5
    next
    edit port26
        set npu-group-index 5
    next
    edit port27
        set npu-group-index 6
    next
    edit port28
        set npu-group-index 6
    end
end
```

You can use the `diagnose npu np7 port-list` command to see the current NPU port map configuration. While the FortiGate-4400F or 4401F is processing traffic, you can use the `diagnose npu np7 cgmac-stats <npu-id>` command to show how traffic is distributed to the NP7 links.

For example, after making the changes described in the example, the `NP_group` column of the `diagnose npu np7 port-list` command output for port25 to port28 shows the new mapping:

```
diagnose npu np7 port-list
Front Panel Port:
Name     Max_speed(Mbps) Dflt_speed(Mbps) NP_group        Switch_id SW_port_id SW_port_name
-------- --------------- ---------------  --------------- --------- ---------- ------------
.
.
.
port25   100000          100000           NP#4            0         91         ce15
port26   100000          100000           NP#4            0         87         ce14
port27   100000          100000           NP#5            0         99         ce17
port28   100000          100000           NP#5            0         95         ce16
-------- --------------- ---------------  --------------- --------- ---------- ------------
```

NP6, NP6XLite, and NP6Lite acceleration

NP6, NP6XLite, and NP6Lite network processors provide fastpath acceleration by offloading communication sessions from the FortiGate CPU. When the first packet of a new session is received by an interface connected to an NP6 processor, just like any session connecting with any FortiGate interface, the session is forwarded to the FortiGate CPU where it is matched with a security policy. If the session is accepted by a security policy and if the session can be offloaded its session key is copied to the NP6 processor that received the packet. All of the rest of the packets in the session are intercepted by the NP6 processor and fast-pathed out of the FortiGate unit to their destination without ever passing through the FortiGate CPU. The result is enhanced network performance provided by the NP6 processor plus the network processing load is removed from the CPU. In addition the NP6 processor can handle some CPU intensive tasks, like IPsec VPN encryption/decryption.

NP6XLite and NP6Lite processors have the same architecture and function in the same way as NP6 processors. All of the descriptions of NP6 processors in this document can be applied to NP6XLite and NP6Lite possessors except where noted.

Session keys (and IPsec SA keys) are stored in the memory of the NP6 processor that is connected to the interface that received the packet that started the session. All sessions are fast-pathed and accelerated, even if they exit the FortiGate unit through an interface connected to another NP6. There is no dependence on getting the right pair of interfaces since the offloading is done by the receiving NP6.

The key to making this possible is an Integrated Switch Fabric (ISF) that connects the NP6s and the FortiGate unit interfaces together. Many FortiGate units with NP6 processors also have an ISF. The ISF allows any interface connectivity to any NP6 on the same ISF. There are no special ingress and egress fast path requirements as long as traffic enters and exits on interfaces connected to the same ISF.

Some FortiGate units, such as the FortiGate 1000D include multiple NP6 processors that are not connected by an ISF. Because the ISF is not present fast path acceleration is supported only between interfaces connected to the same NP6 processor. Since the ISF introduces some latency, models with no ISF provide low-latency network acceleration between network interfaces connected to the same NP6 processor.

Each NP6 has a maximum throughput of 40 Gbps using 4 x 10 Gbps XAUI or Quad Serial Gigabit Media Independent Interface (QSGMII) interfaces or 3 x 10 Gbps and 16 x 1 Gbps XAUI or QSGMII interfaces.

There are at least two limitations to keep in mind:

- The capacity of each NP6 processor. An individual NP6 processor can support between 10 and 16 million sessions. This number is limited by the amount of memory the processor has. Once an NP6 processor hits its session limit, sessions that are over the limit are sent to the CPU. You can avoid this problem by as much as possible distributing incoming sessions evenly among the NP6 processors. To be able to do this you need to be aware of which interfaces connect to which NP6 processors and distribute incoming traffic accordingly.
- The NP6 processors in some FortiGate units employ NP direct technology that removes the ISF. The result is very low latency but no inter-processor connectivity requiring you to make sure that traffic to be offloaded enters and exits the FortiGate through interfaces connected to the same NP processor.

NP6 session fast path requirements

NP6 processors can offload the following traffic and services:

- IPv4 and IPv6 traffic and NAT64 and NAT46 traffic (as well as IPv4 and IPv6 versions of the following traffic types where appropriate).
- Link aggregation (LAG) (IEEE 802.3ad) traffic and traffic from static redundant interfaces (see Increasing NP6 offloading capacity using link aggregation groups (LAGs) on page 109).
- TCP, UDP, ICMP, SCTP, and RDP traffic.
- IPsec VPN traffic, and offloading of IPsec encryption/decryption (including SHA2-256 and SHA2-512)
- NP6 processor IPsec engines support null, DES, 3DES, AES128, AES192, and AES256 encryption algorithms
- NP6 processor IPsec engines support null, MD5, SHA1, SHA256, SHA 384, and SHA512 authentication algorithms
- IPsec traffic that passes through a FortiGate without being unencrypted.
- Anomaly-based intrusion prevention, checksum offload and packet defragmentation.
- IPIP tunneling (also called IP in IP tunneling), SIT tunneling, and IPv6 tunneling sessions.
- UDP traffic with a destination port of 4500 (ESP-in-UDP traffic) (if enabled, see Offloading UDP-encapsulated ESP traffic on page 138).
- Multicast traffic (including Multicast over IPsec).
- CAPWAP and wireless bridge traffic tunnel encapsulation to enable line rate wireless forwarding from FortiAP devices (not supported by the NP6Lite).
- Traffic shaping and priority queuing for both shared and per IP traffic shaping.
- Syn proxying (not supported by the NP6Lite).
- DNS session helper (not supported by the NP6Lite).
- Inter-VDOM link traffic. Inter-VDOM link traffic between two EMAC VLAN interfaces cannot be offloaded.

Sessions that are offloaded must be fast path ready. For a session to be fast path ready it must meet the following criteria:

- Layer 2 type/length must be 0x0800 for IPv4 or 0x86dd for IPv6 (IEEE 802.1q VLAN specification is supported).
- Layer 3 protocol can be IPv4 or IPv6.
- Layer 4 protocol can be UDP, TCP, ICMP, or SCTP.
- In most cases, Layer 3 / Layer 4 header or content modification sessions that require a session helper can be offloaded.
- Local host traffic (originated by the FortiGate unit) can be offloaded.
- If the FortiGate supports, NTurbo sessions can be offloaded if they are accepted by firewall policies that include IPS, Application Control, CASI, flow-based antivirus, or flow-based web filtering.

Offloading Application layer content modification is not supported. This means that sessions are not offloaded if they are accepted by firewall policies that include proxy-based virus scanning, proxy-based web filtering, DNS filtering, DLP, Anti-Spam, VoIP, ICAP, Web Application Firewall, or Proxy options.

DoS policy sessions are also not offloaded by NP6 processors.

If you disable anomaly checks by Intrusion Prevention (IPS), you can still enable hardware accelerated anomaly checks using the `fp-anomaly` field of the `config system interface` CLI command. See Configuring individual NP6 processors on page 124.

If a session is not fast path ready, the FortiGate unit will not send the session key or IPsec SA key to the NP6 processor. Without the session key, all session key lookup by a network processor for incoming packets of that session fails, causing all session packets to be sent to the FortiGate unit's main processing resources, and processed at normal speeds.

If a session is fast path ready, the FortiGate unit will send the session key or IPsec SA key to the network processor. Session key or IPsec SA key lookups then succeed for subsequent packets from the known session or IPsec SA.

Packet fast path requirements

Packets within the session must then also meet packet requirements.

- Incoming packets must not be fragmented.
- Outgoing packets must not require fragmentation to a size less than 385 bytes. Because of this requirement, the configured MTU (Maximum Transmission Unit) for a network processor's network interfaces must also meet or exceed the NP6-supported minimum MTU of 385 bytes.

Mixing fast path and non-fast path traffic

If packet requirements are not met, an individual packet will be processed by the FortiGate CPU regardless of whether other packets in the session are offloaded to the NP6.

Also, in some cases, a protocol's session(s) may receive a mixture of offloaded and non-offloaded processing. For example, VoIP control packets may not be offloaded but VoIP data packets (voice packets) may be offloaded.

NP6XLite processors

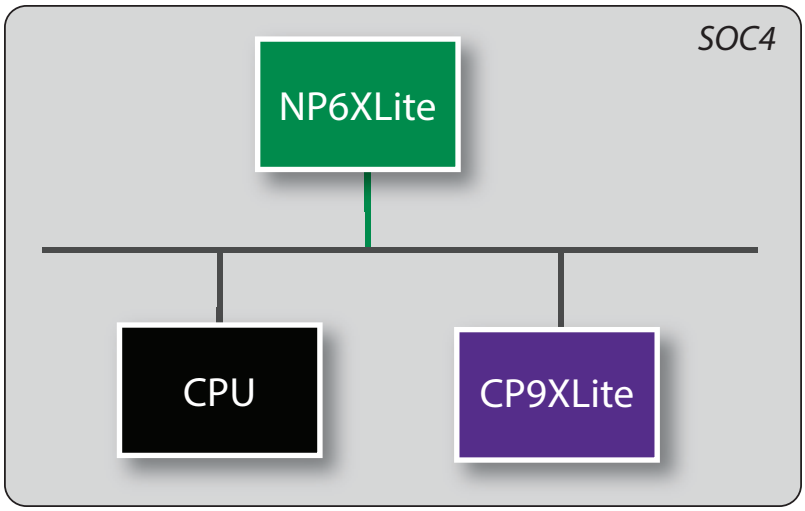
The NP6XLite is a new iteration of NP6 technology that supports more features than the standard NP6 processor. For example, the NP6XLite can offload AES128-GCM and AES256-GCM encryption for IPsec VPN traffic. The NP6XLite has slightly lower throughput (36Gbps) than the NP6 (40Gbps).

The NP6XLite includes 4x KR/USXGMII/QSGMII and 2x(1x) Reduced gigabit media-independent interface (RGMII) interfaces.

The NP6XLite is a component of the Fortinet SOC4. The SOC4 includes a CPU, the NP6XLite network processor, and the CP9XLite content processor that supports most CP9 functionality but with a lower capacity.

Some FortiGate models, such as the FortiGate-200F and 201F include a SOC4 but only use the NP6XLite processor. FortiGate-200F and 201F CPU functionality is supplied by a separate CPU and CP9 functionality by two separate CP9 processors. See FortiGate 200F and 201F fast path architecture on page 230 for more information.

SOC4 architecture



NP6Lite processors

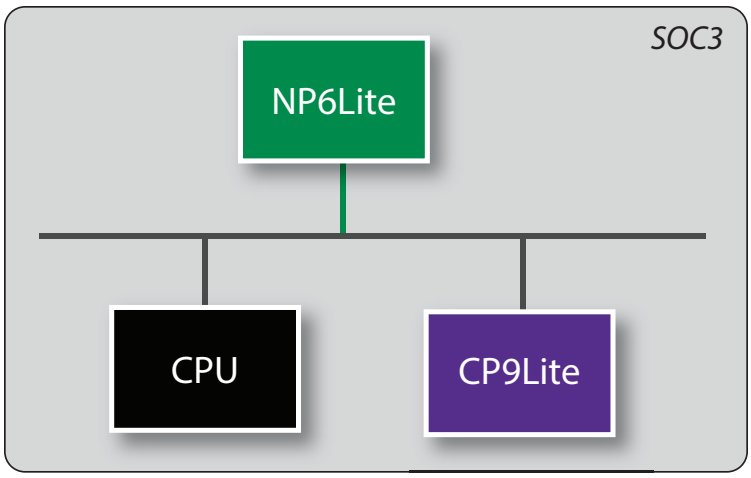
The NP6Lite works the same way as the NP6. Being a lighter version, the NP6Lite has a lower capacity than the NP6. The NP6Lite max throughput is 10 Gbps using 2x QSGMII and 2x Reduced gigabit media-independent interface (RGMII) interfaces.

Also, the NP6Lite does not offload the following types of sessions:

- CAPWAP
- Syn proxy
- DNS session helper

The NP6Lite is a component of the Fortinet SOC3. The SOC3 includes a CPU, the NP6Lite network processor, and a CP9Lite content processor that supports most CP9 functionality but with a lower capacity.

SOC3 architecture



NP6 processors and traffic shaping

NP6-offloaded sessions support most types of traffic shaping. However, in bandwidth and out bandwidth traffic shaping, set using the following command, is not supported:

```
config system interface
   edit port1
      set outbandwidth <value>
      set inbandwidth <value>
   end
```

Configuring in bandwidth traffic shaping has no effect. Configuring out bandwidth traffic shaping imposes more limiting than configured, potentially reducing throughput more than expected.

When NP6 or NP6Lite offloading is enabled, the NP6 and NP6Lite processors do not update traffic shaping statistics, including information about packets dropped by traffic shaping. For example, traffic shaping logs and the output of diagnose commands (for example, `diagnose firewall shaper`) will show traffic shaping counters as 0.

NP6XLite processors do support updating traffic shaping statistics and log messages and diagnose command output related to traffic shaping should show accurate statistics.

NP Direct

On FortiGates with more than one NP6 processor, removing the Internal Switch Fabric (ISF) for NP Direct architecture provides direct access to the NP6 processors for the lowest latency forwarding. Because the NP6 processors are not connected, care must be taken with network design to make sure that all traffic to be offloaded enters and exits the FortiGate through interfaces connected to the same NP6 processor. As well Link Aggregation (LAG) interfaces should only include interfaces all connected to the same NP6 processor.

Example NP direct hardware with more than one NP6 processor includes:

- Ports 25 to 32 of the FortiGate 3700D in low latency mode.
- FortiGate 2000E
- FortiGate 2500E

Viewing your FortiGate NP6, NP6XLite, or NP6Lite processor configuration

Use either of the following commands to view the NP6 processor hardware configuration of your FortiGate unit:

```
get hardware npu np6 port-list
diagnose npu np6 port-list
```

If your FortiGate has NP6XLite processors, you can use the following command:

```
diagnose npu np6xlite port-list
```

If your FortiGate has NP6Lite processors, you can use either of the following commands:

```
get hardware npu np6lite port-list
diagnose npu np6lite port-list
```

For example, for the FortiGate-100E the output would be:

```
get hardware npu np6 port-list
Chip   XAUI Ports            Max   Cross-chip
                            Speed offloading
------ ---- -------          ----- ----------
np6_0  0    port20           1G    Yes
       0    port1            1G    Yes
       0    port2            1G    Yes
       1    port19           1G    Yes
       1    port3            1G    Yes
       1    port4            1G    Yes
       2    port18           1G    Yes
       2    port26           10G   Yes
       2    port5            1G    Yes
       2    port6            1G    Yes
       3    port17           1G    Yes
       3    port25           10G   Yes
       3    port7            1G    Yes
       3    port8            1G    Yes
       0-3  port29           25G   Yes
       0-3  port30           25G   Yes
       0-3  port33           40G   Yes
------ ---- -------          ----- ----------
np6_1  0    port24           1G    Yes
       0    port28           10G   Yes
       0    port9            1G    Yes
       0    port10           1G    Yes
       1    port23           1G    Yes
       1    port27           10G   Yes
       1    port11           1G    Yes
       1    port12           1G    Yes
       2    port22           1G    Yes
       2    port13           1G    Yes
       2    port14           1G    Yes
       3    port21           1G    Yes
       3    port15           1G    Yes
       3    port16           1G    Yes
       0-3  port31           25G   Yes
       0-3  port32           25G   Yes
       0-3  port34           40G   Yes
------ ---- -------          ----- ----------
```

For more example output for different FortiGate models, see FortiGate NP6 architectures on page 151, FortiGate NP6XLite architectures on page 224, and FortiGate NP6Lite architectures on page 232.

You can also use the following command to view the features enabled or disabled on the NP6 processors in your FortiGate unit:

```
diagnose npu np6 npu-feature
                    np_0      np_1
------------------- --------- ---------
Fastpath            Enabled   Enabled
HPE-type-shaping    Disabled  Disabled
Standalone          No        No
IPv4 firewall       Yes       Yes
IPv6 firewall       Yes       Yes
IPv4 IPSec          Yes       Yes
```

```
IPv6 IPSec          Yes       Yes
IPv4 tunnel         Yes       Yes
IPv6 tunnel         Yes       Yes
GRE tunnel          No        No
GRE passthrough     Yes       Yes
IPv4 Multicast      Yes       Yes
IPv6 Multicast      Yes       Yes
CAPWAP              Yes       Yes
RDP Offload         Yes       Yes
```

The following command is available to view the features enabled or disabled on the NP6XLite processors in your FortiGate unit:

```
diagnose  npu np6xlite  npu-feature
                    np_0
------------------- ---------
Fastpath            Enabled
HPE-type-shaping    Disabled
IPv4 firewall       Yes
IPv6 firewall       Yes
IPv4 IPSec          Yes
IPv6 IPSec          Yes
IPv4 tunnel         Yes
IPv6 tunnel         Yes
GRE passthrough     Yes
IPv4 Multicast      Yes
IPv6 Multicast      Yes
CAPWAP              Yes
```

The following command is available to view the features enabled or disabled on the NP6Lite processors in your FortiGate unit:

```
diagnose npu np6lite npu-feature
                    np_0      np_1
------------------- --------- ---------
Fastpath            Enabled   Enabled
IPv4 firewall       Yes       Yes
IPv6 firewall       Yes       Yes
IPv4 IPSec          Yes       Yes
IPv6 IPSec          Yes       Yes
IPv4 tunnel         Yes       Yes
IPv6 tunnel         Yes       Yes
GRE tunnel          No        No
IPv4 Multicast      Yes       Yes
IPv6 Multicast      Yes       Yes
```

Disabling NP6, NP6XLite, and NP6Lite hardware acceleration (fastpath)

You can use the following command to disable NP6 offloading for all traffic. This option disables NP6 offloading for all traffic for all NP6 processors.

```
config system npu
   set fastpath disable
end
```

`fastpath` is enabled by default.

This command is also available on some FortiGate models that include NP6Lite processors depending on the firmware version.

FortiGate models with NP6XLite processors

FortiGate models with NP6XLite processors include the following command to disable NP6XLite offloading:

```
config system np6xlite
   edit np6xlite_0
      set fastpath disable
   end
```

`fastpath` is enabled by default. This command disables offloading for individual NP6XLite processors, in the example, np6xlite_0.

Using a diagnose command to disable hardware acceleration

Most FortiGate models and firmware versions include the following diagnose command to disable or enable hardware acceleration.

```
diagnose npu <processor-name> fastpath disable <id>
```

`processor-name` can be `np6`, `np6xlite`, or `np6lite`.

`fastpath` is enabled by default.

`id` specify the ID of the NP6, NP6XLite, or NP6Lite processor for which to disable offloading.

If you use this command to disable hardware acceleration, when your FortiGate restarts, `fastpath` will be enabled again since diagnose command changes are not saved to the FortiGate configuration database. This may be the only option for disabling hardware acceleration for some FortiGate models and some firmware versions.

Optimizing NP6 performance by distributing traffic to XAUI links

On FortiGate units with NP6 processors, the FortiGate interfaces are switch ports that connect to the NP6 processors with XAUI links. Each NP6 processor has a 40-Gigabit bandwidth capacity. Traffic passes from the interfaces to each NP6 processor over four XAUI links. The four XAUI links each have a 10-Gigabit capacity for a total of 40 Gigabits.

On many FortiGate units with NP6 processors, the NP6 processors and the XAUI links are over-subscribed. Since the NP6 processors are connected by an Integrated Switch Fabric, you do not have control over how traffic is distributed to them. In fact traffic is distributed evenly by the ISF.

However, you can control how traffic is distributed to the XAUI links and you can optimize performance by distributing traffic evenly among the XAUI links. For example, if you have a very high amount of traffic passing between two networks, you can connect each network to interfaces connected to different XAUI links to distribute the traffic for each network to a different XAUI link.

Example: FortiGate 3200D

On the FortiGate 3200D (See FortiGate 3200D fast path architecture on page 188), there are 48 10-Gigabit interfaces that send and receive traffic for two NP6 processors over a total of eight 10-Gigabit XAUI links. Each XAUI link gets traffic from six 10-Gigabit FortiGate interfaces. The amount of traffic that the FortiGate 3200D can offload is limited by the number of NP6 processors and the number of XAUI links. You can optimize the amount of traffic that the FortiGate 3200D can process by distributing it evenly amount the XAUI links and the NP6 processors.

You can see the Ethernet interface, XAUI link, and NP6 configuration by entering the `get hardware npu np6 port-list` command. For the FortiGate 3200D the output is:

```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                    Speed offloading
------ ---- ------- ----- ----------
np6_0  0    port1   10G   Yes
       0    port5   10G   Yes
       0    port10  10G   Yes
       0    port13  10G   Yes
       0    port17  10G   Yes
       0    port22  10G   Yes
       1    port2   10G   Yes
       1    port6   10G   Yes
       1    port9   10G   Yes
       1    port14  10G   Yes
       1    port18  10G   Yes
       1    port21  10G   Yes
       2    port3   10G   Yes
       2    port7   10G   Yes
       2    port12  10G   Yes
       2    port15  10G   Yes
       2    port19  10G   Yes
       2    port24  10G   Yes
       3    port4   10G   Yes
       3    port8   10G   Yes
       3    port11  10G   Yes
       3    port16  10G   Yes
       3    port20  10G   Yes
       3    port23  10G   Yes
------ ---- ------- ----- ----------
np6_1  0    port26  10G   Yes
       0    port29  10G   Yes
       0    port33  10G   Yes
       0    port37  10G   Yes
       0    port41  10G   Yes
       0    port45  10G   Yes
       1    port25  10G   Yes
       1    port30  10G   Yes
       1    port34  10G   Yes
       1    port38  10G   Yes
       1    port42  10G   Yes
       1    port46  10G   Yes
       2    port28  10G   Yes
       2    port31  10G   Yes
       2    port35  10G   Yes
       2    port39  10G   Yes
```

```
       2    port43  10G   Yes
       2    port47  10G   Yes
       3    port27  10G   Yes
       3    port32  10G   Yes
       3    port36  10G   Yes
       3    port40  10G   Yes
       3    port44  10G   Yes
       3    port48  10G   Yes
------ ---- ------- ----- ----------
```

In this command output you can see that each NP6 has for four XAUI links (0 to 3) and that each XAUI link is connected to six 10-gigabit Ethernet interfaces. To optimize throughput you should keep the amount of traffic being processed by each XAUI port to under 10 Gbps. So for example, if you want to offload traffic from four 10-gigabit networks you can connect these networks to Ethernet interfaces 1, 2, 3 and 4. This distributes the traffic from each 10-Gigabit network to a different XAUI link. Also, if you wanted to offload traffic from four more 10-Gigabit networks you could connect them to Ethernet ports 26, 25, 28, and 27. As a result each 10-Gigabit network would be connected to a different XAUI link.

Example FortiGate 3300E

On the FortiGate 3300E (See FortiGate 3300E and 3301E fast path architecture on page 190), there are 34 data interfaces of various speeds that send and receive traffic for four NP6 processors over a total of sixteen 10-Gigabit XAUI links. The amount of traffic that the FortiGate 3300E can offload is limited by the number of NP6 processors and the number of XAUI links. You can optimize the amount of traffic that the FortiGate 3300E can process by distributing it evenly amount the XAUI links and the NP6 processors.

You can see the FortiGate 3300E Ethernet interface, XAUI link, and NP6 configuration by entering the `get hardware npu np6 port-list` command. For the FortiGate 3300E the output is:

```
get hardware npu np6 port-list
Chip   XAUI Ports            Max   Cross-chip
                             Speed offloading
------ ---- -------          ----- ----------
np6_0  0    port1            1G    Yes
       0    port14           10G   Yes
       1    port2            1G    Yes
       1    port15           10G   Yes
       2    port3            1G    Yes
       2    port16           10G   Yes
       3    port13           10G   Yes
       0-3  port17           25G   Yes
       0-3  port31           40G   Yes
------ ---- -------          ----- ----------
np6_1  0    port4            1G    Yes
       1    port5            1G    Yes
       2    port6            1G    Yes
       3
       0-3  port18           25G   Yes
       0-3  port19           25G   Yes
       0-3  port20           25G   Yes
       0-3  port24           25G   Yes
       0-3  port23           25G   Yes
       0-3  port32           40G   Yes
------ ---- -------          ----- ----------
np6_2  0    port7            1G    Yes
```

```
        1    port8            1G    Yes
        2    port9            1G    Yes
        3
        0-3  port22           25G   Yes
        0-3  port21           25G   Yes
        0-3  port26           25G   Yes
        0-3  port25           25G   Yes
        0-3  port28           25G   Yes
        0-3  port33           40G   Yes
------ ---- -------          ----- ----------
np6_3   0    port10           1G    Yes
        1    port11           1G    Yes
        2    port12           1G    Yes
        2    port29           10G   Yes
        3    port30           10G   Yes
        0-3  port27           25G   Yes
        0-3  port34           40G   Yes
------ ---- -------          ----- ----------
```

In this command output you can see that each NP6 has four XAUI links (0 to 3) and the mapping between XAUI ports and interfaces is different for each NP6 processor.

NP6_0 has the following XAUI mapping:

- port1 (1G) and port14 (10G) are connected to XAUI link 0.
- port2 (1G) and port15 (10G) are connected to XAUI link 1.
- port3 (1G) and port16 (10G) are connected to XAUI link 2.
- port13 (10G) is connected to XAUI link 3.
- port17 (25G) and port31 (40G) are connect to all four of the XAUI links (0-3).

The interfaces connected to NP6_0 have a total capacity of 108G, but NP6_0 has total capacity of 40G. For optimal performance, no more than 40G of this capacity should be used or performance will be affected. For example, if you connect port31 to a busy 40G network you should avoid using any of the other ports connected to NP6_0. If you connect port17 to a 25G network, you can also connect one or two 10G interfaces (for example, port14 and 15). You can connect port13, port14, port15, and port16 to four 10G networks if you avoid using any of the other interfaces connected to NP6_0.

Enabling bandwidth control between the ISF and NP6 XAUI ports to reduce the number of dropped egress packets

In some cases, the Internal Switch Fabric (ISF) buffer size may be larger than the buffer size of an NP6 XAUI port that receives traffic from the ISF. If this happens, burst traffic from the ISF may exceed the capacity of an XAUI port and egress or EHP sessions may be dropped during traffic bursts.

You can use the following command to use the ISF switch buffer instead of the NP6 processor buffer to provide bandwidth control between the ISF and XAUI ports. Enabling bandwidth control can smooth burst traffic and keep the XAUI ports from getting overwhelmed and dropping sessions. Since the ISF has a larger buffer it may be able to handle more traffic.

Use the following command to enable bandwidth control:

```
config system npu
   set sw-np-bandwidth {0G | 2G | 4G | 5G | 6G}
end
```

`0G` the default, ISF switch buffer memory is not used to buffer egress packets.

`2G`, `4G`, `5G`, `6G` the amount of ISF switch buffer memory to use for packet buffering to avoid dropped packets. You can adjust the amount of ISF buffer to optimize performance for your system and network conditions.

Increasing NP6 offloading capacity using link aggregation groups (LAGs)

NP6 processors can offload sessions received by interfaces in link aggregation groups (LAGs) (IEEE 802.3ad). 802.3ad Link Aggregation and Link Aggregation Control Protocol (LACP) combines more than one physical interface into a group that functions like a single interface with a higher capacity than a single physical interface. For example, you could use a LAG if you want to offload sessions on a 30 Gbps link by adding three 10-Gbps interfaces to the same LAG.

All offloaded traffic types are supported by LAGs, including IPsec VPN traffic. Just like with normal interfaces, traffic accepted by a LAG is offloaded by the NP6 processor connected to the interfaces in the LAG that receive the traffic to be offloaded. If all interfaces in a LAG are connected to the same NP6 processor, traffic received by that LAG is offloaded by that NP6 processor. The amount of traffic that can be offloaded is limited by the capacity of the NP6 processor.

If a FortiGate has two or more NP6 processors connected by an integrated switch fabric (ISF), you can use LAGs to increase offloading by sharing the traffic load across multiple NP6 processors. You do this by adding physical interfaces connected to different NP6 processors to the same LAG.

Adding a second NP6 processor to a LAG effectively doubles the offloading capacity of the LAG. Adding a third further increases offloading. The actual increase in offloading capacity may not actually be doubled by adding a second NP6 or tripled by adding a third. Traffic and load conditions and other factors may limit the actual offloading result.

The increase in offloading capacity offered by LAGs and multiple NP6s is supported by the integrated switch fabric (ISF) that allows multiple NP6 processors to share session information. Most FortiGate units with multiple NP6 processors also have an ISF. However, FortiGate models such as the 1000D, 2000E, and 2500E do not have an ISF. If you attempt to add interfaces connected to different NP6 processors to a LAG the system displays an error message.

There is also the following limitation to LAG NP6 offloading support for IPsec VPN:

- Because the encrypted traffic for one IPsec VPN tunnel has the same 5-tuple, the traffic from one tunnel can only can be balanced to one interface in a LAG. This limits the maximum throughput for one IPsec VPN tunnel in an NP6 LAG group to 10Gbps.

NP6 processors and redundant interfaces

NP6 processors can offload sessions received by interfaces that are part of a redundant interface. You can combine two or more physical interfaces into a redundant interface to provide link redundancy. Redundant interfaces ensure connectivity if one physical interface, or the equipment on that interface, fails. In a redundant interface, traffic travels only over one interface at a time. This differs from an aggregated interface where traffic travels over all interfaces for distribution of increased bandwidth.

All offloaded traffic types are supported by redundant interfaces, including IPsec VPN traffic. Just like with normal interfaces, traffic accepted by a redundant interface is offloaded by the NP6 processor connected to the interfaces in the redundant interface that receive the traffic to be offloaded. If all interfaces in a redundant interface are connected to the same NP6 processor, traffic received by that redundant interface is offloaded by that NP6 processor. The amount of traffic that can be offloaded is limited by the capacity of the NP6 processor.

If a FortiGate has two or more NP6 processors connected by an integrated switch fabric (ISF), you can create redundant interfaces that include physical interfaces connected to different NP6 processors. However, with a redundant interface, only one of the physical interfaces is processing traffic at any given time. So you cannot use redundant interfaces to increase performance in the same way as you can with aggregate interfaces.

The ability to add redundant interfaces connected to multiple NP6s is supported by the integrated switch fabric (ISF) that allows multiple NP6 processors to share session information. Most FortiGate units with multiple NP6 processors also have an ISF. However, FortiGate models such as the 1000D, 2000E, and 2500E do not have an ISF. If you attempt to add interfaces connected to different NP6 processors to a redundant interface the system displays an error message.

Improving LAG performance on some FortiGate models

Some FortiGate models support one of the following commands that might improve link aggregation (LAG) performance by reducing the number of dropped packets that can occur with some LAG configurations.

If the command is available, depending on hardware architecture, on some models its available under `config system npu`:

```
config system npu
   set lag-sw-out-trunk {disable | enable}
end
```

And on others the following option is available under `config system np6`:

```
config system np6
   edit np6_0
      set lag-npu {disable | enable}
   end
```

If you notice NP6- accelerated LAG interface performance is lower than expected or if you notice excessive dropped packets for sessions over LAG interfaces, you could see if your FortiGate has one of these options in the CLI and if available try enabling it and see if performance improves.

If the option is available for your FortiGate under `config system np6`, you should enable it for every NP6 processor that is connected to a LAG interface.

Eliminating dropped packets on LAG interfaces

In some network and traffic configurations and for some FortiGate models with NP6 processors, traffic passing through a LAG may experience excessive amounts of dropped packets. This can happen if the FortiGate switch fabric and NP6 processor select different ingress and egress XAUI interfaces for the same traffic flow through a LAG interface, resulting in possible collisions and dropped packets.

Some FortiGate models allow you to resolve this problem by using the following command to cause both the switch fabric and the NP6 processor to use the same XAUI port mapping:

```
config system npu
   set lag-out-port-select {disable | enable}
end
```

This option is disabled by default, causing the FortiGate to use a different method for selecting ingress and egress XAUI interfaces for a LAG than for a single interface. Normally the default setting is recommended.

If you enable `lag-out-port-select`, the FortiGate uses the same method for selecting the ingress and egress XAUI interfaces for LAGs as is used for standalone interfaces; which should eliminate the dropped packets. This option is supported on some FortiGate models with NP6 processors including the FortGate-3800D family, 3900E family, 5001E, 6000F family and 7000E family.

Configuring inter-VDOM link acceleration with NP6 processors

FortiGate units with NP6 processors include NPU VDOM links that can be used to accelerate inter-VDOM link traffic.

- A FortiGate with two NP6 processors may have two NPU VDOM links, each with two interfaces:
  - **npu0_vlink** (NPU VDOM link)
    npu0_vlink0 (NPU VDOM link interface)
    npu0_vlink1 (NPU VDOM link interface)
  - **npu1_vlink** (NPU VDOM link)
    npu1_vlink0 (NPU VDOM link interface)
    npu1_vlink1 (NPU VDOM link interface)

These interfaces are visible from the GUI and CLI. Enter the following CLI command to display the NPU VDOM links:

```
get system interface
...
== [ npu0_vlink0 ]
name: npu0_vlink0 mode: static ip: 0.0.0.0 0.0.0.0 status: down netbios-forward: disable
      type: physical sflow-sampler: disable explicit-web-proxy: disable explicit-ftp-proxy:
      disable mtu-override: disable wccp: disable drop-overlapped-fragment: disable drop-
      fragment: disable

== [ npu0_vlink1 ]
name: npu0_vlink1 mode: static ip: 0.0.0.0 0.0.0.0 status: down netbios-forward: disable
      type: physical sflow-sampler: disable explicit-web-proxy: disable explicit-ftp-proxy:
      disable mtu-override: disable wccp: disable drop-overlapped-fragment: disable drop-
      fragment: disable

== [ npu1_vlink0 ]
name: npu1_vlink0 mode: static ip: 0.0.0.0 0.0.0.0 status: down netbios-forward: disable
      type: physical sflow-sampler: disable explicit-web-proxy: disable explicit-ftp-proxy:
      disable mtu-override: disable wccp: disable drop-overlapped-fragment: disable drop-
      fragment: disable

== [ npu1_vlink1 ]
name: npu1_vlink1 mode: static ip: 0.0.0.0 0.0.0.0 status: down netbios-forward: disable
      type: physical sflow-sampler: disable explicit-web-proxy: disable explicit-ftp-proxy:
      disable mtu-override: disable wccp: disable drop-overlapped-fragment: disable drop-
      fragment: disable
...
```

By default the NPU VDOM link interfaces are assigned to the root VDOM. To use them to accelerate inter-VDOM link traffic, assign each interface in the pair to the VDOMs that you want to offload traffic between. For example, if you have added a VDOM named New-VDOM, you can go to **System > Network > Interfaces** and edit the **npu0-vlink1** interface and set the **Virtual Domain** to **New-VDOM**. This results in an accelerated inter-VDOM link between root and New-VDOM. You can also do this from the CLI:

```
config system interface
   edit npu0-vlink1
      set vdom New-VDOM
end
```

Using VLANs to add more accelerated inter-VDOM link interfaces

You can add VLAN interfaces to NPU VDOM link interfaces to create accelerated links between more VDOMs. For the links to work, the VLAN interfaces must be added to the same NPU VDOM link interface, must be on the same subnet, and must have the same VLAN ID.

NP6 processors do not support offloading traffic flowing between Enhanced MAC (EMAC) VLAN interfaces added to NPU VDOM link interfaces.

For example, to accelerate inter-VDOM traffic between VDOMs named Marketing and Engineering using VLANs with VLAN ID 100 go to **System > Network > Interfaces** and select **Create New** to create the VLAN interface associated with the Marketing VDOM:

Name	Marketing-link
Type	VLAN
Interface	npu0_vlink0
VLAN ID	100
Virtual Domain	Marketing
IP/Network Mask	172.20.120.12/24

Create the inter-VDOM link associated with Engineering VDOM:

Name	Engineering-link
Type	VLAN
Interface	npu0_vlink1
VLAN ID	100
Virtual Domain	Engineering
IP/Network Mask	172.20.120.22/24

Or do the same from the CLI:

```
config system interface
   edit Marketing-link
      set vdom Marketing
```

```
    set ip 172.20.120.12/24
    set interface npu0_vlink0
    set vlanid 100
  next
  edit Engineering-link
    set vdom Engineering
    set ip 172.20.120.22/24
    set interface npu0_vlink1
    set vlanid 100
  end
```

Confirm that the traffic is accelerated

Use the following diagnose commands to obtain the interface index and then correlate them with the session entries. In the following example traffic was flowing between new accelerated inter-VDOM link interfaces and physical interfaces port1 and port 2 also attached to the NP6 processor.

```
diagnose ip address list
IP=172.31.17.76->172.31.17.76/255.255.252.0 index=5 devname=port1
IP=10.74.1.76->10.74.1.76/255.255.252.0 index=6 devname=port2
IP=172.20.120.12->172.20.120.12/255.255.255.0 index=55 devname=IVL-VLAN1_ROOT
IP=172.20.120.22->172.20.120.22/255.255.255.0 index=56 devname=IVL-VLAN1_VDOM1

diagnose sys session list
session info: proto=1 proto_state=00 duration=282 expire=24 timeout=0 session info:
     proto=1 proto_state=00 duration=124 expire=59 timeout=0 flags=00000000
     sockflag=00000000 sockport=0 av_idx=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0 policy_dir=0 tunnel=/
state=may_dirty npu
statistic(bytes/packets/allow_err): org=180/3/1 reply=120/2/1 tuples=2
orgin->sink: org pre->post, reply pre->post dev=55->5/5->55
     gwy=172.31.19.254/172.20.120.22
hook=post dir=org act=snat 10.74.2.87:768->10.2.2.2:8(172.31.17.76:62464)
hook=pre dir=reply act=dnat 10.2.2.2:62464->172.31.17.76:0(10.74.2.87:768)
misc=0 policy_id=4 id_policy_id=0 auth_info=0 chk_client_info=0 vd=0
serial=0000004e tos=ff/ff ips_view=0 app_list=0 app=0
dd_type=0 dd_mode=0
per_ip_bandwidth meter: addr=10.74.2.87, bps=880
npu_state=00000000
npu info: flag=0x81/0x81, offload=8/8, ips_offload=0/0, epid=160/218, ipid=218/160,
     vlan=32769/0


session info: proto=1 proto_state=00 duration=124 expire=20 timeout=0 flags=00000000
     sockflag=00000000 sockport=0 av_idx=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0 policy_dir=0 tunnel=/
state=may_dirty npu
statistic(bytes/packets/allow_err): org=180/3/1 reply=120/2/1 tuples=2
orgin->sink: org pre->post, reply pre->post dev=6->56/56->6 gwy=172.20.120.12/10.74.2.87
hook=pre dir=org act=noop 10.74.2.87:768->10.2.2.2:8(0.0.0.0:0)
```

```
hook=post dir=reply act=noop 10.2.2.2:768->10.74.2.87:0(0.0.0.0:0)
misc=0 policy_id=3 id_policy_id=0 auth_info=0 chk_client_info=0 vd=1
serial=0000004d tos=ff/ff ips_view=0 app_list=0 app=0
dd_type=0 dd_mode=0
per_ip_bandwidth meter: addr=10.74.2.87, bps=880
npu_state=00000000
npu info: flag=0x81/0x81, offload=8/8, ips_offload=0/0, epid=219/161, ipid=161/219,
     vlan=0/32769
total session 2
```

IPv6 IPsec VPN over NPU VDOM links

If you have configured your FortiGate to send IPv6 IPsec traffic over NP6-accelerated NPU VDOM links bound to the same NP6 processor, you should also enable the following option (which is disabled by default):

```
config system npu
   set ipsec-over-vlink enable
end
```

If your FortiGate has one NP6 processor, all accelerated inter-VDOM interfaces that you create will be bound to this NP6 processor. If you are sending IPv6 IPsec traffic between two inter-VDOM link interfaces you should enable `ipsec-over-vlink` or some traffic may be dropped.

If your FortiGate has multiple NP6 processors, to send IPv6 IPsec traffic between inter-VDOM link interfaces you can do either of the following:

- If the two inter-VDOM link interfaces used for passing IPv6 IPsec traffic are bound to different NPU VDOM links (for example, npu0 and npu1) disable `ipsec-over-vlink`. This is the recommended configuration.
- If the two inter-VDOM link interfaces are bound to the same NPU VDOM link, enable `ipsec-over-vlink`.

Disabling offloading IPsec Diffie-Hellman key exchange

You can use the following command to disable using ASIC offloading to accelerate IPsec Diffie-Hellman key exchange for IPsec ESP traffic. By default hardware offloading is used. For debugging purposes or other reasons you may want this function to be processed by software.

Use the following command to disable using ASIC offloading for IPsec Diffie-Hellman key exchange:

```
config system global
   set ipsec-asic-offload disable
end
```

Supporting IPsec anti-replay protection

Because of how NP6 processors cache inbound IPSec SAs, IPsec VPN sessions with anti-reply protection that are terminated by the FortiGate may fail the replay check and be dropped.

You can use the following command to disable caching of inbound IPsec VPN SAs, allowing IPsec VPN sessions with anti-reply protection that are terminated by the FortiGate to work normally:

```
config system npu
```

```
   set ipsec-inbound-cache disable
end
```

With caching enabled (the default), a single NP6 processor can run multiple IPsec engines to process IPsec VPN sessions terminated by the FortiGate. Disabling `ipsec-inbound-cache` reduces performance of IPsec VPN sessions terminated by the FortiGate, because without caching an NP6 processor can only run one IPsec engine.

You must manually restart your FortiGate after disabling or enabling `ipsec-inbound-cache`.

If your FortiGate contains multiple NP6 processors, you can improve performance while supporting anti-replay protection by creating a LAG of interfaces connected to multiple NP6 processors. This allows distribution of IPsec anti-replay traffic from one traffic stream to more than one NP6 processor; resulting in multiple IPsec engines being available. See Increasing NP6 offloading capacity using link aggregation groups (LAGs) on page 109.

Disabling `ipsec-inbound-cache` does not affect performance of other traffic terminated by the FortiGate and does not affect performance of traffic passing through the FortiGate.

NP6XLite and NP6Lite processors do not have this caching limitation. IP Sec VPN sessions with anti-replay protection that are passing through the FortiGate are not affected by this limitation.

Access control lists (ACLs)

Access Control Lists (ACLs) use NP6 offloading to drop IPv4 or IPv6 packets at the physical network interface before the packets are analyzed by the CPU. On a busy appliance this can really help the performance. This feature is available on FortiGates with NP6 processors and is not supported by FortiGates with NP6XLite and NP6Lite processors.

The ACL feature is available only on FortiGates with NP6-accelerated interfaces. ACL checking is one of the first things that happens to the packet and checking is done by the NP6 processor. The result is very efficient protection that does not use CPU or memory resources.

Use the following command to configure IPv4 ACL lists:

```
config firewall acl
   edit 0
      set status enable
      set interface <interface-name>
      set scraddr <firewall-address>
      set dstaddr <firewall-address>
      set service <firewall-service>
   end
```

Use the following command to configure IPv6 ACL lists:

```
config firewall acl6
   edit 0
      set status enable
      set interface <interface-name>
      set scraddr <firewall-address6>
      set dstaddr <firewall-address6>
      set service <firewall-service>
   end
```

Where:

`<interface-name>` is the interface on which to apply the ACL. There is a hardware limitation that needs to be taken into account. The ACL is a Layer 2 function and is offloaded to the ISF hardware, therefore no CPU resources are used in the processing of the ACL. It is handled by the inside switch chip which can do hardware acceleration, increasing the performance of the FortiGate. The ACL function is only supported on switch fabric driven interfaces.

`<firewall-address> <firewall-address6>` can be any of the address types used by the FortiGate, including address ranges. The traffic is blocked not on an either or basis of these addresses but the combination of the two, so that they both have to be correct for the traffic to be denied. To block all of the traffic from a specific address all you have to do is make the destination address `ALL`.

Because the blocking takes place at the interface based on the information in the packet header and before any processing such as NAT can take place, a slightly different approach may be required. For instance, if you are trying to protect a VIP which has an external address of x.x.x.x and is forwarded to an internal address of y.y.y.y, the destination address that should be used is x.x.x.x, because that is the address that will be in the packet's header when it hits the incoming interface.

`<firewall-service>` the firewall service to block. Use `ALL` to block all services.

NP6 HPE host protection engine

The NP6 host protection engine (HPE) uses NP6 processors to protect the FortiGate CPU from excessive amounts of ingress traffic, which typically occurs during DDoS attacks or network problems (for example an ARP flood due to a network loop). You can use the HPE to prevent ingress traffic received on data interfaces connected to NP6 processors from overloading the FortiGate CPU.

You configure the HPE by enabling it and setting traffic thresholds. The HPE then acts like a traffic shaper, dropping packets that exceed the configured traffic thresholds. You can enable HPE monitoring to record log messages when the HPE drops packets. You can also run the HPE with monitoring enabled but without dropping packets. Using these tools you can monitor HPE activity and set HPE threshold values that are low enough to protect the CPU and high enough to not impact legitimate traffic.

The HPE does not affect offloaded traffic, just CPU traffic. The HPE is not as granular as DoS policies and should be used as a first level of protection.

DoS policies can be used as a second level of protection. For information about DoS policies, see DoS protection. DoS policy sessions are not offloaded by NP6 processors.

You can use the following command to configure the HPE.

```
config system {np6 | np6xlite | np6lite}
   edit <np6-processor-name>
      config hpe
         set enable-shaper {disable | enable}
         set tcpsyn-max <packets-per-second>
         set tcpsyn-ack-max <packets-per-second>
         set tcpfin-rst-max <packets-per-second>
         set tcp-max <packets-per-second>
         set udp-max <packets-per-second>
         set icmp-max <packets-per-second>
         set sctp-max <packets-per-second>
         set esp-max <packets-per-second>
         set ip-frag-max <packets-per-second>
```

```
    set ip-others-max <packets-per-second>
    set arp-max <packets-per-second>
    set l2-others-max <packets-per-second>
    set pri-type-max <packets-per-second>
end
```

You can use HPE monitoring to verify how many packets the HPE is actually dropping. See Monitoring NP6 HPE activity on page 122. You can also use the `diagnose npu np6 monitor-hpe` command to monitor HPE activity without dropping packets. See Monitor HPE activity without dropping packets on page 123.

The HPE also includes an overflow option for high-priority traffic, see NP6 HPE and high priority traffic on page 121.

For more information about the NP6 HPE, see this Fortinet KB article:Technical Note: Host Protection Engine (HPE) feature overview.

NP6 HPE packet flow and host queues

You configure the NP6 HPE separately for each NP6 processor. Each NP6 processor has multiple host queues and each HPE packets-per-second setting is applied separately to each host queue. The actual amount of traffic allowed by an HPE threshold depends on the number of host queues that each NP6 processor has. You can use the following command to see the number of host queues of the NP6 processors in your FortiGate.

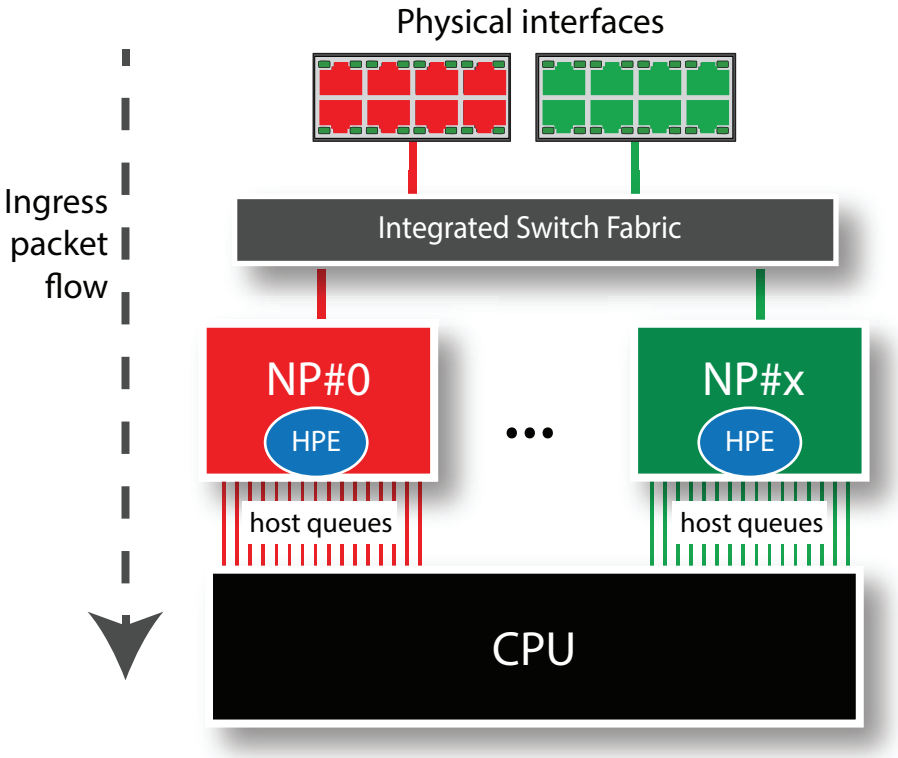
For example, for a FortiGate-1500D, the following command output shows that the number of host queues for NP6_0 is 6 (`hpe_ring:6`).

```
diagnose npu np6 hpe 0 | grep ring
HPE HW pkt_credit:20000 , tsref_inv:60000, tsref_gap:4 , np:0, hpe_type_max:200000, hpe_
ring:6
```

Based on the number of host queues, you can calculate the total number of packets per second allowed for a given HPE threshold for an NP6 processor. Some examples.

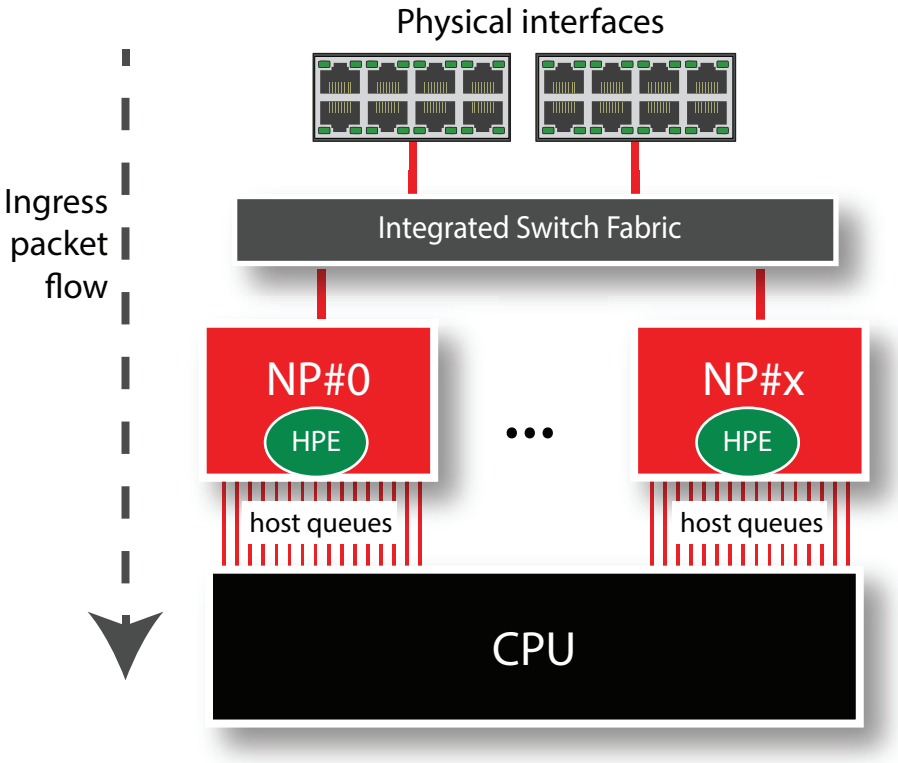
- On the FortiGate-1500D, interfaces port1-8, port17-24 and port33-36 are connected to NP6_0. The default HPE `tcpsyn-max` setting of 600000 for NP6_0, limits the total number of TCP_SYN host packets per second that these interfaces can process to 600000 x 6 = 3,600,000 host packets per second.

HPE packet flow with multiple NP6 processors connected to different interfaces



- The FortiGate-3600E has six NP6 processors and each NP6 processor has 20 host queues. All front panel data interfaces are connected to all NP6 processors over the integrated switch fabric. The default `tcpsyn-ack-max` setting of 600000 limits the of total number of TCP SYN_ACK host packets per second that the FortiGate-3600E can process to 600000 x 20 x 6 = 72,000,000 TCP SYN_ACK host packets per second.

HPE packet flow with multiple NP6 processors connected to all interfaces



NP6 HPE configuration options

The NP6 HPE supports setting individual limits for the following traffic types:

- TCP SYN
- TCP SYN_ACK
- TCP FIN and RST
- TCP
- UDP
- ICMP
- SCTP
- ESP
- Fragmented IP packets
- Other types of IP packets
- ARP
- Other layer-2 packets that are not ARP packets

The following table lists and describes the HPE options for each traffic type.

Option	Description	Default
`enable-shaper {disable |`	Enable or disable the HPE for the current NP6 processor.	disable

Option	Description	Default
enable}		
tcpsyn-max	Limit the maximum number of TCP SYN packets received per second per host queue. The range is 1000 to 1000000000 pps.	600000
tcpsyn-ack-max	Prevent SYN_ACK reflection attacks by limiting the number of TCP SYN_ACK packets received per second per host queue. The range is 1000 to 1000000000 pps. TCP SYN_ACK reflection attacks consist of an attacker sending large amounts of SYN_ACK packets without first sending SYN packets. These attacks can cause high CPU usage because the firewall assumes that these SYN_ACK packets are the first packets in a session, so the packets are processed by the CPU instead of the NP6 processor.	600000
tcpfin-rst-max	Limit the maximum number of TCP FIN and RST packets received per second per host queue. The range is 1000 to 1000000000 pps.	600000
tcp-max	Limit the maximum number of TCP packets received per second per host queue that are not filtered by tcpsyn-max, tcpsyn-ack-max, or tcpfin-rst-max. The range is 1000 to 1000000000 pps.	600000
udp-max	Limit the maximum number of UDP packets received per second per host queue. The range is 1000 to 1000000000 pps.	600000
icmp-max	Limit the maximum number of ICMP packets received per second per host queue. The range is 1000 to 1000000000 pps.	200000
sctp-max	Limit the maximum number of SCTP packets received per second per host queue. The range is 1000 to 1000000000 pps.	200000
esp-max	Limit the maximum number of ESP packets received per second per host queue. The range is 1000 to 1000000000 pps.	200000
ip-frag-max	Limit the maximum number of fragmented IP packets received per second per host queue. The range is 1000 to 1000000000 pps.	200000
ip-others-max	Limit the maximum number of other types of IP packets received per second per host queue. Other packet types are IP packets that cannot be set with other HPE options. The range is 1000 to 1000000000 pps.	200000
arp-max	Limit the maximum number of ARP packets received per	200000

Option	Description	Default
	second per host queue. The range is 1000 to 1000000000 pps.	
`l2-others-max`	Limit the maximum number of other layer-2 packets that are not ARP packets received per second per host queue. The range is 1000 to 1000000000 pps. This option limits HA heartbeat, HA session sync, LACP/802.3ad, FortiSwitch heartbeat, and wireless-controller CAPWAP packets.	200000

NP6 HPE and high priority traffic

The NP6 HPE `pri-type-max` option allows you to set a maximum overflow limit for high-priority traffic. The range is 1000 to 1000000000 packets per second per host queue. The default `pri-type-max` setting is 200000.

By default, the high-priority overflow is applied to the following types of traffic that are treated as high-priority by the NP6 processor:

- HA heartbeat
- LACP/802.3ad
- OSPF
- BGP
- IKE
- SLBC
- BFD

The `high-priority` setting adds an overflow for high priority traffic, causing the HPE to allow more of these high priority packets.

The overflow is added to the maximum number of packets allowed by the HPE based on other HPE settings. For example, by default, the HPE limits HA heartbeat traffic to `l2-others-max` + `pri-type-max` pps, which works out to 200000 + 200000 = 400,000 packets per second per host queue.

Adjusting NP6 HPE BGP, SLBC, and BFD priorities

Use the following command to adjust the priority of BGP, SLBC, and BFD traffic to control whether the NP6 HPE treats these traffic types as high-priority traffic

```
config system npu
   config priority-protocol
      set bgp {disable | enable}
      set slbc {disable | enable}
      set bfd {disable | enable}
   end
```

By default, all options are set to `enable` and BGP, SLBC, and BFD packets are treated by the HPE as high priority traffic subject to high-priority overflow. In some cases, the overflow can allow excessive amounts of BGP, SLBC, and BFD host traffic that can cause problems such as route flapping and CPU spikes. If you encounter this problem, or for other reasons you can use this command to set BGP, SLBC, or BFD traffic to low priority, bypassing the HPE `pri-type-max`

overflow. For example, if your FortiGate is not processing one or more of these traffic types, you can set them to low priority to limit the amount of the selected type of packets allowed by the HPE.

Changing these traffic types to low priority can cause problems if your FortiGate is actively processing traffic. Fortinet recommends that you make changes with this command during a maintenance window and then monitor your system to make sure its working properly once it gets busy again.

Monitoring NP6 HPE activity

You can use the following command to generate event log messages when the NP6 HPE blocks packets:

```
config monitoring npu-hpe
   set status {enable | disable}
   set interval <integer>
   set multiplers <m1>, <m2>, ... <m12>
end
```

`status` enable or disable HPE status monitoring.

`interval` the HPE status check interval, in seconds. The range is 1 to 60 seconds. The default interval is 1 second.

`multipliers` set 12 multipliers to control how often an event log message is generated for each HPE packet type in the following order:

- `tcpsyn-max` default 4
- `tcpsyn-ack-max` default 4
- `tcpfin-rst-max` default 4
- `tcp-max` default 4
- `udp-max` default 8
- `icmp-max` default 8
- `sctp-max` default 8
- `esp-max` default 8
- `ip-frag-max` default 8
- `ip-others-max` default 8
- `arp-max` default 8
- `l2-others-max` default 8

An event log is generated after every (interval × multiplier) seconds for any HPE type when drops occur for that HPE type. Increase the interval or individual multipliers to generate fewer event log messages.

An attack log is generated after every (4 × multiplier) number of continuous event logs.

Example HPE monitoring configuration

```
config monitoring npu-hpe
   set status enable
   set interval 2
   set multipliers 3 2 2 2 4 4 4 4 4 4 4 4
end
```

Monitor HPE activity without dropping packets

If you have enabled monitoring using the `config monitoring npu-hpe` command, you can use the following command to monitor HPE activity without causing the HPE to drop packets. This can be useful when testing HPE, allowing you to see how many packets the HPE would be dropping without actually affecting traffic.

```
diagnose npu np6 monitor-hpe {disable | enable} <np6-id>
```

This command is disabled by default. If you enable it, the HPE will not drop packets, but if monitoring is enabled, will create log messages for packets that would have been dropped.

Since this is a diagnose command, monitoring the HPE without dropping packets will be disabled when the FortiGate restarts.

Sample HPE event log messages

```
date=2021-01-13 time=16:00:01 eventtime=1610582401563369503 tz="-0800"
logid="0100034418" type="event" subtype="system" level="warning" vd="root" logdesc="NP6
HPE is dropping packets" msg="NPU HPE module is stop dropping packet types of:udp in
NP6_0."
```

```
date=2021-01-13 time=16:00:00 eventtime=1610582400562601540 tz="-0800"
logid="0100034418" type="event" subtype="system" level="warning" vd="root" logdesc="NP6
HPE is dropping packets" msg="NPU HPE module is likely dropping packets of one or more
of these types:udp in NP6_0."
```

```
date=2021-01-13 time=15:59:59 eventtime=1610582399558325686 tz="-0800"
logid="0100034419" type="event" subtype="system" level="critical" vd="root"
logdesc="NP6 HPE under a packets flood" msg="NPU HPE module is likely under attack
of:udp in NP6_0."
```

Displaying NP6 HPE configuration and status information

You can use the following diagnose command to display NP6 HPE configuration and status information for one of the NP6 processors in your FortiGate.

```
diagnose npu np6 hpe 0
Queue   Type        NPU-min      NPU-max      CFG-min(pps)   CFG-max(pps)   Pkt-credit
------------------------------------------------------------------------------------
0       tcpsyn      595285       797354       600000         800000         2465962479
0       tcpsyn-ack  595285       797354       600000         800000         1735820781
0       tcpfin-rst  595285       797354       600000         800000         3821949227
0       tcp         595285       797354       600000         800000         1579628705
0       udp         595285       797354       600000         800000         2556292862
0       icmp        199338       199338       200000         200000         2110740782
0       sctp        199338       199338       200000         200000         1608215169
0       esp         199338       199338       200000         200000         2877067841
0       ip-frag     199338       199338       200000         200000         1557653257
0       ip-others   199338       398677       200000         400000         3575419133
0       arp         199338       398677       200000         400000         1232744934
0       l2-others   199338       398677       200000         400000         2335483153
------------------------------------------------------------------------------------
HPE HW pkt_credit:20000 , tsref_inv:60000, tsref_gap:4 , np:0, hpe_type_max:200000, hpe_
```

```
ring:6
HPE Dropping    :0000000000000000
```

Configuring individual NP6 processors

You can use the `config system np6` command to configure a wide range of settings for each of the NP6 processors in your FortiGate unit including enabling session accounting and adjusting session timeouts. As well you can set anomaly checking for IPv4 and IPv6 traffic.

For FortiGates with NP6XLite processors, the `config system np6xlite` command has similar options.

For FortiGates with NP6Lite processors, the `config system np6lite` command has similar options.

You can also enable and adjust Host Protection Engine (HPE) to protect networks from DoS attacks by categorizing incoming packets based on packet rate and processing cost and applying packet shaping to packets that can cause DoS attacks.

The settings that you configure for an NP6 processor with the `config system np6` command apply to traffic processed by all interfaces connected to that NP6 processor. This includes the physical interfaces connected to the NP6 processor as well as all subinterfaces, VLAN interfaces, IPsec interfaces, LAGs and so on associated with the physical interfaces connected to the NP6 processor.

```
config system {np6 | np6xlite | np6lite}
   edit <np6-processor-name>
      set low-latency-mode {disable | enable}
      set per-session-accounting {disable | enable | traffic-log-only}
      set session-timeout-random-range <range>
      set garbage-session-collector {disable | enable}
      set session-collector-interval <range>
      set session-timeout-interval <range>
      set session-timeout-random-range <range>
      set session-timeout-fixed {disable | enable}
         config hpe
            set tcpsyn-max <packets-per-second>
            set tcpsyn-ack-max <packets-per-second>
            set tcpfin-rst-max <packets-per-second>
            set tcp-max <packets-per-second>
            set udp-max <packets-per-second>
            set icmp-max <packets-per-second>
            set sctp-max <packets-per-second>
            set esp-max <packets-per-second>
            set ip-frag-max <packets-per-second>
            set ip-others-max <packets-per-second>
            set arp-max <packets-per-second>
            set l2-others-max <packets-per-second>
            set pri-type-max <packets-per-second>
            set enable-shaper {disable | enable}
         config fp-anomaly
            set tcp-syn-fin {allow | drop | trap-to-host}
            set tcp-fin-noack {allow | drop | trap-to-host}
            set tcp-fin-only {allow | drop | trap-to-host}
            set tcp-no-flag {allow | drop | trap-to-host}
            set tcp-syn-data {allow | drop | trap-to-host}
            set tcp-winnuke {allow | drop | trap-to-host}
            set tcp-land {allow | drop | trap-to-host}
```

```
        set udp-land {allow | drop | trap-to-host}
        set icmp-land {allow | drop | trap-to-host}
        set icmp-frag {allow | drop | trap-to-host}
        set ipv4-land {allow | drop | trap-to-host}
        set ipv4-proto-err {allow | drop | trap-to-host}
        set ipv4-unknopt {allow | drop | trap-to-host}
        set ipv4-optrr {allow | drop | trap-to-host}
        set ipv4-optssrr {allow | drop | trap-to-host}
        set ipv4-optlsrr {allow | drop | trap-to-host}
        set ipv4-optstream {allow | drop | trap-to-host}
        set ipv4-optsecurity {allow | drop | trap-to-host}
        set ipv4-opttimestamp {allow | drop | trap-to-host}
        set ipv4-csum-err {drop | trap-to-host}
        set tcp-csum-err {drop | trap-to-host}
        set udp-csum-err {drop | trap-to-host}
        set icmp-csum-err {drop | trap-to-host}
        set ipv6-land {allow | drop | trap-to-host}
        set ipv6-proto-err {allow | drop | trap-to-host}
        set ipv6-unknopt {allow | drop | trap-to-host}
        set ipv6-saddr-err {allow | drop | trap-to-host}
        set ipv6-daddr-err {allow | drop | trap-to-host}
        set ipv6-optralert {allow | drop | trap-to-host}
        set ipv6-optjumbo {allow | drop | trap-to-host}
        set ipv6-opttunnel {allow | drop | trap-to-host}
        set ipv6-opthomeaddr {allow | drop | trap-to-host}
        set ipv6-optnsap {allow | drop | trap-to-host}
        set ipv6-optendpid {allow | drop | trap-to-host}
        set ipv6-optinvld {allow | drop | trap-to-host}
    end
```

Command syntax

Command	Description	Default
`low-latency-mode {disable | enable}`	Enable low-latency mode. In low latency mode the integrated switch fabric is bypassed. Low latency mode requires that packet enter and exit using the same NP6 processor. This option is only available for NP6 processors that can operate in low-latency mode, currently only np6_0 and np6_1 on the FortiGate 3700D and DX.	disable
`per-session-accounting {disable | enable | traffic-log-only}`	Disable NP6 per-session accounting or enable it and control how it works. If set to `traffic-log-only` (the default) NP6 per-session accounting is only enabled if firewall policies accepting offloaded traffic have traffic logging enabled. If set to `enable`, NP6 per-session accounting is always enabled for all traffic offloaded by the NP6 processor. Enabling per-session accounting can affect performance.	traffic-log-only
`garbage-session-collector {disable | enable}`	Enable deleting expired or garbage sessions.	disable

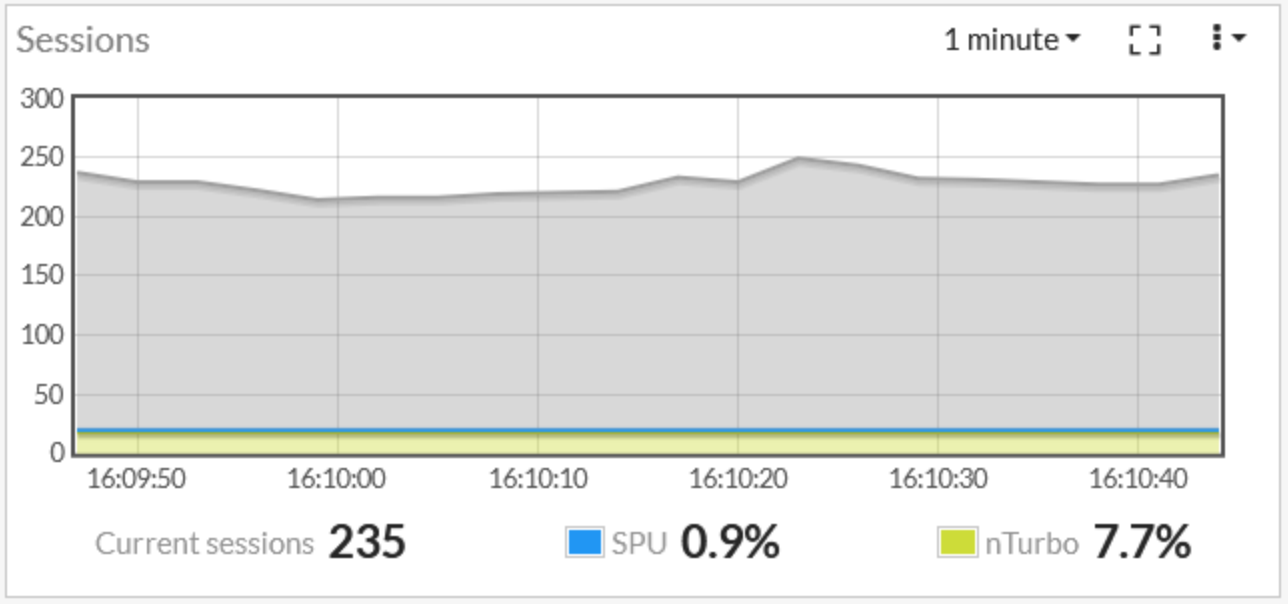
Command	Description	Default
`session-collector-interval <range>`	Set the expired or garbage session collector time interval in seconds. The range is 1 to 100 seconds.	64
`session-timeout-interval <range>`	Set the timeout for checking for and removing inactive NP6 sessions. The range is 0 to 1000 seconds.	40
`session-timeout-random-range <range>`	Set the random timeout for checking and removing inactive NP6 sessions. The range is 0 to 1000 seconds. For more information, see Configuring NP6 session timeouts on page 130.	8
`session-timeout-fixed {disable | enable}`	Enable to force checking for and removing inactive NP6 sessions at the `session-timeout-interval` time interval. Set to disable (the default) to check for and remove inactive NP6 sessions at random time intervals. For more information, see Configuring NP6 session timeouts on page 130.	disable
config hpe	See NP6 HPE host protection engine on page 116.	
config fp-anomaly		
`fp-anomaly`	Configure how the NP6 processor performs traffic anomaly protection. In most cases you can configure the NP6 processor to allow or drop the packets associated with an attack or forward the packets that are associated with the attack to FortiOS (called `trap-to-host`). Selecting `trap-to-host` turns off NP6 anomaly protection for that anomaly. If you require anomaly protection but don't want to use the NP6 processor, you can select `trap-to-host` and enable anomaly protection with a DoS policy.	
`tcp-syn-fin {allow | drop | trap-to-host}`	Detects TCP SYN flood SYN/FIN flag set anomalies.	allow
`tcp-fin-noack {allow | drop | trap-to-host}`	Detects TCP SYN flood with FIN flag set without ACK setting anomalies.	trap-to-host
`tcp-fin-only {allow | drop | trap-to-host}`	Detects TCP SYN flood with only FIN flag set anomalies.	trap-to-host
`tcp-no-flag {allow | drop | trap-to-host}`	Detects TCP SYN flood with no flag set anomalies.	allow
`tcp-syn-data {allow | drop | trap-to-host}`	Detects TCP SYN flood packets with data anomalies.	allow
`tcp-winnuke {allow | drop | trap-to-host}`	Detects TCP WinNuke anomalies.	trap-to-host
`tcp-land {allow | drop | trap-to-host}`	Detects TCP land anomalies.	trap-to-host
`udp-land {allow | drop |`	Detects UDP land anomalies.	trap-to-host

Command	Description	Default
`trap-to-host}`		
`icmp-land {allow | drop | trap-to-host}`	Detects ICMP land anomalies.	trap-to-host
`icmp-frag {allow | drop | trap-to-host}`	Detects Layer 3 fragmented packets that could be part of a layer 4 ICMP anomalies.	allow
`ipv4-land {allow | drop | trap-to-host}`	Detects IPv4 land anomalies.	trap-to-host
`ipv4-proto-err {allow | drop | trap-to-host}`	Detects invalid layer 4 protocol anomalies. For information about the error codes that are produced by setting this option to `drop`, see NP6 anomaly error codes.	trap-to-host
`ipv4-unknopt {allow | drop | trap-to-host}`	Detects unknown option anomalies.	trap-to-host
`ipv4-optrr {allow | drop | trap-to-host}`	Detects IPv4 with record route option anomalies.	trap-to-host
`ipv4-optssrr {allow | drop | trap-to-host}`	Detects IPv4 with strict source record route option anomalies.	trap-to-host
`ipv4-optlsrr {allow | drop | trap-to-host}`	Detects IPv4 with loose source record route option anomalies.	trap-to-host
`ipv4-optstream {allow | drop | trap-to-host}`	Detects stream option anomalies.	trap-to-host
`ipv4-optsecurity {allow | drop | trap-to-host}`	Detects security option anomalies.	trap-to-host
`ipv4-opttimestamp {allow | drop | trap-to-host}`	Detects timestamp option anomalies.	trap-to-host
`ipv4-csum-err {drop | trap-to-host}`	Detects IPv4 checksum errors.	drop
`tcp-csum-err {drop | trap-to-host}`	Detects TCP checksum errors.	drop
`udp-csum-err {drop | trap-to-host}`	Detects UDP checksum errors.	drop
`icmp-csum-err {drop | trap-to-host}`	Detects ICMP checksum errors.	drop
`ipv6-land {allow | drop | trap-to-host}`	Detects IPv6 land anomalies	trap-to-host
`ipv6-unknopt {allow | drop | trap-to-host}`	Detects unknown option anomalies.	trap-to-host

Command	Description	Default
`ipv6-saddr-err {allow | drop | trap-to-host}`	Detects source address as multicast anomalies.	trap-to-host
`ipv6-daddr-err {allow | drop | trap-to-host}`	Detects destination address as unspecified or loopback address anomalies.	trap-to-host
`ipv6-optralert {allow | drop | trap-to-host}`	Detects router alert option anomalies.	trap-to-host
`ipv6-optjumbo {allow | drop | trap-to-host}`	Detects jumbo options anomalies.	trap-to-host
`ipv6-opttunnel {allow | drop | trap-to-host}`	Detects tunnel encapsulation limit option anomalies.	trap-to-host
`ipv6-opthomeaddr {allow | drop | trap-to-host}`	Detects home address option anomalies.	trap-to-host
`ipv6-optnsap {allow | drop | trap-to-host}`	Detects network service access point address option anomalies.	trap-to-host
`ipv6-optendpid {allow | drop | trap-to-host}`	Detects end point identification anomalies.	trap-to-host
`ipv6-optinvld {allow | drop | trap-to-host}`	Detects invalid option anomalies.	trap-to-host

Per-session accounting for offloaded NP6, NP6XLite, and NP6Lite sessions

Per-session accounting is a logging feature that allows the FortiGate to report the correct bytes/pkt numbers per session for sessions offloaded to an NP6, NP6XLite, or NP6Lite processor. This information appears in traffic log messages as well as in FortiView. The following example shows the Sessions dashboard widget tracking SPU and nTurbo sessions. **Current sessions** shows the total number of sessions, **SPU** shows the percentage of these sessions that are SPU sessions and **Nturbo** shows the percentage that are nTurbo sessions.



You can hover over the SPU icon to see some information about the offloaded sessions.

You configure per-session accounting for each NP6 processor. For example, use the following command to enable per-session accounting for NP6_0 and NP6_1:

```
config system np6
   edit np6_0
      set per-session-accounting traffic-log-only
   next
   edit np6_1
      set per-session-accounting traffic-log-only
   end
```

You configure per-session accounting for each NP6XLite processor. For example, use the following command to enable per-session accounting for np6xlite_0:

```
config system np6xlite
   edit np6xlite_0
      set per-session-accounting traffic-log-only
   end
```

If your FortiGate has NP6Lite processors, you can use the following command to enable per-session accounting for all of the NP6Lite processors in the FortiGate unit:

```
   config system npu
      set per-session-accounting traffic-log-only
   end
```

The option `traffic-log-only` enables per-session accounting for offloaded sessions with traffic logging.

The option `enable` enables per-session accounting for all offloaded sessions.

By default, `per-session-accounting` is set to `traffic-log-only`, which results in per-session accounting being turned on when you enable traffic logging in a policy.

Per-session accounting can affect offloading performance. So you should only enable per-session accounting if you need the accounting information.

Enabling per-session accounting does not provide traffic flow data for sFlow or NetFlow.

Multicast per-session accounting

Some FortiGates with NP6 processors include the following command to configure multicast session accounting:

```
config system npu
   set mcast-session-accounting {tpe-based | session-based | disable}
end
```

`tpe-based` (the default) enables TPE-based multicast session accounting. TPE is the NP6 accounting and traffic shaping module. In most cases, if you want multicast session accounting, you should select `tpe-based` for optimal performance and reliability. This setting may be incompatible with some traffic. If problems such as packet order issues occur, you can disable multicast session accounting or select `session-based` multicast accounting.

`session-based` enables session-based multicast session accounting.

`disable` disables multicast session accounting.

Generally speaking, session-based accounting has better performance than TPE-based when there are high number of multicast sessions (on the order of 7,000 sessions, depending on network and other conditions).

TPE-based accounting generally can have better performance when there are a fewer multicast sessions with very high throughput.

Some FortiGate models support the following command to enable or disable multicast session accounting. For these models, multicast session accounting is enabled by default:

```
config system npu
   set mcast-session-counting {disable | enable}
   set mcast-session-counting6 {disable | enable}
end
```

Configuring NP6 session timeouts

For NP6 traffic, FortiOS refreshes an NP6 session's lifetime when it receives a session update message from the NP6 processor. To avoid session update message congestion, these NP6 session checks are performed all at once after a random time interval and all of the update messages are sent from the NP6 processor to FortiOS at once. This can result in fewer messages being sent because they are only sent at random time intervals instead of every time a session times out.

In fact, if your NP6 processor is processing a lot of short lived sessions, it is recommended that you use the default setting of random checking every 8 seconds to avoid very bursty session updates. If the time between session updates is very long and very many sessions have been expired between updates a large number of updates will need to be done all at once.

You can use the following command to set the random time range.

```
config system {np6 | np6xlite}
   edit <np6-processor-name>
      set session-timeout-fixed disable
      set session-timeout-random-range 8
   end
```

This is the default configuration. The random timeout range is 1 to 1000 seconds and the default range is 8. So, by default, NP6 sessions are checked at random time intervals of between 1 and 8 seconds. So sessions can be inactive for up to 8 seconds before they are removed from the FortiOS session table.

If you want to reduce the amount of checking you can increase the `session-timeout-random-range`. This could result in inactive sessions being kept in the session table longer. But if most of your NP6 sessions are relatively long this shouldn't be a problem.

You can also change this session checking to a fixed time interval and set a fixed timeout:

```
config system {np6 | np6xlite}
   edit <np6-processor-name>
      set session-timeout-fixed enable
      set session-timeout-interval 40
   end
```

The fixed timeout default is every 40 seconds and the rang is 1 to 1000 seconds. Using a fixed interval further reduces the amount of checking that occurs.

You can select random or fixed updates and adjust the time intervals to minimize the refreshing that occurs while still making sure inactive sessions are deleted regularly. For example, if an NP6 processor is processing sessions with long lifetimes you can reduce checking by setting a relatively long fixed timeout.

Configure the number of IPsec engines NP6 processors use

NP6 processors use multiple IPsec engines to accelerate IPsec encryption and decryption. In some cases out of order ESP packets can cause problems if multiple IPsec engines are running. To resolve this problem you can configure all of the NP6 processors to use fewer IPsec engines.

Use the following command to change the number of IPsec engines used for decryption (`ipsec-dec-subengine-mask`) and encryption (`ipsec-enc-subengine-mask`). These settings are applied to all of the NP6 processors in the FortiGate unit.

```
config system npu
   set ipsec-dec-subengine-mask <engine-mask>
   set ipsec-enc-subengine-mask <engine-mask>
end
```

`<engine-mask>` is a hexadecimal number in the range 0x01 to 0xff where each bit represents one IPsec engine. The default `<engine-mask>` for both options is 0xff which means all IPsec engines are used. Add a lower `<engine-mask>` to use fewer engines. You can configure different engine masks for encryption and decryption.

Stripping clear text padding and IPsec session ESP padding

In some situations, when clear text or ESP packets in IPsec sessions may have large amounts of layer 2 padding, the NP6 IPsec engine may not be able to process them and the session may be blocked.

If you notice dropped IPsec sessions, you could try using the following CLI options to cause the NP6 processor to strip clear text padding and ESP padding before send the packets to the IPsec engine. With padding stripped, the session can be processed normally by the IPsec engine.

Use the following command to strip ESP padding:

```
config system npu
   set strip-esp-padding enable
   set strip-clear-text-padding enable
end
```

Stripping clear text and ESP padding are both disabled by default.

Disabling NP6 and NP6XLite CAPWAP offloading

By default and where possible, managed FortiAP and FortiLink CAPWAP sessions are offloaded to NP6 and NP6XLite processors. You can use the following command to disable CAWAP session offloading:

```
config system npu
   set capwap-offload disable
end
```

Optionally disable NP6 offloading of traffic passing between 10Gbps and 1Gbps interfaces

Due to NP6 internal packet buffer limitations, some offloaded packets received at a 10Gbps interface and destined for a 1Gbps interface can be dropped, reducing performance for TCP and IP tunnel traffic. If you experience this performance reduction, you can use the following command to disable offloading sessions passing from 10Gbps interfaces to 1Gbps interfaces:

```
config system npu
   set host-shortcut-mode host-shortcut
end
```

Select `host-shortcut` to stop offloading TCP and IP tunnel packets passing from 10Gbps interfaces to 1Gbps interfaces. TCP and IP tunnel packets passing from 1Gbps interfaces to 10Gbps interfaces are still offloaded as normal.

If `host-shortcut` is set to the default `bi-directional` setting, packets in both directions are offloaded.

This option is only available if your FortiGate has 10G and 1G interfaces accelerated by NP6 processors.

Offloading RDP traffic

FortiOS supports NP6 offloading of Reliable Data Protocol (RDP) traffic. RDP is a network transport protocol that optimizes remote loading, debugging, and bulk transfer of images and data. RDP traffic uses Assigned Internet Protocol number 27 and is defined in RFC 908 and updated in RFC 1151. If your network is processing a lot of RDP traffic, offloading it can improve overall network performance.

You can use the following command to enable or disable NP6 RDP offloading. RDP offloading is enabled by default.

```
config system npu
   set rdp-offload {disable | enable}
end
```

NP6 session drift

In some cases, sessions processed by NP6 processors may fail to be deleted leading to a large number of idle or orphaned sessions. This is called session drift. You can use SNMP to be alerted when the number of idle sessions becomes high. SNMP also allows you to see which NP6 processor has the abnormal number of idle sessions and you can use a diagnose command to delete them.

The following MIB fields allow you to use SNMP to monitor session table information for NP6 processors including drift for each NP6 processor:

```
FORTINET-FORTIGATE-MIB::fgNPUNumber.0 = INTEGER: 2
FORTINET-FORTIGATE-MIB::fgNPUName.0 = STRING: NP6
FORTINET-FORTIGATE-MIB::fgNPUDrvDriftSum.0 = INTEGER: 0
FORTINET-FORTIGATE-MIB::fgNPUIndex.0 = INTEGER: 0
FORTINET-FORTIGATE-MIB::fgNPUIndex.1 = INTEGER: 1
FORTINET-FORTIGATE-MIB::fgNPUSessionTblSize.0 = Gauge32: 33554432
FORTINET-FORTIGATE-MIB::fgNPUSessionTblSize.1 = Gauge32: 33554432
FORTINET-FORTIGATE-MIB::fgNPUSessionCount.0 = Gauge32: 0
FORTINET-FORTIGATE-MIB::fgNPUSessionCount.1 = Gauge32: 0
FORTINET-FORTIGATE-MIB::fgNPUDrvDrift.0 = INTEGER: 0
FORTINET-FORTIGATE-MIB::fgNPUDrvDrift.1 = INTEGER: 0
```

You can also use the following diagnose command to determine if drift is occurring. The command output shows a drift summary for all the NP6 processors in the FortiGate, and shows the total drift. The following example command output, from a FortiGate 1500D, shows that the two NP6 processors in the FortiGate-1500D are not experiencing any drift.

```
diagnose npu np6 sse-drift-summary
NPU   drv-drift
----- ---------
np6_0 0
np6_1 0
----- ---------
Sum   0
----- ---------
```

For the best results you should restart your FortiGate to remove orphaned sessions causing session drift. However, the following command can be a useful workaround until you are able to reboot the FortiGate or if you troubleshooting an issue and want to remove orphaned sessions.

```
diagnose npu np6 sse-purge-drift <np6_id> [<time>]
```

Where `<np6_id>` is the number (starting with NP6_0 with a np6_id of 0) of the NP6 processor for which to delete idle sessions in.

`<time>` is the time in seconds during which the NP6 processor attempts to delete orphaned sessions. The default time is 300 seconds.

The command instructs the selected NP6 processor to scan session tables and delete (or purge) orphaned sessions, which are sessions that have been idle for a long time. During the session purge, traffic may be disrupted. The longer the purge time, the longer the amount of time that a disruption might occur.

The command purges all orphaned sessions during the specified time and you only have to execute the command once to purge all orphaned sessions.

In most cases the NP6 processor should recover and continue working normally after the purge. In rare cases, the NP6 processor may not be able to recover successfully after the purge and you may need to restart the FortiGate.

Optimizing FortiGate 3960E and 3980E IPsec VPN performance

You can use the following command to configure outbound hashing to improve IPsec VPN performance for the FortiGate 3960E and 3980E. If you change these settings, to make sure they take affect, you should reboot your device.

```
config system np6
   edit np6_0
      set ipsec-outbound-hash {disable | enable}
      set ipsec-ob-hash-function {switch-group-hash | global- hash | global-hash-weighted |
           round-robin-switch-group | round-robin-global}
   end
```

Where:

`ipsec-outbound-hash` is disabled by default. If you enable it you can set `ipsec-ob-hash-function` as follows:

`switch-group-hash` (the default) distribute outbound IPsec Security Association (SA) traffic to NP6 processors connected to the same switch as the interfaces that received the incoming traffic. This option, keeps all traffic on one switch and the NP6 processors connected to that switch, to improve performance.

`global-hash` distribute outbound IPsec SA traffic among all NP6 processors.

`global-hash-weighted` distribute outbound IPsec SA traffic from switch 1 among all NP6 processors with more sessions going to the NP6s connected to switch 0. This options is only recommended for the FortiGate 3980E because it is designed to weigh switch 0 higher to send more sessions to switch 0 which on the FortiGate 3980E has more NP6 processors connected to it. On the FortiGate 3960E, both switches have the same number of NP6s so for best performance one switch shouldn't have a higher weight.

`round-robin-switch-group` round-robin distribution of outbound IPsec SA traffic among the NP6 processors connected to the same switch.

`round-robin-global` round-robin distribution of outbound IPsec SA traffic among all NP6 processors.

FortiGate 3960E and 3980E support for high throughput traffic streams

FortiGate devices with multiple NP6 processors support high throughput by distributing sessions to multiple NP6 processors. However, default ISF hash-based load balancing has some limitations for single traffic streams or flows that use more than 10Gbps of bandwidth. Normally, the ISF sends all of the packets in a single traffic stream over the same 10Gbps interface to an NP6 processor. If a single traffic stream is larger than 10Gbps, packets are also sent to 10Gbps interfaces that may be connected to the same NP6 or to other NP6s. Because the ISF uses hash-based load balancing, this can lead to packets being processed out of order and other potential drawbacks.

You can configure the FortiGate 3960E and 3980E to support single traffic flows that are larger than 10Gbps. To enable this feature, you can assign interfaces to round robin groups using the following configuration. If you assign an interface to a Round Robin group, the ISF uses round-robin load balancing to distribute incoming traffic from one stream to multiple NP6 processors. Round-robin load balancing prevents the potential problems associated with hash-based load balancing of packets from a single stream.

```
config system npu
   config port-npu-map
      edit <interface>
         set npu-group-index <npu-group>
```

```
    end
  end
```

<interface> is the name of an interface that receives or sends large traffic streams.

<npu-group> is the number of an NPU group.To enable round-robin load balancing select a round-robin NPU group. Use ? to see the list of NPU groups. The output shows which groups support round robin load balancing. For example, the following output shows that NPU group 30 supports round robin load balancing to NP6 0 to 7.

```
set npu-group-index ?
index: npu group
0 : NP#0-7
2 : NP#0
3 : NP#1
4 : NP#2
5 : NP#3
6 : NP#4
7 : NP#5
8 : NP#6
9 : NP#7
10 : NP#0-1
11 : NP#2-3
12 : NP#4-5
13 : NP#6-7
14 : NP#0-3
15 : NP#4-7
30 : NP#0-7 - Round Robin
```

For example, use the following command to assign port1, port2, port17 and port18 to NPU group 30.

```
config system npu
  config port-npu-map
    edit port1
      set npu-group-index 30
    next
    edit port2
      set npu-group-index 30
    next
    edit port7
      set npu-group-index 30
    next
    edit port18
      set npu-group-index 30
    next
    end
  end
```

Recalculating packet checksums if the iph.reserved bit is set to 0

NP6 processors clear the iph.flags.reserved bit. This results in the packet checksum becoming incorrect because by default the packet is changed but the checksum is not recalculated. Since the checksum is incorrect these packets may be dropped by the network stack. You can enable this option to cause the system to re-calculate the checksum. Enabling this option may cause a minor performance reduction. This option is disabled by default.

To enabled checksum recalculation for packets with the iph.flags.reserved header:

```
config system npu
   set iph-rsvd-re-cksum enable
end
```

NP6 IPsec engine status monitoring

Use the following command to configure NP6 IPsec engine status monitoring.

```
config monitoring np6-ipsec-engine
   set status enable
   set interval 5
   set threshold 10 10 8 8 6 6 4 4
end
```

Use this command to configure NP6 IPsec engine status monitoring. NP6 IPsec engine status monitoring writes a system event log message if the IPsec engines in an NP6 processor become locked after receiving malformed packets.

If an IPsec engine becomes locked, that particular engine can no longer process IPsec traffic, reducing the capacity of the NP6 processor. The only way to recover from a locked IPsec engine is to restart the FortiGate device. If you notice an IPsec performance reduction over time on your NP6 accelerated FortiGate device, you could enable NP6 IPsec engine monitoring and check log messages to determine if your NP6 IPsec engines are becoming locked.

To configure IPsec engine status monitoring you set status to enable and then configure the following options:

`interval`

Set the IPsec engine status check time interval in seconds (range 1 to 60 seconds, default = 1).

`threshold <np6_0-threshold> <np6_1-threshold>...<np6_7-threshold>`

Set engine status check thresholds. An NP6 processor has eight IPsec engines and you can set a threshold for each engine. NP6 IPsec engine status monitoring regularly checks the status of all eight engines in all NP6 processors in the FortiGate device.

Each threshold can be an integer between 1 and 255 and represents the number of times the NP6 IPsec engine status check detects that the NP6 processor is busy before generating a log message.

The default thresholds are 15 15 12 12 8 8 5 5. Any IPsec engine exceeding its threshold triggers the event log message. The default interval and thresholds have been set to work for most network topologies based on a balance of timely reporting a lock-up and accuracy and on how NP6 processors distribute sessions to their IPsec engines. The default settings mean:

- If engine 1 or 2 are busy for 15 checks (15 seconds) trigger an event log message.
- If engine 3 or 4 are busy for 12 checks (15 seconds) trigger an event log message.
- And so on.

NP6 IPsec engine monitoring writes three levels of log messages:

- Information if an IPsec engine is found to be busy.
- Warning if an IPsec engine exceeds a threshold.
- Critical if a lockup is detected, meaning an IPsec engine continues to exceed its threshold.

The log messages include the NP6 processor and engine affected.

Interface to CPU mapping

In some cases, packets in a multicast traffic stream with fragmented packets can be forwarded by the FortiGate in the wrong order. This can happen if different CPU cores are processing different packets from the same multicast stream. If you notice this problem, on some FortiGates with NP6 processors you can use the following command to configure the FortiGate to send all traffic received by an interface to the same CPU core.

```
config system npu
   config port-cpu-map
      edit <interface-name>
         set cpu-core <core-number>
      end
```

Where:

`<interface-name>` is the name of the interface to map to a CPU core. You can map any interface connected to an NP6 processor to a CPU core.

`<core-number>` is the number of the CPU core to map to the interface. Use `?` to see the list of available CPU cores. You can map one CPU core to an interface. The default setting is `all`, which maps the traffic to all CPU cores.

Allowing offloaded IPsec packets that exceed the interface MTU

In some cases, encrypted IPsec packets offloaded to NP6 processors may be larger than unencrypted packets. When this happens, the packets may be blocked or fragmented by the exiting IPsec VPN interface if the encrypted packet size exceeds the MTU value of the IPsec VPN interface. This can happen even if `mtu-override` is enabled for the interface.

You can use the following option to allow offloaded IPsec packets that exceed the MTU value of the exiting interface to be allowed without fragmentation.

```
config system npu
   set ipsec-mtu-override enable
end
```

Configuring the QoS mode for NP6-accelerated traffic

If you have a FortiGate with multiple NP6 processors and an internal switch fabric (ISF), you can use the following command to configure the QoS mode to control how the ISF distributes traffic to the NP6 processors:

```
config system npu
   set qos-mode {disable | piority | round-robin}
end
```

Where:

`disable` (the default setting) disables QoS for NP6-accelerated traffic.

`priority` uses priority-based QoS that is applied to ingress and egress traffic based on the traffic CoS value. Traffic with a higher CoS value has a higher QoS priority.

`round-robin` applies round-robin or bandwidth control distribution to ingress traffic only based on the traffic CoS value. This mode helps smooth out incoming burst traffic by distributing traffic evenly among the NP6 processors.

Recovering from an internal link failure

Some FortiGate models with NP6 processors include the following option that can help your FortiGate recover from an internal link failure:

```
config system npu
   set recover-np6-link {disable | enable}
end
```

This command is available on several FortiGate models, including the 1200D, 1500D, 1500DT, 3000D, 3100D, and 3200D.

In some configurations with aggregate interfaces, an internal link failure can occur on some FortiGate models. This failure can cause one of the aggregate interface members to transmit irregular LACP packets. You can recover from this failure by enabling `recover-np6-link` and restarting the FortiGate. Every time the FortiGate restarts, this command checks for and recovers from any internal link failures that it finds.

Enabling this option may cause the FortiGate to take slightly longer to start up but should not affect performance.

Offloading UDP-encapsulated ESP traffic

You can use the following command to enable or disable NP6 offloading of UDP-encapsulated ESP traffic on port 4500.

```
config system npu
   set uesp-offload {disable | enable}
end
```

Enable to offload UDP traffic with a destination port of 4500 (ESP-in-UDP traffic). This option is disabled by default.

In addition to enabling this option, to make sure UDP-encapsulated ESP traffic can be offloaded successfully, you should disable IPsec anti-replay protection and use large MTU check values in NAT-traversal sessions to avoid fragmented packets and MTU exceptions.

NP6 get and diagnose commands

This section describes some `get` and `diagnose` commands you can use to display useful information about NP6 processors and about sessions processed by NP6 processors.

get hardware npu np6

You can use the `get hardware npu np6` command to display information about the NP6 processors in your FortiGate and the sessions they are processing. This command contains a subset of the options available from the `diagnose npu np6` command. The command syntax is:

```
get hardware npu np6 {dce <np6-id> | ipsec-stats | port-list | session-stats <np6-id> | sse-
     stats <np6-id> | synproxy-stats}
```

`<np6-id>` identifies the NP6 processor. `0` is `np6_0`, `1` is `np6_1` and so on.

`dce` show NP6 non-zero sub-engine drop counters for the selected NP6.

`ipsec-stats` show overall NP6 IPsec offloading statistics.

`port-list` show the mapping between the FortiGate physical interfaces and NP6 processors.

`session-stats` show NP6 session offloading statistics counters for the selected NP6.

`sse-stats` show hardware session statistics counters.

`synproxy-stats` show overall NP6 synproxy statistics for TCP connections identified as being syn proxy DoS attacks.

diagnose npu np6

The diagnose npu np6 command displays extensive information about NP6 processors and the sessions that they are processing. Some of the information displayed can be useful for understanding the NP6 configuration, seeing how sessions are being processed and diagnosing problems. Some of the commands may only be useful for Fortinet software developers. The command syntax is:

```
diagnose npu np6 {options}
```

The following options are available:

`fastpath {disable | enable} <np6-od>` enable or disable fastpath processing for a selected NP6.

`dce` shows NP6 non-zero sub-engine drop counters for the selected NP6.

`dce-all` show all subengine drop counters.

`anomaly-drop` show non-zero L3/L4 anomaly check drop counters.

`anomaly-drop-all` show all L3/L4 anomaly check drop counters.

`hrx-drop` show non-zero host interface drop counters.

`hrx-drop-all` show all host interface drop counters.

`session-stats` show session offloading statistics counters.

`session-stats-clear` clear session offloading statistics counters.

`sse-stats` show hardware session statistics counters.

`sse-stats-clear` show hardware session statistics counters.

`pdq` show packet buffer queue counters.

`xgmac-stats` show XGMAC MIBs counters.

`xgmac-stats-clear` clear XGMAC MIBS counters.

`port-list` show port list.

`ipsec-stats` show IPsec offloading statistics.

`ipsec-stats-clear` clear IPsec offloading statistics.

`eeprom-read` read NP6 EEPROM.

`npu-feature` show NPU feature and status.

`register` show NP6 registers.

`fortilink` configure managed FortiSwitch.

`synproxy-stats` show synproxy statistics.

diagnose npu np6 npu-feature (verify enabled NP6 features)

You can use the `diagnose npu np6 npu-feature` command to see the NP6 features that are enabled on your FortiGate and those that are not.

The following command output, from a FortiGate 1500D, shows the default NP6 configuration for most FortiGates with NP6 processors:

```
diagnose npu np6 npu-feature
                    np_0      np_1
------------------- --------- ---------
Fastpath            Enabled   Enabled
HPE-type-shaping    Disabled  Disabled
Standalone          No        No
IPv4 firewall       Yes       Yes
IPv6 firewall       Yes       Yes
IPv4 IPSec          Yes       Yes
IPv6 IPSec          Yes       Yes
IPv4 tunnel         Yes       Yes
IPv6 tunnel         Yes       Yes
GRE tunnel          No        No
GRE passthrough     Yes       Yes
IPv4 Multicast      Yes       Yes
IPv6 Multicast      Yes       Yes
CAPWAP              Yes       Yes
RDP Offload         Yes       Yes
```

If you use the following command to disable fastpath:

```
config system npu
   set fastpath disable
end
```

The `npu-feature` command output shows this configuration change:

```
diagnose npu np6 npu-feature
                    np_0      np_1
------------------- --------- ---------
Fastpath            Disabled  Disabled
HPE-type-shaping    Disabled  Disabled
Standalone          No        No
IPv4 firewall       Yes       Yes
IPv6 firewall       Yes       Yes
IPv4 IPSec          Yes       Yes
IPv6 IPSec          Yes       Yes
IPv4 tunnel         Yes       Yes
IPv6 tunnel         Yes       Yes
GRE tunnel          No        No
GRE passthrough     Yes       Yes
IPv4 Multicast      Yes       Yes
IPv6 Multicast      Yes       Yes
CAPWAP              Yes       Yes
RDP Offload         Yes       Yes
```

diagnose npu np6xlite npu-feature (verify enabled NP6Lite features)

You can use the `diagnose npu np6xlite npu-feature` command to see the NP6XLite features that are enabled on your FortiGate and those that are not.

The following command output, from a FortiGate 60F, shows the default NP6XLite configuration for most FortiGates with NP6XLite processors:

```
diagnose npu np6xlite npu-feature
                    np_0
------------------- ---------
Fastpath            Enabled
HPE-type-shaping    Disabled
IPv4 firewall       Yes
IPv6 firewall       Yes
IPv4 IPSec          Yes
IPv6 IPSec          Yes
IPv4 tunnel         Yes
IPv6 tunnel         Yes
GRE passthrough     Yes
IPv4 Multicast      Yes
IPv6 Multicast      Yes
CAPWAP              Yes
```

If you use the following commands to disable fastpath:

```
config system np6xlite
   edit np6xlite_0
      set fastpath disable
   end
```

The `npu-feature` command output show this configuration change:

```
diagnose npu np6xlite npu-feature
                    np_0
------------------- ---------
```

```
Fastpath            Disabled
HPE-type-shaping    Disabled
IPv4 firewall       Yes
IPv6 firewall       Yes
IPv4 IPSec          Yes
IPv6 IPSec          Yes
IPv4 tunnel         Yes
IPv6 tunnel         Yes
GRE passthrough     Yes
IPv4 Multicast      Yes
IPv6 Multicast      Yes
CAPWAP              Yes
```

diagnose npu np6lite npu-feature (verify enabled NP6Lite features)

You can use the `diagnose npu np6lite npu-feature` command to see the NP6Lite features that are enabled on your FortiGate and those that are not.

The following command output, from a FortiGate 200E, shows the default NP6Lite configuration for most FortiGates with NP6Lite processors:

```
diagnose npu np6 npu-feature
                    np_0      np_1
------------------- --------- ---------
Fastpath            Enabled   Enabled
IPv4 firewall       Yes       Yes
IPv6 firewall       Yes       Yes
IPv4 IPSec          Yes       Yes
IPv6 IPSec          Yes       Yes
IPv4 tunnel         Yes       Yes
IPv6 tunnel         Yes       Yes
GRE tunnel          No        No
```

If you use the following command to disable fastpath:

```
config system npu
   set fastpath disable
end
```

The `npu-feature` command output show this configuration change:

```
diagnose npu np6 npu-feature
                    np_0      np_1
------------------- --------- ---------
Fastpath            Disabled  Disabled
IPv4 firewall       Yes       Yes
IPv6 firewall       Yes       Yes
IPv4 IPSec          Yes       Yes
IPv6 IPSec          Yes       Yes
IPv4 tunnel         Yes       Yes
IPv6 tunnel         Yes       Yes
GRE tunnel          No        No
```

diagnose sys session/session6 list (view offloaded NP6 sessions)

The `diagnose sys session list` and `diagnose sys session6 list` commands list all of the current IPv4 or IPv6 sessions being processed by the FortiGate. For each session the command output includes an `npu info` line that displays NPx offloading information for the session. If a session is not offloaded the command output includes a `no_ofld_reason` line that indicates why the session was not offloaded.

Displaying NP6 offloading information for a session

The `npu info` line of the `diagnose sys session list` command includes information about the offloaded session that indicates the type of processor and whether its IPsec or regular traffic:

- `offload=8/8` for NP6 sessions.
- `flag 0x81` means regular traffic.
- `flag 0x82` means IPsec traffic.

Example offloaded IPv4 NP6 session

The following session output by the `diagnose sys session list` command shows an offloaded session. The information in the `npu info` line shows this is a regular session (`flag=0x81/0x81`) that is offloaded by an NP6 processor (`offload=8/8`).

```
diagnose sys session list
session info: proto=6 proto_state=01 duration=4599 expire=2753 timeout=3600 flags=00000000
sockflag=00000000 sockport=0 av_idx=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0 policy_dir=0 tunnel=/ vlan_cos=0/255
state=log may_dirty npu none log-start
statistic(bytes/packets/allow_err): org=1549/20/1 reply=1090/15/1 tuples=2
speed(Bps/kbps): 0/0
orgin->sink: org pre->post, reply pre->post dev=15->17/17->15
gwy=172.20.121.2/5.5.5.33
hook=post dir=org act=snat 5.5.5.33:60656->91.190.218.66:12350(172.20.121.135:60656)
hook=pre dir=reply act=dnat 91.190.218.66:12350->172.20.121.135:60656(5.5.5.33:60656)
pos/(before,after) 0/(0,0), 0/(0,0)
src_mac=98:90:96:af:89:b9
misc=0 policy_id=1 auth_info=0 chk_client_info=0 vd=0
serial=00058b9c tos=ff/ff app_list=0 app=0 url_cat=0
dd_type=0 dd_mode=0
npu_state=0x000c00
npu info: flag=0x81/0x81, offload=8/8, ips_offload=0/0, epid=140/138, ipid=138/140,
vlan=0x0000/0x0000
vlifid=138/140, vtag_in=0x0000/0x0000 in_npu=1/1, out_npu=1/1, fwd_en=0/0, qid=0/2
```

Example IPv4 session that is not offloaded

The following session, output by the diagnose sys session list command includes the `no_ofld_reason` line that indicates that the session was not offloaded because it is a local-in session.

```
session info: proto=6 proto_state=01 duration=19 expire=3597 timeout=3600
flags=00000000 sockflag=00000000 sockport=0 av_idx=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0 policy_dir=0 tunnel=/ vlan_cos=8/8
state=local may_dirty
statistic(bytes/packets/allow_err): org=6338/15/1 reply=7129/12/1 tuples=2
speed(Bps/kbps): 680/5
orgin->sink: org pre->in, reply out->post dev=15->50/50->15 gwy=5.5.5.5/0.0.0.0
hook=pre dir=org act=noop 5.5.5.33:60567->5.5.5.5:443(0.0.0.0:0)
hook=post dir=reply act=noop 5.5.5.5:443->5.5.5.33:60567(0.0.0.0:0)
pos/(before,after) 0/(0,0), 0/(0,0)
src_mac=98:90:96:af:89:b9
misc=0 policy_id=0 auth_info=0 chk_client_info=0 vd=0
serial=000645d8 tos=ff/ff app_list=0 app=0 url_cat=0
dd_type=0 dd_mode=0
npu_state=00000000
no_ofld_reason:  local
```

Example IPv4 IPsec NP6 session

```
diagnose sys session list
session info: proto=6 proto_state=01 duration=34 expire=3565 timeout=3600 flags=00000000
sockflag=00000000 sockport=0 av_idx=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0 policy_dir=0 tunnel=/p1-vdom2
state=re may_dirty npu
statistic(bytes/packets/allow_err): org=112/2/1 reply=112/2/1 tuples=2
orgin->sink: org pre->post, reply pre->post dev=57->7/7->57 gwy=10.1.100.11/11.11.11.1
hook=pre dir=org act=noop 172.16.200.55:35254->10.1.100.11:80(0.0.0.0:0)
hook=post dir=reply act=noop 10.1.100.11:80->172.16.200.55:35254(0.0.0.0:0)
pos/(before,after) 0/(0,0), 0/(0,0)
misc=0 policy_id=1 id_policy_id=0 auth_info=0 chk_client_info=0 vd=4
serial=00002d29 tos=ff/ff ips_view=0 app_list=0 app=0
dd_type=0 dd_mode=0
per_ip_bandwidth meter: addr=172.16.200.55, bps=260
npu_state=00000000
npu info: flag=0x81/0x82, offload=8/8, ips_offload=0/0, epid=1/3, ipid=3/1, vlan=32779/0
```

Example IPv6 NP6 session

```
diagnose sys session6 list
session6 info: proto=6 proto_state=01 duration=2 expire=3597 timeout=3600 flags=00000000
sockport=0 sockflag=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0
policy_dir=0 tunnel=/
state=may_dirty npu
statistic(bytes/packets/allow_err): org=152/2/0 reply=152/2/0 tuples=2
```

```
speed(Bps/kbps): 0/0
orgin->sink: org pre->post, reply pre->post dev=13->14/14->13
hook=pre dir=org act=noop 2000:172:16:200::55:59145 ->2000:10:1:100::11:80(:::0)
hook=post dir=reply act=noop 2000:10:1:100::11:80 ->2000:172:16:200::55:59145(:::0)
misc=0 policy_id=1 auth_info=0 chk_client_info=0 vd=0 serial=0000027a
npu_state=0x000c00
npu info: flag=0x81/0x81, offload=8/8, ips_offload=0/0, epid=137/136, ipid=136/137, vlan=0/0
```

Example NAT46 NP6 session

```
diagnose sys session list
session info: proto=6 proto_state=01 duration=19 expire=3580 timeout=3600 flags=00000000
sockflag=00000000 sockport=0 av_idx=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0 policy_dir=0 tunnel=/
state=npu nlb
statistic(bytes/packets/allow_err): org=112/2/1 reply=112/2/1 tuples=2
speed(Bps/kbps): 0/0
orgin->sink: org nataf->post, reply pre->org dev=52->14/14->52 gwy=0.0.0.0/10.1.100.1
hook=5 dir=org act=noop 10.1.100.1:21937->10.1.100.11:80(0.0.0.0:0)
hook=6 dir=reply act=noop 10.1.100.11:80->10.1.100.1:21937(0.0.0.0:0)
hook=pre dir=org act=noop 2000:172:16:200::55:33945 ->64:ff9b::a01:640b:80(:::0)
hook=post dir=reply act=noop 64:ff9b::a01:640b:80 ->2000:172:16:200::55:33945(:::0)
pos/(before,after) 0/(0,0), 0/(0,0)
misc=0 policy_id=1 auth_info=0 chk_client_info=0 vd=0
serial=04051aae tos=ff/ff ips_view=0 app_list=0 app=0
dd_type=0 dd_mode=0
npu_state=00000000
npu info: flag=0x81/0x00, offload=0/8, ips_offload=0/0, epid=0/136, ipid=0/137, vlan=0/0
```

Example NAT64 NP6 session

```
diagnose sys session6 list
session6 info: proto=6 proto_state=01 duration=36 expire=3563 timeout=3600 flags=00000000
sockport=0 sockflag=0 use=3
origin-shaper=
reply-shaper=
per_ip_shaper=
ha_id=0
policy_dir=0 tunnel=/
state=may_dirty npu nlb
statistic(bytes/packets/allow_err): org=72/1/0 reply=152/2/0 tuples=2
speed(Bps/kbps): 0/0
orgin->sink: org pre->org, reply nataf->post dev=13->14/14->13
hook=pre dir=org act=noop 2000:172:16:200::55:33945 ->64:ff9b::a01:640b:80(:::0)
hook=post dir=reply act=noop 64:ff9b::a01:640b:80 ->2000:172:16:200::55:33945(:::0)
hook=5 dir=org act=noop 10.1.100.1:21937->10.1.100.11:80(0.0.0.0:0)
hook=6 dir=reply act=noop 10.1.100.11:80->10.1.100.1:21937(0.0.0.0:0)
misc=0 policy_id=1 auth_info=0 chk_client_info=0 vd=0 serial=0000027b
npu_state=00000000
npu info: flag=0x00/0x81, offload=8/0, ips_offload=0/0, epid=137/0, ipid=136/0, vlan=0/0
```

diagnose sys session list no_ofld_reason field

The `no_ofld_reason` field appears in the output of the `diagnose sys session list` or `diagnose sys sessions6 list` command to indicate why the session wasn't offloaded by an NP6 processor. The field appears for sessions that normally would be offloaded but for some reason can't currently be offloaded. The following table lists and explains some of the reasons that a session could not be offloaded. Note that more than one of these reasons can appear in the `no_ofld_reason` field for a single session.

no_ofld_reason	Description
`dirty`	Because of a configuration change to routing, firewall policies, interfaces, ARP tables, or other configuration, the session needs to be revalidated by FortiOS. Traffic may still be processed by the session, but it will not be offloaded until the session has been revalidated.
`local`	The session is a local-in or local-out session that can't be offloaded. Examples include management sessions, SSL VPN sessions accessing an SSL VPN portal, explicit proxy sessions, and so on.
`disabled-by-policy`	The firewall policy option `auto-asic-offload` is disabled in the firewall policy that accepted the session. This reason can also appear if one or more of the interfaces handling the session are software switch interfaces.
`non-npu-intf`	The incoming or outgoing interface handling the sessions is not an NP6-accelerated interface or is part of a software switch. This reason may also appear if when the `config system npu` option `fastpath` is disabled.
`npu-flag-off`	The session is not offloaded because of hardware or software limitations. For example, the session could be using EMAC VLAN interfaces or the session could be for a protocol or service for which offloading is not supported. For example, before NP6 processors supported offloading IPv6 tunnel sessions, `npu-flag-off` would appear in the `no_ofld_reason` field for IPv6 tunnel sessions.
`redir-to-ips`	Normally this session is expected to be offloaded to the NP6 processor by the IPS, but for some reason the session cannot be offloaded. May be caused by a bug. The `no_ofld_reason` field may contain more information.
`denied-by-nturbo`	A session being processed by the IPS that could normally be offloaded is not supported by nTurbo. May be caused by a bug. Can be paired with `redir-to-ips`.
`block-by-ips`	A session being processed by the IPS that could normally be offloaded is blocked. May be caused by a bug. Can be paired with `redir-to-ips`.
`intf-dos`	The session is matched by an interface policy or a DoS policy and sessions processed by interface policies or DoS policies are not offloaded.
`redir-to-av`	Flow-based antivirus is preventing offloading of this session.
`sflow`	sFlow is enabled for one or both of the interfaces handling the session. sFlow periodic traffic sampling that can only be done by the CPU.

no_ofld_reason	Description
mac-host-check	Device identification has not yet identified the device communicating with the FortiGate using this session. Once the device has been identified the session may be offloaded.
offload-denied	Usually this reason appears if the session is being handled by a session helper and sessions handled by this session helper can't be offloaded.
not-established	A TCP session is not in its established state (proto_state=01).

diagnose npu np6 session-stats <np6-id> (number of NP6 IPv4 and IPv6 sessions)

You can use the `diagnose npu np6 portlist` command to list the NP6 processor IDs and the interfaces that each NP6 is connected to. The <np6-id> of np6_0 is 0, the <np6-id> of np6_1 is 1 and so on. The `diagnose npu np6 session-stats <np6-id>` command output includes the following headings:

- `ins44` installed IPv4 sessions
- `ins46` installed NAT46 sessions
- `del4` deleted IPv4 and NAT46 sessions
- `ins64` installed NAT64 sessions
- `ins66` installed IPv6 sessions
- `del6` deleted IPv6 and NAT64 sessions
- `e` is the error counter for each session type

```
diagnose npu np6 session-stats 0
qid    ins44      ins46      del4       ins64      ins66      del6
       ins44_e    ins46_e    del4_e     ins64_e    ins66_e    del6_e
---------------- ---------- ---------- ---------- ---------- ----------
0      94         0          44         0          40         30
       0          0          0          0          0          0
1      84         0          32         0          30         28
       0          0          0          0          0          0
2      90         0          42         0          40         30
       0          0          0          0          0          0
3      86         0          32         0          24         27
       0          0          0          0          0          0
4      72         0          34         0          34         28
       0          0          0          0          0          0
5      86         0          30         0          28         32
       0          0          0          0          0          0
6      82         0          38         0          32         34
       0          0          0          0          0          0
7      86         0          30         0          30         30
       0          0          0          0          0          0
8      78         0          26         0          36         26
       0          0          0          0          0          0
9      86         0          34         0          32         32
       0          0          0          0          0          0
---------------- ---------- ---------- ---------- ---------- ----------
Total  844        0          342        0          326        297
       0          0          0          0          0          0
---------------- ---------- ---------- ---------- ---------- ----------
```

diagnose npu np6 ipsec-stats (NP6 IPsec statistics)

The command output includes IPv4, IPv6, and NAT46 IPsec information:

- spi_ses4 is the IPv4 counter
- spi_ses6 is the IPv6 counter
- 4to6_ses is the NAT46 counter

```
diagnose npu np6 ipsec-stats
vif_start_oid       03ed       vif_end_oid         03fc
IPsec Virtual interface stats:
vif_get             00000000000        vif_get_expired     00000000000
vif_get_fail        00000000000        vif_get_invld       00000000000
vif_set             00000000000        vif_set_fail        00000000000
vif_clear           00000000000        vif_clear_fail      00000000000
np6_0:
sa_install          00000000000        sa_ins_fail         00000000000
sa_remove           00000000000        sa_del_fail         00000000000
4to6_ses_ins        00000000000        4to6_ses_ins_fail   00000000000
4to6_ses_del        00000000000        4to6_ses_del_fail   00000000000
spi_ses6_ins        00000000000        spi_ses6_ins_fail   00000000000
spi_ses6_del        00000000000        spi_ses6_del_fail   00000000000
spi_ses4_ins        00000000000        spi_ses4_ins_fail   00000000000
spi_ses4_del        00000000000        spi_ses4_del_fail   00000000000
sa_map_alloc_fail   00000000000        vif_alloc_fail      00000000000
sa_ins_null_adapter 00000000000        sa_del_null_adapter 00000000000
del_sa_mismatch     00000000000        ib_chk_null_adpt    00000000000
ib_chk_null_sa      00000000000        ob_chk_null_adpt    00000000000
ob_chk_null_sa      00000000000        rx_vif_miss         00000000000
rx_sa_miss          00000000000        rx_mark_miss        00000000000
waiting_ib_sa       00000000000        sa_mismatch         00000000000
msg_miss            00000000000
np6_1:
sa_install          00000000000        sa_ins_fail         00000000000
sa_remove           00000000000        sa_del_fail         00000000000
4to6_ses_ins        00000000000        4to6_ses_ins_fail   00000000000
4to6_ses_del        00000000000        4to6_ses_del_fail   00000000000
spi_ses6_ins        00000000000        spi_ses6_ins_fail   00000000000
spi_ses6_del        00000000000        spi_ses6_del_fail   00000000000
spi_ses4_ins        00000000000        spi_ses4_ins_fail   00000000000
spi_ses4_del        00000000000        spi_ses4_del_fail   00000000000
sa_map_alloc_fail   00000000000        vif_alloc_fail      00000000000
sa_ins_null_adapter 00000000000        sa_del_null_adapter 00000000000
del_sa_mismatch     00000000000        ib_chk_null_adpt    00000000000
ib_chk_null_sa      00000000000        ob_chk_null_adpt    00000000000
ob_chk_null_sa      00000000000        rx_vif_miss         00000000000
rx_sa_miss          00000000000        rx_mark_miss        00000000000
waiting_ib_sa       00000000000        sa_mismatch         00000000000
msg_miss            00000000000
```

diagnose npu np6 sse-stats <np6-id> (number of NP6 sessions and dropped sessions)

This command displays the total number of inserted, deleted and purged sessions processed by a selected NP6 processor. The number of dropped sessions of each type cam be determined by subtracting the number of successful sessions from the total number of sessions. For example, the total number of dropped insert sessions is `insert-total - insert-success`.

```
diagnose npu np6 sse-stats 0
Counters        SSE0            SSE1            Total
--------------- --------------- --------------- ---------------
active          0               0               0
insert-total    25              0               0
insert-success  25              0               0
delete-total    25              0               0
delete-success  25              0               0
purge-total     0               0               0
purge-success   0               0               0
search-total    40956           38049           79005
search-hit      37714           29867           67581
--------------- --------------- --------------- ---------------
pht-size        8421376         8421376
oft-size        8355840         8355840
oftfree         8355839         8355839
PBA             3001
```

diagnose npu np6 dce <np6-id> (number of dropped NP6 packets)

This command displays the number of dropped packets for the selected NP6 processor.

- `IHP1_PKTCHK` number of dropped IP packets
- `IPSEC0_ENGINB0` number of dropped IPSec
- `TPE_SHAPER` number of dropped traffic sharper packets

```
diag npu np6 dce 1
IHP1_PKTCHK :0000000000001833 [5b] IPSEC0_ENGINB0 :0000000000000003 [80]
TPE_SHAPER :0000000000000552 [94]
```

diagnose hardware deviceinfo nic <interface-name> (number of packets dropped by an interface)

This command displays a wide variety of statistics for FortiGate interfaces. The fields `Host Rx dropped` and `Host Tx dropped` display the number of received and transmitted packets that have been dropped.

```
diagnose hardware deviceinfo nic port2
...
============ Counters ===========
Rx Pkts         :20482043
Rx Bytes        :31047522516
Tx Pkts         :19000495
Tx Bytes        :1393316953
Host Rx Pkts    :27324
```

```
Host Rx Bytes   :1602755
Host Rx dropped :0
Host Tx Pkts    :8741
Host Tx Bytes   :5731300
Host Tx dropped :0
sw_rx_pkts      :20482043
sw_rx_bytes     :31047522516
sw_tx_pkts      :19000495
sw_tx_bytes     :1393316953
sw_np_rx_pkts   :19000495
sw_np_rx_bytes  :1469318933
sw_np_tx_pkts   :20482042
sw_np_tx_bytes  :31129450620
```

diagnose npu np6 synproxy-stats (NP6 SYN-proxied sessions and unacknowledged SYNs)

This command display information about NP6 syn-proxy sessions including the total number proxied sessions. As well the `Number of attacks, no ACK from client` shows the total number of acknowledged SYNs.

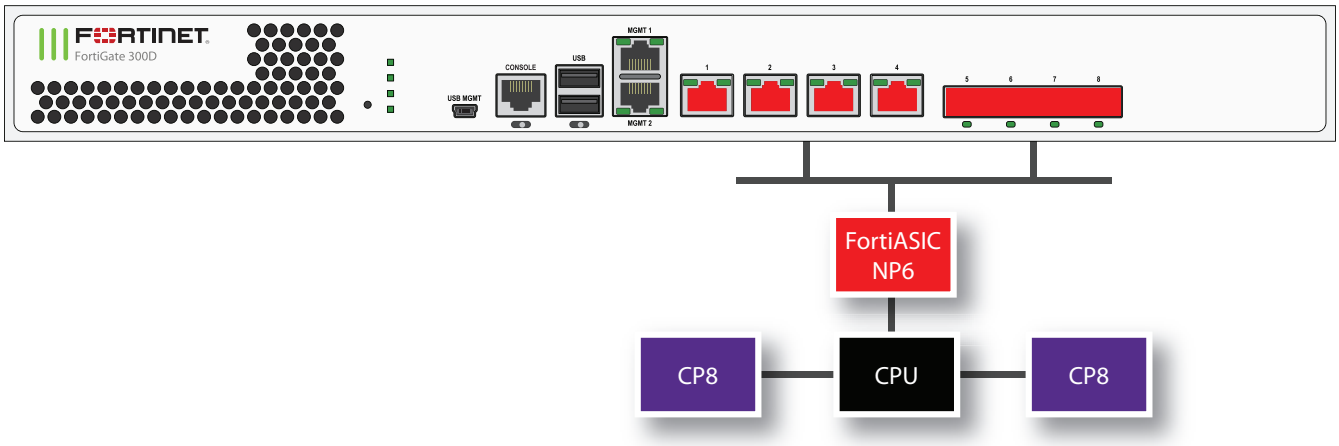
```
diagnose npu np6 synproxy-stats
DoS SYN-Proxy:
Number of proxied TCP connections : 39277346
Number of working proxied TCP connections : 182860
Number of retired TCP connections : 39094486
Number of attacks, no ACK from client : 208
```

FortiGate NP6 architectures

This chapter shows the NP6 architecture for FortiGate models that include NP6 processors.

FortiGate 300D fast path architecture

The FortiGate 300D includes one NP6 processor connected to four 1Gb RJ-45 Ethernet ports (port1-4) and four 1Gb SFP interfaces (port5-port8).



You can use the following get command to display the FortiGate 300D NP6 configuration. The command output shows one NP6 named NP6_0 and the interfaces (ports) connected to it. You can also use the `diagnose npu np6 port-list` command to display this information.

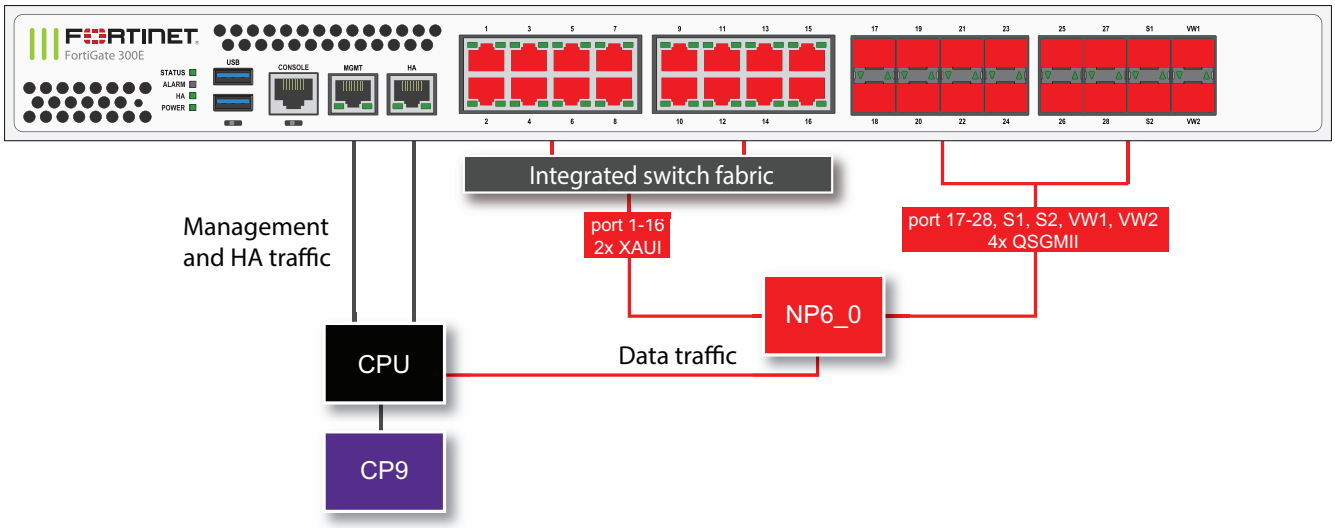
```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                   Speed offloading
------ ---- ------- ----- ----------
np6_0   0
        1    port5   1G    Yes
        1    port7   1G    Yes
        1    port8   1G    Yes
        1    port6   1G    Yes
        1    port3   1G    Yes
        1    port4   1G    Yes
        1    port1   1G    Yes
        1    port2   1G    Yes
        2
        3
------ ---- ------- ----- ----------
```

FortiGate 300E and 301E fast path architecture

The FortiGate 300E and 301E models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (MGNT and HA, not connected to the NP6 processor)
- Sixteen 10/100/1000BASE-T Copper (1 to 16)
- Sixteen 1 GigE SFP (17 - 28, S1, S2, VW1, VW2) (S1 and S2 are configured as sniffer interfaces, VW1 and VW2 are configured as virtual wire interfaces)

The following diagram also shows the XAUI and QSGMII port connections between the NP6 processor and the front panel interfaces.



The FortiGate 300E and 301E each include one NP6 processor. All supported traffic passing between any two data interfaces can be offloaded by the NP6 processor. Data traffic to be processed by the CPU takes a dedicated data path through the NP6 processor to the CPU. Interfaces 1 to 16 connect to an integrated switch fabric to allow these sixteen interfaces to share two XAUI ports that connect to the NP6 processor.

The MGMT interface is not connected to the NP6 processor. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. The HA interface is also not connected to the NP6 processors. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing. The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

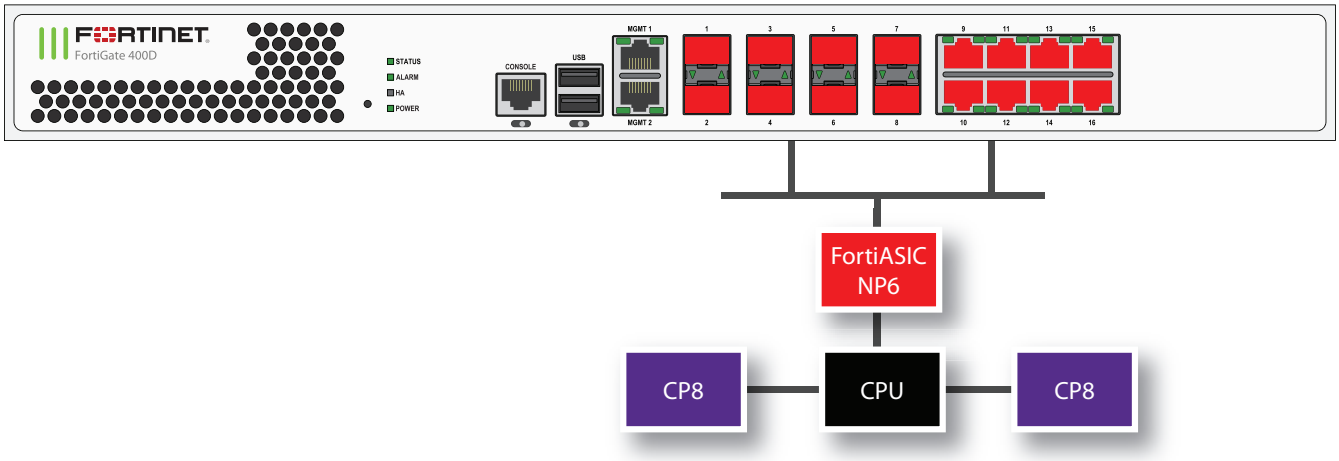
You can use the following get command to display the FortiGate 300E or 301E NP6 configuration. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports         Max   Cross-chip
                          Speed offloading
------ ---- --------      ----- ----------
np6_0   0   port1         1G    Yes
        0   port2         1G    Yes
        0   port3         1G    Yes
        0   port4         1G    Yes
        0   port5         1G    Yes
        0   port6         1G    Yes
```

```
          0   port7          1G   Yes
          0   port8          1G   Yes
          1   port9          1G   Yes
          1   port10         1G   Yes
          1   port11         1G   Yes
          1   port12         1G   Yes
          1   port13         1G   Yes
          1   port14         1G   Yes
          1   port15         1G   Yes
          1   port16         1G   Yes
          2   port17         1G   Yes
          2   port18         1G   Yes
          2   port19         1G   Yes
          2   port20         1G   Yes
          2   port21         1G   Yes
          2   port22         1G   Yes
          2   port23         1G   Yes
          2   port2          1G   Yes
          3   port25         1G   Yes
          3   port26         1G   Yes
          3   port27         1G   Yes
          3   port28         1G   Yes
          3   s1             1G   Yes
          3   s2             1G   Yes
          3   vw1            1G   Yes
          3   vw2            1G   Yes
------ ---- ------- ----- ----------
```

FortiGate 400D fast path architecture

The FortiGate 400D includes one NP6 processor connected to eight 1Gb SFP interfaces (port1-port8) and eight 1Gb RJ-45 Ethernet ports (port9-16).



You can use the following get command to display the FortiGate 400D NP6 configuration. The command output shows one NP6 named NP6_0 and the interfaces (ports) connected to it. You can also use the `diagnose npu np6 port-list` command to display this information.

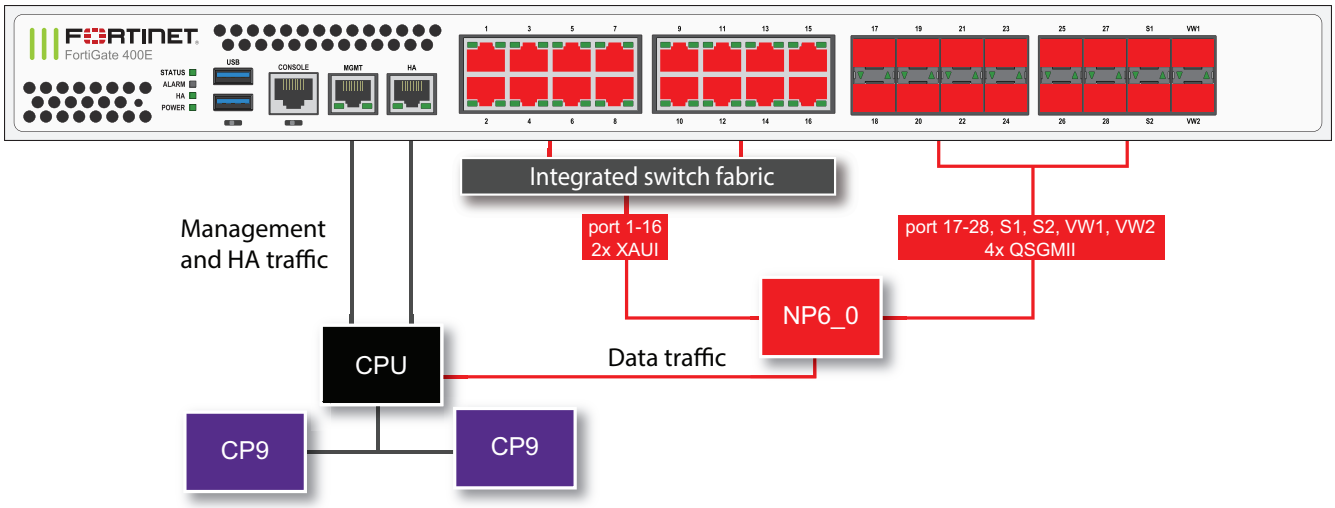
```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                  Speed offloading
------ ---- ------- ----- ----------
np6_0  0
       1    port10  1G    Yes
       1    port9   1G    Yes
       1    port12  1G    Yes
       1    port11  1G    Yes
       1    port14  1G    Yes
       1    port13  1G    Yes
       1    port16  1G    Yes
       1    port15  1G    Yes
       1    port5   1G    Yes
       1    port7   1G    Yes
       1    port8   1G    Yes
       1    port6   1G    Yes
       1    port3   1G    Yes
       1    port4   1G    Yes
       1    port1   1G    Yes
       1    port2   1G    Yes
       2
       3
------ ---- ------- ----- ----------
```

FortiGate 400E and 401E fast path architecture

The FortiGate 400E and 401E models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (MGMT and HA, not connected to the NP6 processor)
- Sixteen 10/100/1000BASE-T Copper (1 to 16)
- Sixteen 1 GigE SFP (17 - 28, S1, S2, VW1, VW2) (S1 and S2 are configured as sniffer interfaces, VW1 and VW2 are configured as virtual wire interfaces)

The following diagram also shows the XAUI and QSGMII port connections between the NP6 processor and the integrated switch fabric.



The FortiGate 400E and 401E each include one NP6 processor. All supported traffic passing between any two data interfaces can be offloaded by the NP6 processor. Data traffic to be processed by the CPU takes a dedicated data path through the NP6 processor to the CPU. Interfaces 1 to 16 connect to an integrated switch fabric to allow these sixteen interfaces to share two XAUI ports that connect to the NP6 processor.

The MGMT interface is not connected to the NP6 processor. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. The HA interface is also not connected to the NP6 processors. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing. The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following get command to display the FortiGate 400E or 401E NP6 configuration. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip    XAUI Ports         Max   Cross-chip
                           Speed offloading
------ ---- --------      ----- ----------
np6_0    0   port1         1G    Yes
         0   port2         1G    Yes
         0   port3         1G    Yes
         0   port4         1G    Yes
         0   port5         1G    Yes
         0   port6         1G    Yes
         0   port7         1G    Yes
         0   port8         1G    Yes
         1   port9         1G    Yes
         1   port10        1G    Yes
         1   port11        1G    Yes
         1   port12        1G    Yes
         1   port13        1G    Yes
         1   port14        1G    Yes
         1   port15        1G    Yes
         1   port16        1G    Yes
         2   port17        1G    Yes
         2   port18        1G    Yes
         2   port19        1G    Yes
         2   port20        1G    Yes
```

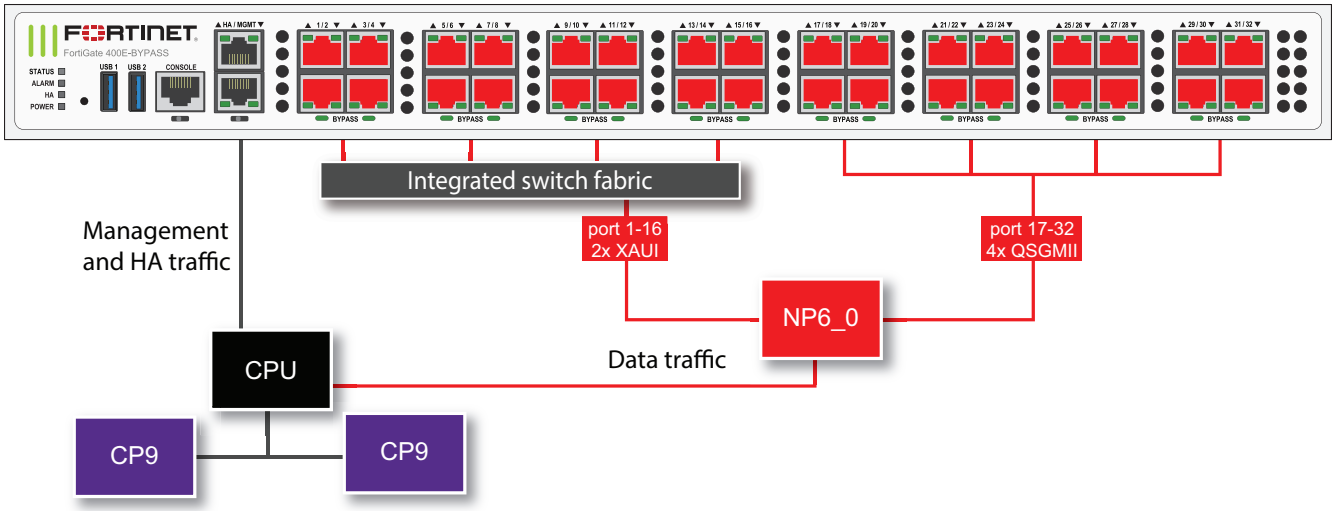
```
        2   port21       1G   Yes
        2   port22       1G   Yes
        2   port23       1G   Yes
        2   port2        1G   Yes
        3   port25       1G   Yes
        3   port26       1G   Yes
        3   port27       1G   Yes
        3   port28       1G   Yes
        3   s1           1G   Yes
        3   s2           1G   Yes
        3   vw1          1G   Yes
        3   vw2          1G   Yes
------ ---- ------- ----- ----------
```

FortiGate 400E Bypass fast path architecture

The FortiGate 400E Bypass model features the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (MGMT and HA, not connected to the NP6 processor)
- Thirty-two 10/100/1000BASE-T Copper (1 to 32) that make up sixteen copper virtual wire bypass pairs

The following diagram also shows the XAUI and QSGMII port connections between the NP6 processor and the integrated switch fabric.



The FortiGate 400E Bypass includes one NP6 processor. All supported traffic passing between any two data interfaces can be offloaded by the NP6 processor. Data traffic to be processed by the CPU takes a dedicated data path through the NP6 processor to the CPU. Interfaces 1 to 16 connect to an integrated switch fabric to allow these sixteen interfaces to share two XAUI ports that connect to the NP6 processor. Interfaces 17 to 20, 21 to 24, 25 to 28, and 29 to 32 each connect to one of four QSFMII ports that connect them to the NP6 processor.

The MGMT interface is not connected to the NP6 processor. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. The HA interface is also not connected to the NP6 processors. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing. The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following command to display the FortiGate 400E Bypass NP6 configuration. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports        Max  Cross-chip
                        Speed offloading
------ ---- -------     ----- ----------
np6_0   0   port1        1G   Yes
        0   port2        1G   Yes
        0   port3        1G   Yes
        0   port4        1G   Yes
        0   port5        1G   Yes
        0   port6        1G   Yes
        0   port7        1G   Yes
        0   port8        1G   Yes
        1   port9        1G   Yes
        1   port10       1G   Yes
        1   port11       1G   Yes
        1   port12       1G   Yes
        1   port13       1G   Yes
        1   port14       1G   Yes
        1   port15       1G   Yes
        1   port16       1G   Yes
        2   port17       1G   Yes
        2   port18       1G   Yes
        2   port19       1G   Yes
        2   port20       1G   Yes
        2   port21       1G   Yes
        2   port22       1G   Yes
        2   port23       1G   Yes
        2   port24       1G   Yes
        3   port25       1G   Yes
        3   port26       1G   Yes
        3   port27       1G   Yes
        3   port28       1G   Yes
        3   port29       1G   Yes
        3   port30       1G   Yes
        3   port31       1G   Yes
        3   port32       1G   Yes
------ ---- ------- ----- ----------
```

Bypass interfaces

The FortiGate 400E Bypass includes sixteen bypass interface pairs that can provide fail open support for up to sixteen networks. Each consecutively numbered pair of interfaces can be configured to operate as a bypass pair by adding the interfaces to a virtual wire bypass pair. Interface 1 and 2, interface 3 and 4, interface 5 and interface 6, and so on can form virtual wire bypass pairs.

When bypass mode is activated, the interfaces in each virtual wire bypass pair are directly connected. Traffic can pass between these interfaces, bypassing the FortiOS firewall and the NP6 processor, but continuing to provide network connectivity.

In bypass mode, each virtual wire bypass pair acts like a patch cable, failing open and allowing all traffic to pass through. Traffic on the virtual wire bypass pair interfaces that are using VLANs or other network extensions can only continue flowing if the connected network equipment is configured for these features.

If the FortiGate 400E Bypass fails or looses power, the virtual wire bypass pairs will contunue to operate in bypass mode until the failed device is replaced or power is restored. If power is restored and the FortiGate 400E Bypass starts up, the device resumes operating as a FortiGate device without interrupting traffic flow. Replacing a failed FortiGate 400E Bypass disrupts traffic while the technician physically replaces the failed device with a new one.

If bypass mode is enabled because of a software or hardware failure, the virtual wire bypass pairs continue to operate in bypass mode until the FortiGate 400E Bypass restarts. You can configure the FortiGate 400E Bypass to resume normal operation after a restart or to keep the virtual wire bypass pairs operating in bypass mode after a restart.

Configuring bypass settings

You can use the following command to configure how bypass operates.

```
config system bypass
   set bypass-watchdog {disable | enable}
   set bypass-timeout {1 | 10 | 60}
   set auto-recover {disable | enable}
end
```

`bypass-watchdog` enable to turn on the bypass watchdog. The bypass watchdog monitors traffic passing between interfaces in each of the virtual wire bypass pairs. If the watchdog detects that traffic is blocked on any virtual wire bypass pair, that virtual wire bypass pair switches to bypass mode.

`bypass-timeout` select the amount of time the bypass watchdog waits after detecting a failure before enabling bypass mode. You can select to wait 1, 10, or 60 seconds. The default timeout is 10 seconds.

`auto-recover` enable to cause all virtual wire bypass pairs to return to normal operation after bypass mode has been turned on and then the FortiGate 400E Bypass has restarted. Disable to keep virtual wire bypass pairs in bypass mode, if bypass mode was turned on and the FortiGate 400E Bypass has restarted.

Creating a virtual wire bypass pair

Use the following command to configure two interfaces to act as a virtual wire bypass pair. FortiGate 400E Bypass interfaces that are not configured in this way will operate in the same way as any FortiGate interfaces and not as bypass pairs.

```
config system virtual-wire-pair
   edit <name>
      set member <interface> <interface>
      set poweron-bypass {disable | enable}
      set poweroff-bypass {disable | enable}
   end
```

`<interface> <interface>` the interfaces in the virtual wire bypass pair have to be two interfaces that can form a bypass pair. For example port1 and port2, port3 and port4, and so on can form virtual wire bypass pairs.

`poweron-bypass` enable bypass mode for this virtual wire bypass pair when the FortiGate 400E Bypass is powered on. With this mode enabled, the virtual wire bypass pair can switch to bypass mode if the bypass watchdog detects a failure while the FortiGate 400E Bypass is operating.

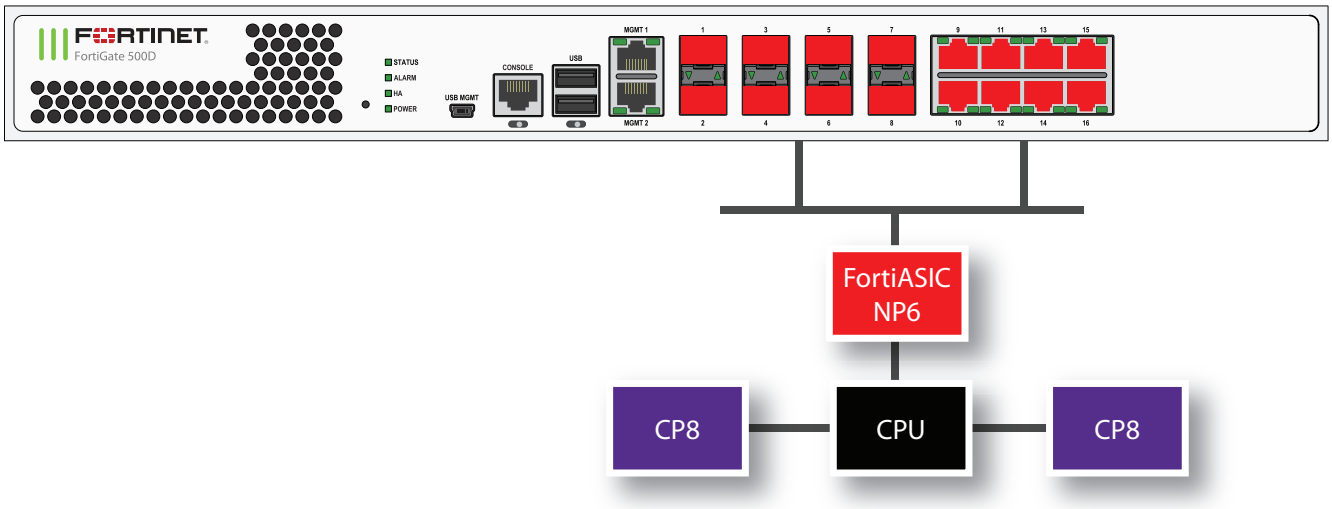
`poweroff-bypass` enable bypass mode for this virtual wire bypass pair when the FortiGate 400E Bypass looses power or is powered off.

For example, use the following command to configure port5 and port6 to operate as a virtual wire bypass pair that will switch to bypass mode if the bypass watchdog detects a failure or if the FortiGate 400E bypass is powered off.

```
config system virtual-wire-pair
   edit <name>
      set member port5 port6
      set poweron-bypass enable
      set poweroff-bypass enable
   end
```

FortiGate 500D fast path architecture

The FortiGate 500D includes one NP6 processor connected to eight 1Gb SFP interfaces (port1-port8) and eight 1Gb RJ-45 Ethernet ports (port9-16).



You can use the following get command to display the FortiGate 500D NP6 configuration. The command output shows one NP6 named NP6_0 and the interfaces (ports) connected to it. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                   Speed offloading
------ ---- ------- ----- ----------
np6_0  0
       1    port10  1G    Yes
       1    port9   1G    Yes
       1    port12  1G    Yes
       1    port11  1G    Yes
       1    port14  1G    Yes
       1    port13  1G    Yes
       1    port16  1G    Yes
       1    port15  1G    Yes
       1    port5   1G    Yes
       1    port7   1G    Yes
       1    port8   1G    Yes
       1    port6   1G    Yes
```

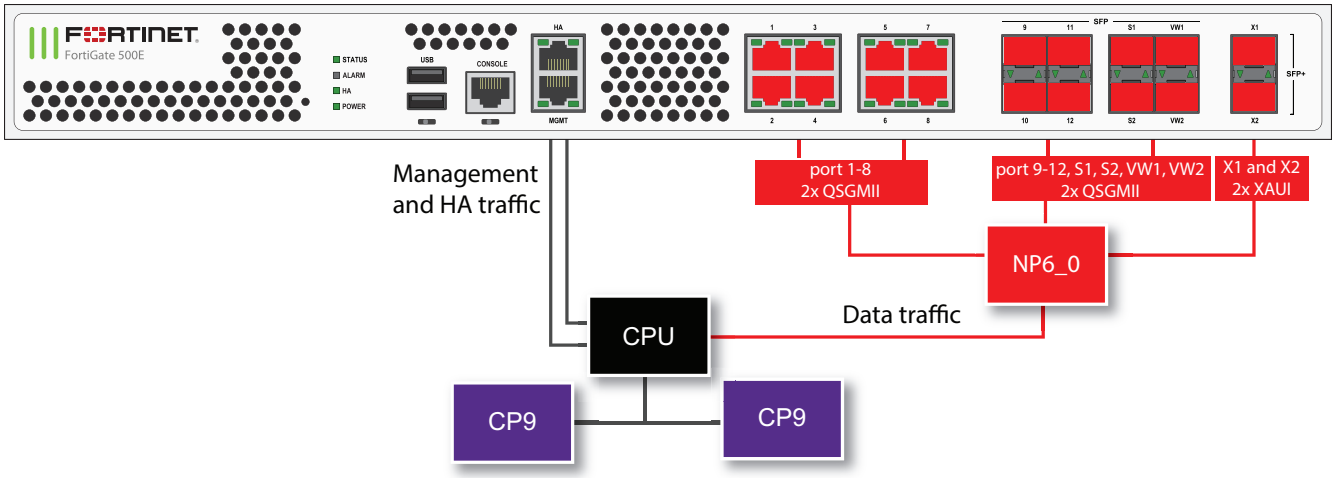
```
          1     port3    1G     Yes
          1     port4    1G     Yes
          1     port1    1G     Yes
          1     port2    1G     Yes
          2
          3
------ ---- ------- ----- ----------
```

FortiGate 500E and 501E fast path architecture

The FortiGate 500E and 501E models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (HA and MGMT, not connected to the NP6 processors)
- Eight 10/100/1000BASE-T Copper (1 to 8)
- Eight 1 GigE SFP (9 - 12, S1, S2, VW1, VW2) (S1 and S2 are configured as sniffer interfaces, VW1 and VW2 are configured as virtual wire interfaces)
- Two 10 GigE SFP+ (X1 and X2) (cannot be configured to be SFP interfaces)

The following diagram also shows the QSGMII and XAUI port connections between the NP6 processor and the front panel interfaces.



The FortiGate 500E and 501E each include one NP6 processor. All supported traffic passing between any two data interfaces can be offloaded by the NP6 processor. Data traffic to be processed by the CPU takes a dedicated data path through the NP6 processor to the CPU.

The MGMT interface is not connected to the NP6 processor. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. The HA interface is also not connected to the NP6 processors. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing. The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following get command to display the FortiGate 500E or 501E NP6 configuration. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports        Max  Cross-chip
```

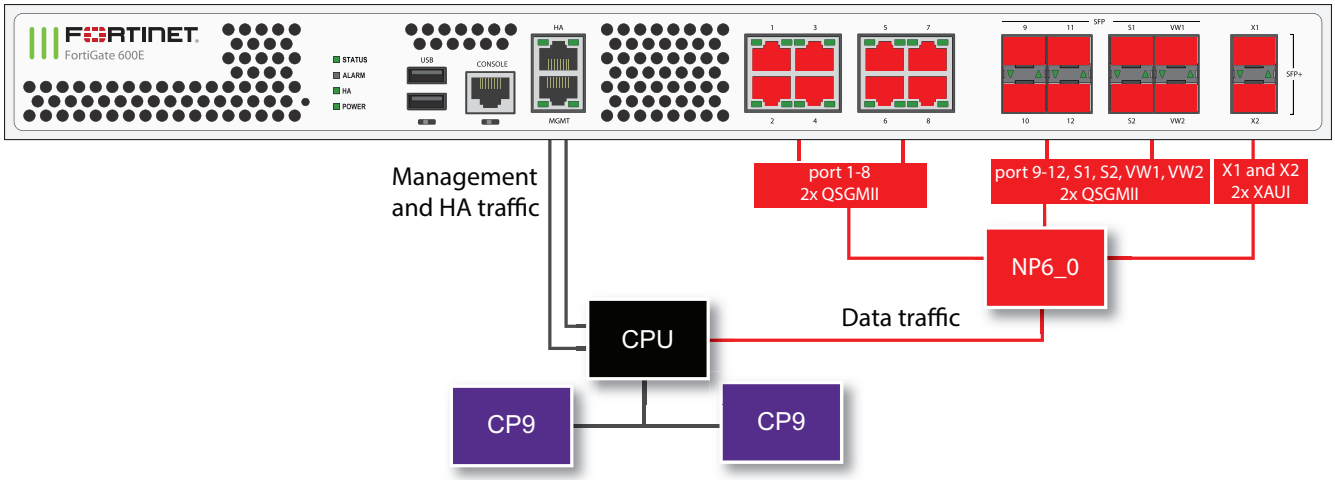
```
                          Speed offloading
------ ---- -------       ----- ----------
np6_0    0    x1            10G  Yes
         1    port1         1G   Yes
         1    port2         1G   Yes
         1    port3         1G   Yes
         1    port4         1G   Yes
         1    port5         1G   Yes
         1    port6         1G   Yes
         1    port7         1G   Yes
         1    port8         1G   Yes
         1    port9         1G   Yes
         1    port10        1G   Yes
         1    port11        1G   Yes
         1    port12        1G   Yes
         1    s1            1G   Yes
         1    s2            1G   Yes
         1    vw1           1G   Yes
         1    vw2           1G   Yes
         2    x2            10G  Yes
         3
------ ---- ------- ----- ----------
```

FortiGate 600E and 601E fast path architecture

The FortiGate 600E and 601E models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (HA and MGMT, not connected to the NP6 processors)
- Eight 10/100/1000BASE-T Copper (1 to 8)
- Eight 1 GigE SFP (9 - 12, S1, S2, VW1, VW2) (S1 and S2 are configured as sniffer interfaces, VW1 and VW2 are configured as virtual wire interfaces)
- Two 10 GigE SFP+ (X1 and X2) (cannot be configured to be SFP interfaces)

The following diagram also shows the QSGMII and XAUI port connections between the NP6 processor and the front panel interfaces.



The FortiGate 600E and 601E each include one NP6 processor. All supported traffic passing between any two data interfaces can be offloaded by the NP6 processor. Data traffic to be processed by the CPU takes a dedicated data path through the NP6 processor to the CPU.

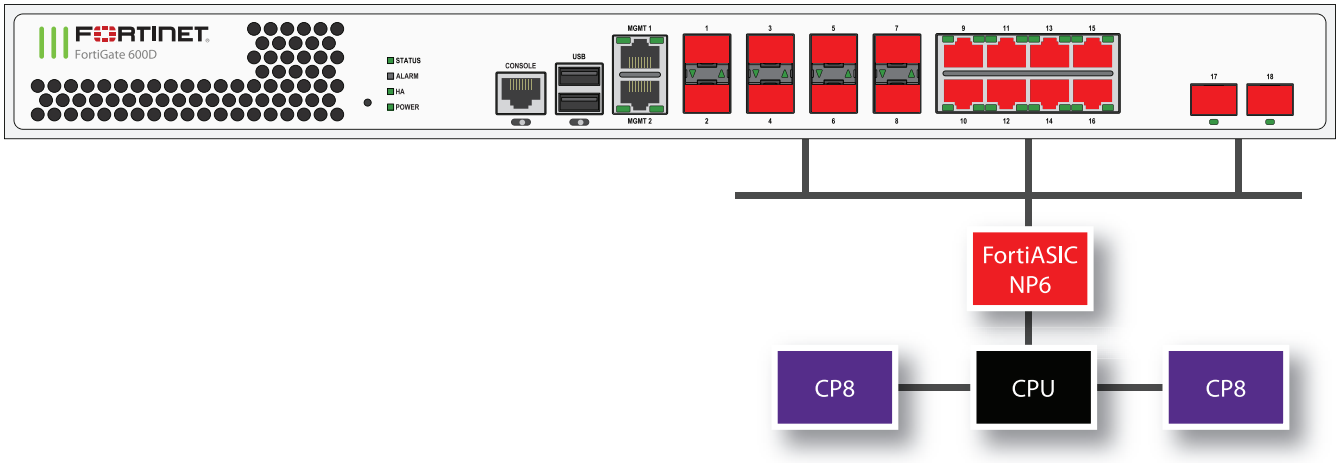
The MGMT interface is not connected to the NP6 processor. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. The HA interface is also not connected to the NP6 processors. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing. The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following get command to display the FortiGate 600E or 601E NP6 configuration. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports        Max  Cross-chip
                        Speed offloading
------ ---- -------     ----- ----------
np6_0   0   x1           10G  Yes
        1   port1        1G   Yes
        1   port2        1G   Yes
        1   port3        1G   Yes
        1   port4        1G   Yes
        1   port5        1G   Yes
        1   port6        1G   Yes
        1   port7        1G   Yes
        1   port8        1G   Yes
        1   port9        1G   Yes
        1   port10       1G   Yes
        1   port11       1G   Yes
        1   port12       1G   Yes
        1   s1           1G   Yes
        1   s2           1G   Yes
        1   vw1          1G   Yes
        1   vw2          1G   Yes
        2   x2           10G  Yes
        3
------ ---- ------- ----- ----------
```

FortiGate 600D fast path architecture

The FortiGate 600D includes one NP6 processor connected to eight 1Gb SFP interfaces (port1-port8) and eight 1Gb RJ-45 Ethernet ports (port9-16) and two 10Gb SFP+ interfaces (port17 and port18).



You can use the following get command to display the FortiGate 600D NP6 configuration. The command output shows one NP6 named NP6_0 and the interfaces (ports) connected to it. You can also use the `diagnose npu np6 port-list` command to display this information.

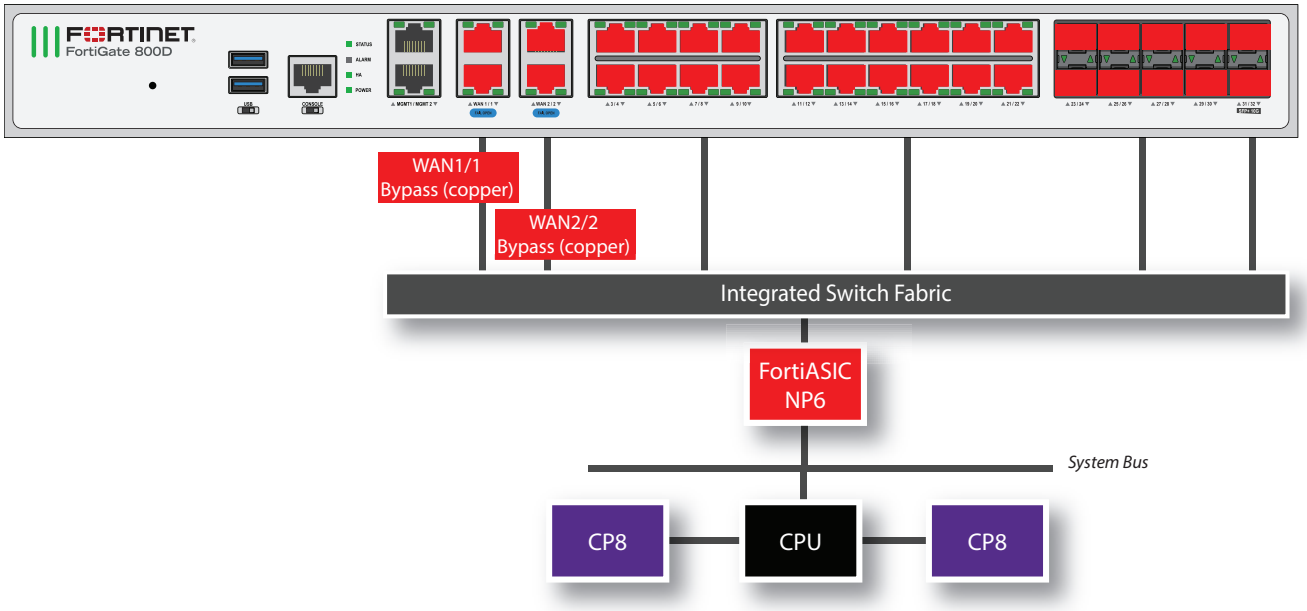
```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                    Speed offloading
------ ---- ------- ----- ----------
np6_0  0
       1    port10  1G    Yes
       1    port9   1G    Yes
       1    port12  1G    Yes
       1    port11  1G    Yes
       1    port14  1G    Yes
       1    port13  1G    Yes
       1    port16  1G    Yes
       1    port15  1G    Yes
       1    port5   1G    Yes
       1    port7   1G    Yes
       1    port8   1G    Yes
       1    port6   1G    Yes
       1    port3   1G    Yes
       1    port4   1G    Yes
       1    port1   1G    Yes
       1    port2   1G    Yes
       2    port17  10G   Yes
       3    port18  10G   Yes
------ ---- ------- ----- ----------
```

FortiGate 800D fast path architecture

The FortiGate 800D includes one NP6 processor connected through an integrated switch fabric to all of the FortiGate 800D network interfaces. This hardware configuration supports NP6-accelerated fast path offloading for sessions between any of the FortiGate 800D interfaces.

The FortiGate 800D features the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (MGMT1 and MGMT2, not connected to the NP6 processors)
- Two 10/100/1000BASE-T Copper bypass pairs (WAN1 and 1 and WAN2 and 2)
- Eighteen 10/100/1000BASE-T Copper (3 to 22)
- Eight 1 GigE SFP (23 to 30)
- Two 10 GigE SFP+ (31 and 32)



You can use the following get command to display the FortiGate 800D NP6 configuration. The command output shows one NP6 named NP6_0. The output also shows all of the FortiGate 800D interfaces (ports) connected to NP6_0. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                    Speed offloading
------ ---- ------- ----- ----------
np6_0  0    port31  10G   Yes
       1    wan1    1G    Yes
       1    port1   1G    Yes
       1    wan2    1G    Yes
       1    port2   1G    Yes
       1    port3   1G    Yes
       1    port4   1G    Yes
       1    port5   1G    Yes
       1    port6   1G    Yes
       1    port30  1G    Yes
       1    port29  1G    Yes
       1    port28  1G    Yes
       1    port27  1G    Yes
       1    port26  1G    Yes
       1    port25  1G    Yes
       1    port24  1G    Yes
       1    port23  1G    Yes
       2    port7   1G    Yes
       2    port8   1G    Yes
       2    port9   1G    Yes
```

```
        2    port10  1G    Yes
        2    port11  1G    Yes
        2    port12  1G    Yes
        2    port13  1G    Yes
        2    port14  1G    Yes
        2    port15  1G    Yes
        2    port16  1G    Yes
        2    port17  1G    Yes
        2    port18  1G    Yes
        2    port19  1G    Yes
        2    port20  1G    Yes
        2    port21  1G    Yes
        2    port22  1G    Yes
        3    port32  10G   Yes
------ ---- ------- ----- ----------
```

Bypass interfaces (WAN1/1 and WAN2/2)

The FortiGate 800D includes two bypass interface pairs: WAN1 and 1 and WAN2 and 2 that provide fail open support. When a FortiGate 800D experiences a hardware failure or loses power, or when bypass mode is enabled, the bypass interface pairs operate in bypass mode. In bypass mode, WAN1 and 1 are directly connected and WAN2 and 2 are directly connected. Traffic can pass between WAN1 and 1 and between WAN2 and 2, bypassing the FortiOS firewall and the NP6 processor, but continuing to provide network connectivity.

In bypass mode, the bypass pairs act like patch cables, failing open and allowing all traffic to pass through. Traffic on the bypass interfaces that is using VLANs or other network extensions can only continue flowing if the connected network equipment is configured for these features.

The FortiGate 800D will continue to operate in bypass mode until the failed FortiGate 800D is replaced, power is restored, or bypass mode is disabled. If power is restored or bypass mode is disabled, the FortiGate 800D resumes operating as a FortiGate device without interrupting traffic flow. Replacing a failed FortiGate 800D disrupts traffic as a technician physically replaces the failed FortiGate 800D with a new one.

Manually enabling bypass mode

You can manually enable bypass mode if the FortiGate 800D is operating in transparent mode. You can also manually enable bypass mode for a VDOM if WAN1 and 1 or WAN2 and 2 are both connected to the same VDOM operating in transparent mode.

Use the following command to enable bypass mode:

```
execute bypass-mode enable
```

This command changes the configuration, so bypass mode will still be enabled if the FortiGate 800D restarts.

You can use the following command to disable bypass mode:

```
execute bypass-mode disable
```

Configuring bypass settings

You can use the following command to configure how bypass operates.

```
config system bypass
```

```
    set bypass-watchdog {disable | enable}
    set poweroff-bypass {disable | enable}
end
```

`bypass-watchdog` enable to turn on bypass mode. When bypass mode is turned on, if the bypass watchdog detects a software or hardware failure, bypass mode will be activated.

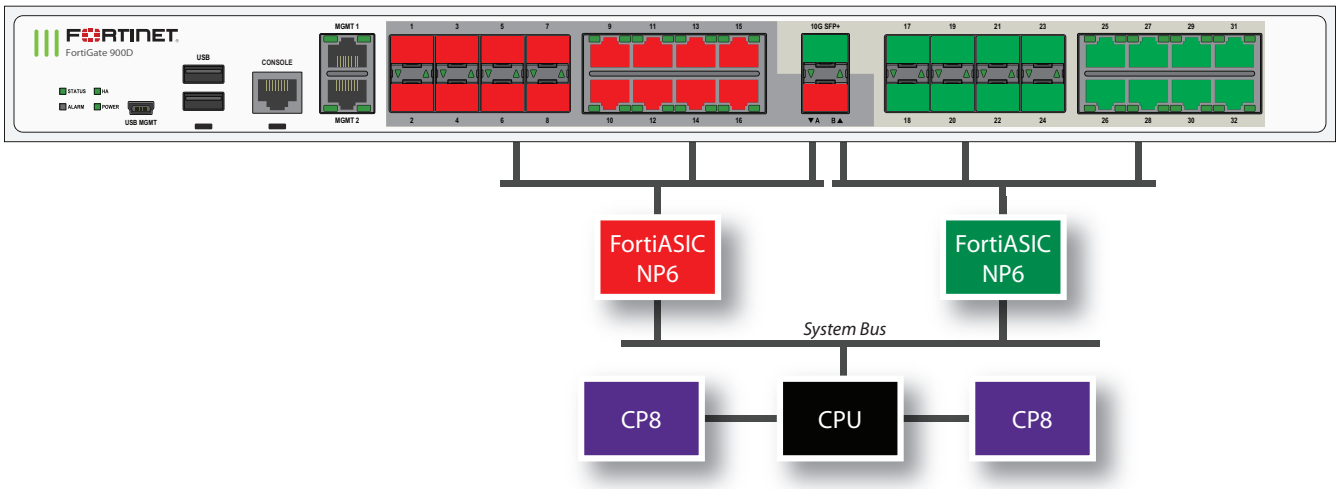
`poweroff-bypass` if enabled, traffic will be able to pass between WAN1 and 1 and between WAN2 and 2 if the FortiGate 800D is powered off.

FortiGate 900D fast path architecture

The FortiGate 900D includes two NP6 processors that are not connected by an integrated switch fabric (ISF). Without an ISF, traffic through a FortiGate 900D could experience lower latency than traffic through similar hardware with an ISF. The NP6 processors are connected to network interfaces as follows:

Because the FortiGate 900D does not have an ISF you cannot create Link Aggregation Groups (LAGs) that include interfaces connected to both NP6 processors.

- Eight 1Gb SFP interfaces (port17-port24), eight 1Gb RJ-45 Ethernet interfaces (port25-32) and one 10Gb SFP+ interface (portB) share connections to the first NP6 processor.
- Eight 1Gb SFP interfaces (port1-port8), eight RJ-45 Ethernet interfaces (port9-16) and one 10Gb SFP+ interface (portA) share connections to the second NP6 processor.



You can use the following get command to display the FortiGate 900D NP6 configuration. The command output shows two NP6s named NP6_0 and NP6_1. The output also shows the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                    Speed offloading
------ ---- ------- ----- ----------
np6_0  0
       1    port17  1G    Yes
```

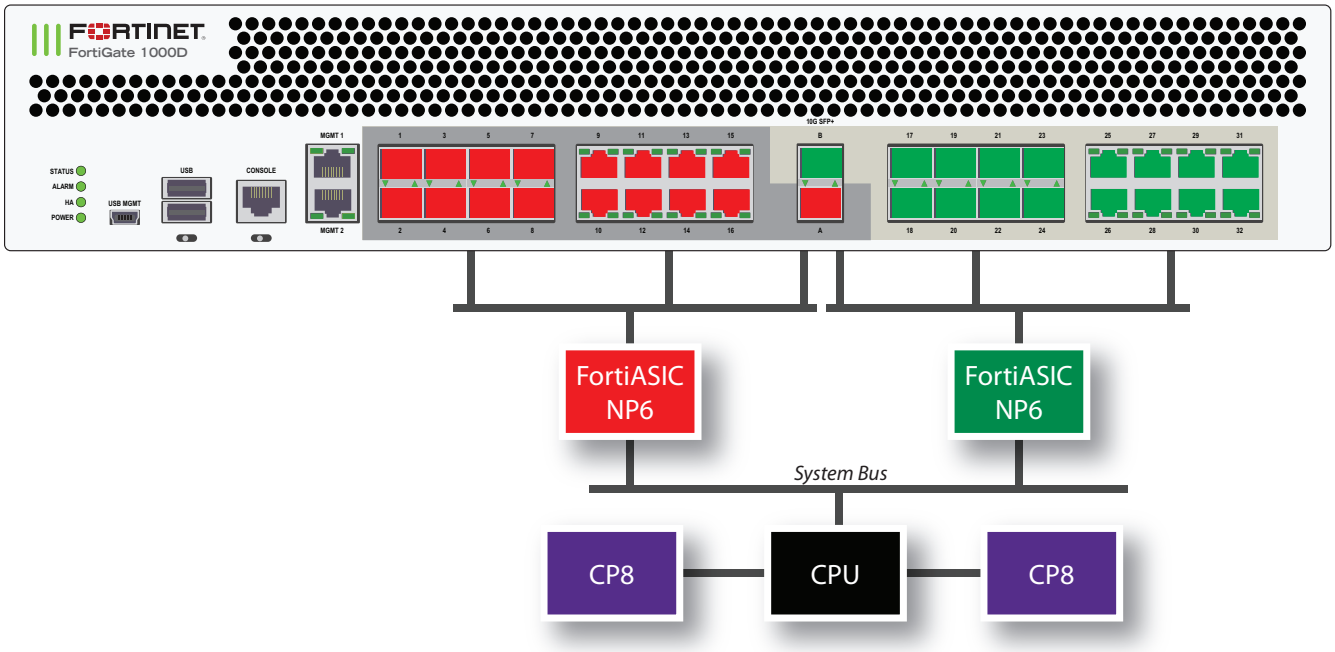
```
          1    port18  1G    Yes
          1    port19  1G    Yes
          1    port20  1G    Yes
          1    port21  1G    Yes
          1    port22  1G    Yes
          1    port23  1G    Yes
          1    port24  1G    Yes
          1    port27  1G    Yes
          1    port28  1G    Yes
          1    port25  1G    Yes
          1    port26  1G    Yes
          1    port31  1G    Yes
          1    port32  1G    Yes
          1    port29  1G    Yes
          1    port30  1G    Yes
          2    portB   10G   Yes
          3
------ ---- ------- ----- ----------
np6_1    0
          1    port1  1G    Yes
          1    port2  1G    Yes
          1    port3  1G    Yes
          1    port4  1G    Yes
          1    port5  1G    Yes
          1    port6  1G    Yes
          1    port7  1G    Yes
          1    port8  1G    Yes
          1    port11 1G    Yes
          1    port12 1G    Yes
          1    port9  1G    Yes
          1    port10 1G    Yes
          1    port15 1G    Yes
          1    port16 1G    Yes
          1    port13 1G    Yes
          1    port14 1G    Yes
          2    portA  10G   Yes
          3
```

FortiGate 1000D fast path architecture

The FortiGate 1000D includes two NP6 processors that are not connected by an integrated switch fabric (ISF). The NP6 processors are connected to network interfaces as follows:

Because the FortiGate 1000D does not have an ISF you cannot create Link Aggregation Groups (LAGs) or redundant interfaces that include interfaces connected to both NP6 processors.

- Eight 1Gb SFP interfaces (port17-port24), eight 1Gb RJ-45 Ethernet interfaces (port25-32) and one 10Gb SFP+ interface (portB) share connections to the first NP6 processor.
- Eight 1Gb SFP interfaces (port1-port8), eight RJ-45 Ethernet interfaces (port9-16) and one 10Gb SFP+ interface (portA) share connections to the second NP6 processor.



You can use the following get command to display the FortiGate 1000D NP6 configuration. The command output shows two NP6s named NP6_0 and NP6_1. The output also shows the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

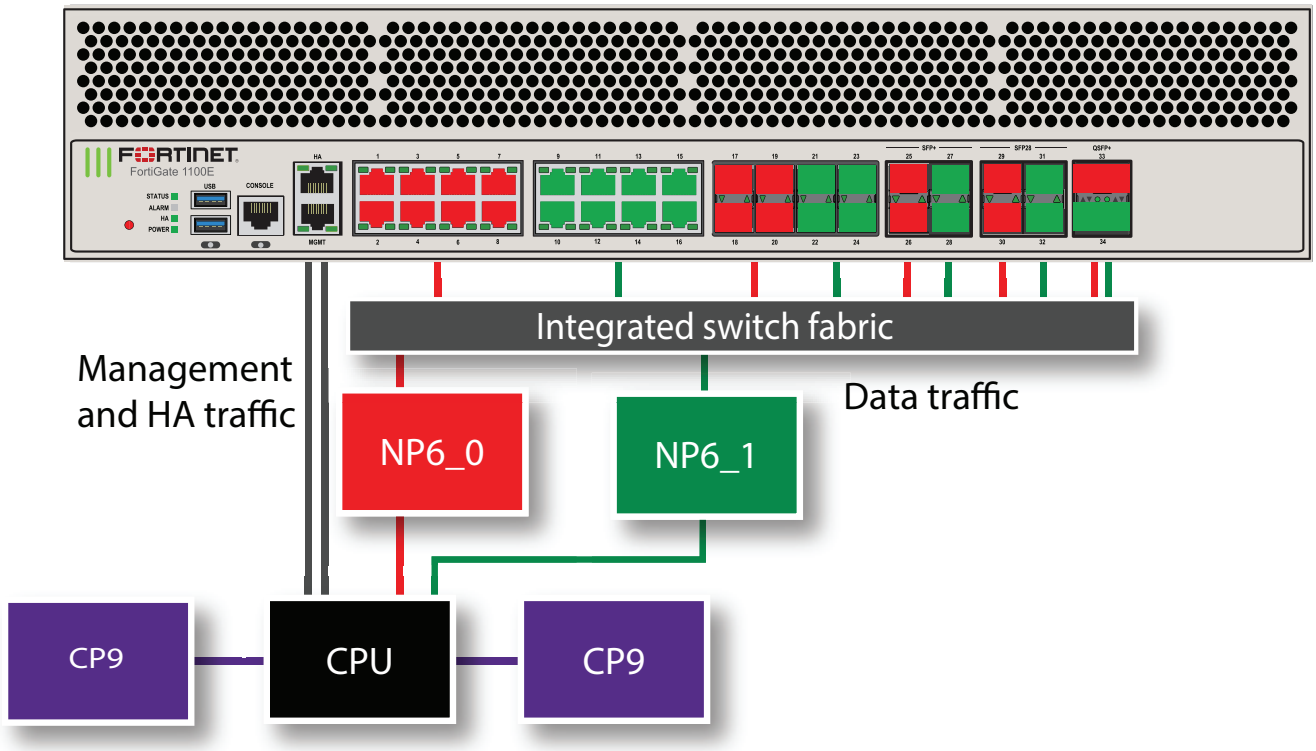
```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                    Speed offloading
------ ---- ------- ----- ----------
np6_0  0
       1    port17  1G    Yes
       1    port18  1G    Yes
       1    port19  1G    Yes
       1    port20  1G    Yes
       1    port21  1G    Yes
       1    port22  1G    Yes
       1    port23  1G    Yes
       1    port24  1G    Yes
       1    port27  1G    Yes
       1    port28  1G    Yes
       1    port25  1G    Yes
       1    port26  1G    Yes
       1    port31  1G    Yes
       1    port32  1G    Yes
       1    port29  1G    Yes
       1    port30  1G    Yes
       2    portB   10G   Yes
       3
------ ---- ------- ----- ----------
np6_1   0
        1    port1  1G    Yes
        1    port2  1G    Yes
        1    port3  1G    Yes
        1    port4  1G    Yes
        1    port5  1G    Yes
```

```
1     port6  1G    Yes
1     port7  1G    Yes
1     port8  1G    Yes
1     port11 1G    Yes
1     port12 1G    Yes
1     port9  1G    Yes
1     port10 1G    Yes
1     port15 1G    Yes
1     port16 1G    Yes
1     port13 1G    Yes
1     port14 1G    Yes
2     portA  10G   Yes
3
```

FortiGate 1100E and 1101E fast path architecture

The FortiGate 1100E and 1101E models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (HA and MGMT, not connected to the NP6 processors)
- Sixteen 10/100/1000BASE-T Copper (1 to 16)
- Eight 1 GigE SFP (17 - 24)
- Four 10 GigE SFP+ (25 - 28)
- Four 25 GigE SFP28 (29 - 32) interface group: 29 - 32
- Two 40 GigE QSFP+ (33 and 34)



The FortiGate 1100E and 1101E each include two NP6 processors. All front panel data interfaces and both NP6 processors connect to the integrated switch fabric (ISF). All data traffic passes from the data interfaces through the ISF to the NP6 processors. Because of the ISF, all supported traffic passing between any two data interfaces can be offloaded by the NP6 processors. Data traffic processed by the CPU takes a dedicated data path through the ISF and an NP6 processor to the CPU.

The MGMT interface is not connected to the NP6 processors. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. You can also dedicate separate CPU resources for management traffic to further isolate management processing from data processing (see Dedicated management CPU on page 27).

The HA interface is also not connected to the NP6 processors. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing.

The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following command to display the FortiGate 1100E or 1101E NP6 configuration. The command output shows two NP6s named NP6_0 and NP6_1 and the interfaces (ports) connected to each NP6. This interface to NP6 mapping is also shown in the diagram above.

The command output also shows the XAUI configuration for each NP6 processor. Each NP6 processor has a 40-Gigabit bandwidth capacity. Traffic passes to each NP6 processor over four 10-Gigabit XAUI links. The XAUI links are numbered 0 to 3.

You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports            QSGMII Max   Cross-chip
                                   Speed offloading
------ ---- -------          ------ ----- ----------
np6_0  0    port20           NA     1G    Yes
       0    port1            NA     1G    Yes
       0    port2            NA     1G    Yes
       1    port19           NA     1G    Yes
       1    port3            NA     1G    Yes
       1    port4            NA     1G    Yes
       2    port18           NA     1G    Yes
       2    port5            NA     1G    Yes
       2    port6            NA     1G    Yes
       3    port17           NA     1G    Yes
       3    port7            NA     1G    Yes
       3    port8            NA     1G    Yes
       0-3  port25           NA     10G   Yes
       0-3  port26           NA     10G   Yes
       0-3  port29           NA     25G   Yes
       0-3  port30           NA     25G   Yes
       0-3  port33           NA     40G   Yes
------ ---- -------          ------ ----- ----------
np6_1  0    port24           NA     1G    Yes
       0    port9            NA     1G    Yes
       0    port10           NA     1G    Yes
       1    port23           NA     1G    Yes
       1    port11           NA     1G    Yes
       1    port12           NA     1G    Yes
       2    port22           NA     1G    Yes
       2    port13           NA     1G    Yes
       2    port14           NA     1G    Yes
```

```
        3    port21           NA     1G    Yes
        3    port15           NA     1G    Yes
        3    port16           NA     1G    Yes
        0-3  port27           NA     10G   Yes
        0-3  port28           NA     10G   Yes
        0-3  port31           NA     25G   Yes
        0-3  port32           NA     25G   Yes
        0-3  port34           NA     40G   Yes
------ ---- -------          ------ ----- ----------
```

Distributing traffic evenly among the NP6 processors can optimize performance. For details, see Optimizing NP6 performance by distributing traffic to XAUI links on page 105.

You can also add LAGs to improve performance. For details, see Increasing NP6 offloading capacity using link aggregation groups (LAGs) on page 109.

Interface groups and changing data interface speeds

FortiGate-1100E and 1101E front panel data interfaces 29 to 32 are in an interface group and all operate at the same speed. Changing the speed of an interface in this group changes the speeds of all of the interfaces in the group.

For example, the default speed of the port29 to port32 interfaces is 25Gbps. If you want to install 10GigE transceivers in port29 to port32 to convert all of these data interfaces to connect to 10Gbps networks, you can enter the following from the CLI:

```
config system interface
   edit port29
      set speed 10000full
   end
```

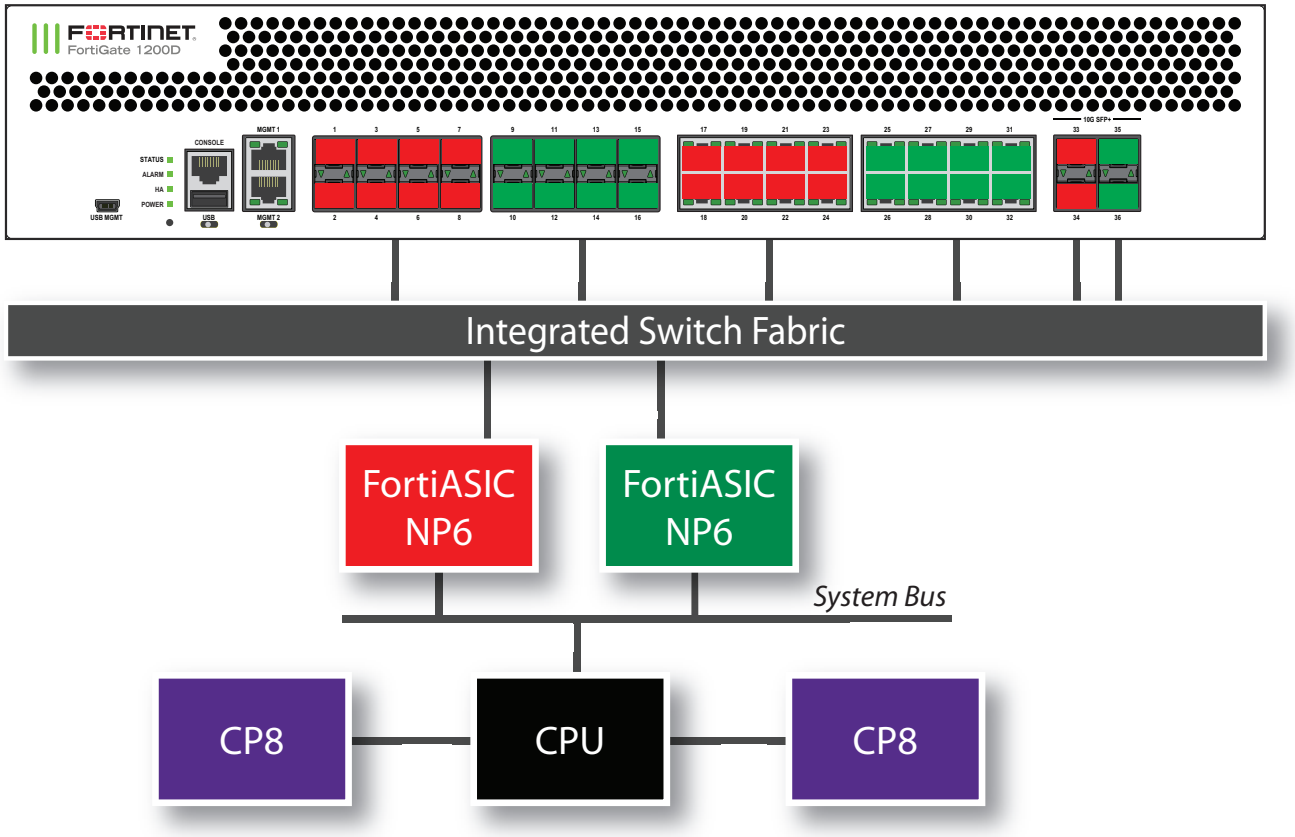
Every time you change a data interface speed, when you enter the `end` command, the CLI confirms the range of interfaces affected by the change. For example, if you change the speed of port29 the following message appears:

```
config system interface
   edit port29
      set speed 10000full
   end
port29-port32 speed will be changed to 10000full due to hardware limit.
Do you want to continue? (y/n)
```

FortiGate 1200D fast path architecture

The FortiGate 1200D features two NP6 processors both connected to an integrated switch fabric.

- Eight SFP 1Gb interfaces (port1-port8), eight RJ-45 Ethernet ports (port17-24) and two SFP+ 10Gb interfaces (port33 and port34) share connections to the first NP6 processor.
- Eight SFP 1Gb interfaces (port9-port16), eight RJ-45 Ethernet ports (port25-32) and two SFP+ 10Gb interfaces (port35-port36) share connections to the second NP6 processor.



You can use the following get command to display the FortiGate 1200D NP6 configuration. The command output shows two NP6s named NP6_0 and NP6_1. The output also shows the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                    Speed offloading
------ ---- ------- ----- ----------
np6_0  0    port33  10G   Yes
       1    port34  10G   Yes
       2    port1   1G    Yes
       2    port3   1G    Yes
       2    port5   1G    Yes
       2    port7   1G    Yes
       2    port17  1G    Yes
       2    port19  1G    Yes
       2    port21  1G    Yes
       2    port23  1G    Yes
       3    port2   1G    Yes
       3    port4   1G    Yes
       3    port6   1G    Yes
       3    port8   1G    Yes
       3    port18  1G    Yes
       3    port20  1G    Yes
       3    port22  1G    Yes
       3    port24  1G    Yes
------ ---- ------- ----- ----------
```

```
np6_1  0    port35  10G   Yes
       1    port36  10G   Yes
       2    port9   1G    Yes
       2    port11  1G    Yes
       2    port13  1G    Yes
       2    port15  1G    Yes
       2    port25  1G    Yes
       2    port27  1G    Yes
       2    port29  1G    Yes
       2    port31  1G    Yes
       3    port10  1G    Yes
       3    port12  1G    Yes
       3    port14  1G    Yes
       3    port16  1G    Yes
       3    port26  1G    Yes
       3    port28  1G    Yes
       3    port30  1G    Yes
       3    port32  1G    Yes
------ ---- ------- ----- ----------
```

Improving FortiGate 1200D connections per second performance

On the FortiGate 1200D, you can use the following command to potentially improve connections per second (CPS) performance:

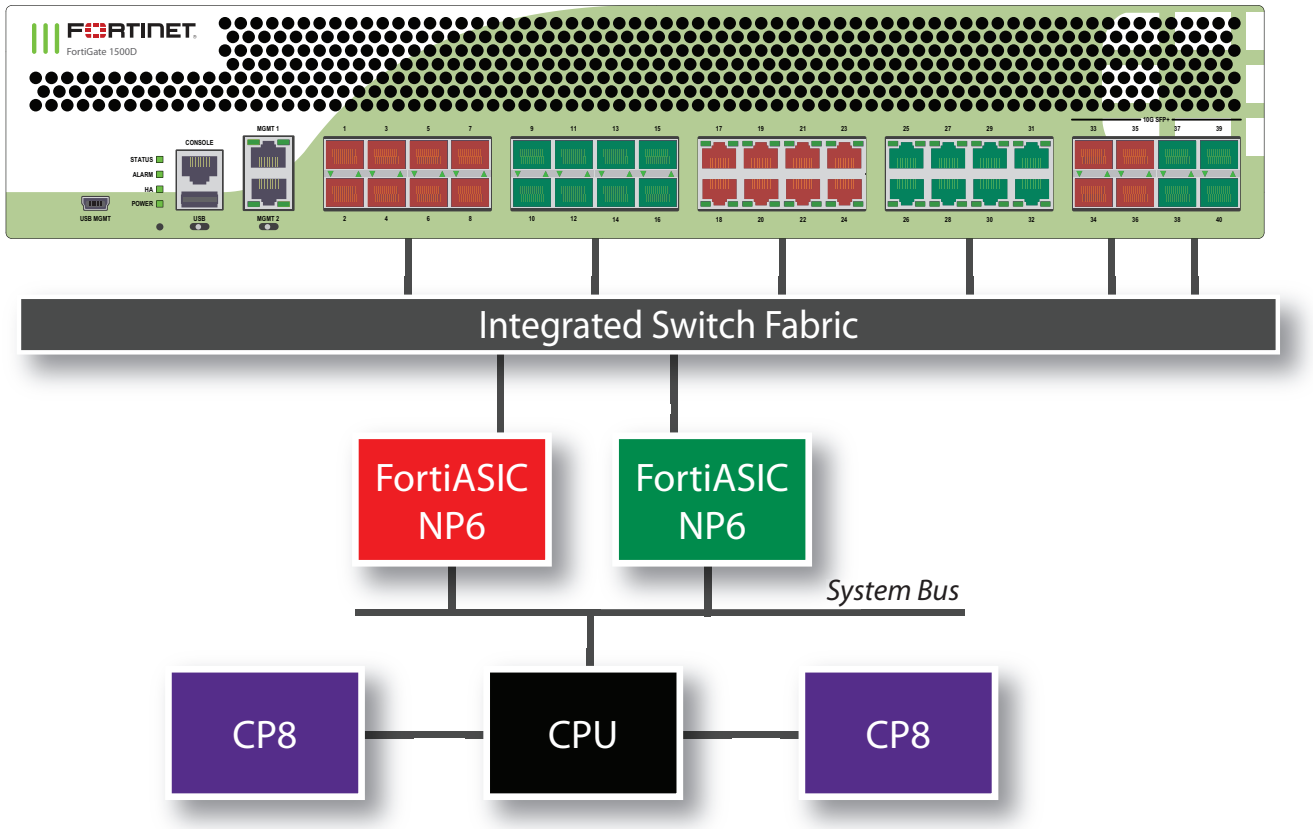
```
config system npu
   set np6-cps-optimization-mode {disable | enable}
end
```

Disabled by default, enabling this option can increase CPS performance by using more CPUs for interrupt processing. If your FortiGate 1200D is processing very large numbers sessions with short life times, you can try enabling this feature to see if performance improves.

FortiGate 1500D fast path architecture

The FortiGate 1500D features two NP6 processors both connected to an integrated switch fabric.

- Eight SFP 1Gb interfaces (port1-port8), eight RJ-45 1Gb Ethernet interfaces (port17-24) and four SFP+ 10Gb interfaces (port33-port36) share connections to the first NP6 processor.
- Eight SFP 1Gb interfaces (port9-port16), eight RJ-45 1Gb Ethernet interfaces (port25-32) and four SFP+ 10Gb interfaces (port37-port40) share connections to the second NP6 processor.



You can use the following get command to display the FortiGate 1500D NP6 configuration. The command output shows two NP6s named NP6_0 and NP6_1. The output also shows the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip    XAUI Ports            Max    Cross-chip
                              Speed  offloading
------  ---- -------          -----  ----------
np6_0   0    port1            1G     Yes
        0    port5            1G     Yes
        0    port17           1G     Yes
        0    port21           1G     Yes
        0    port33           10G    Yes
        1    port2            1G     Yes
        1    port6            1G     Yes
        1    port18           1G     Yes
        1    port22           1G     Yes
        1    port34           10G    Yes
        2    port3            1G     Yes
        2    port7            1G     Yes
        2    port19           1G     Yes
        2    port23           1G     Yes
        2    port35           10G    Yes
        3    port4            1G     Yes
        3    port8            1G     Yes
        3    port20           1G     Yes
        3    port24           1G     Yes
        3    port36           10G    Yes
```

```
------ ---- -------          ----- ----------
np6_1  0    port9            1G    Yes
       0    port13           1G    Yes
       0    port25           1G    Yes
       0    port29           1G    Yes
       0    port37           10G   Yes
       1    port10           1G    Yes
       1    port14           1G    Yes
       1    port26           1G    Yes
       1    port30           1G    Yes
       1    port38           10G   Yes
       2    port11           1G    Yes
       2    port15           1G    Yes
       2    port27           1G    Yes
       2    port31           1G    Yes
       2    port39           10G   Yes
       3    port12           1G    Yes
       3    port16           1G    Yes
       3    port28           1G    Yes
       3    port32           1G    Yes
       3    port40           10G   Yes
------ ---- -------          ----- ----------
```

Improving FortiGate 1500D connections per second performance

On the FortiGate 1500D, you can use the following command to potentially improve connections per second (CPS) performance:

```
config system npu
   set np6-cps-optimization-mode {disable | enable}
end
```

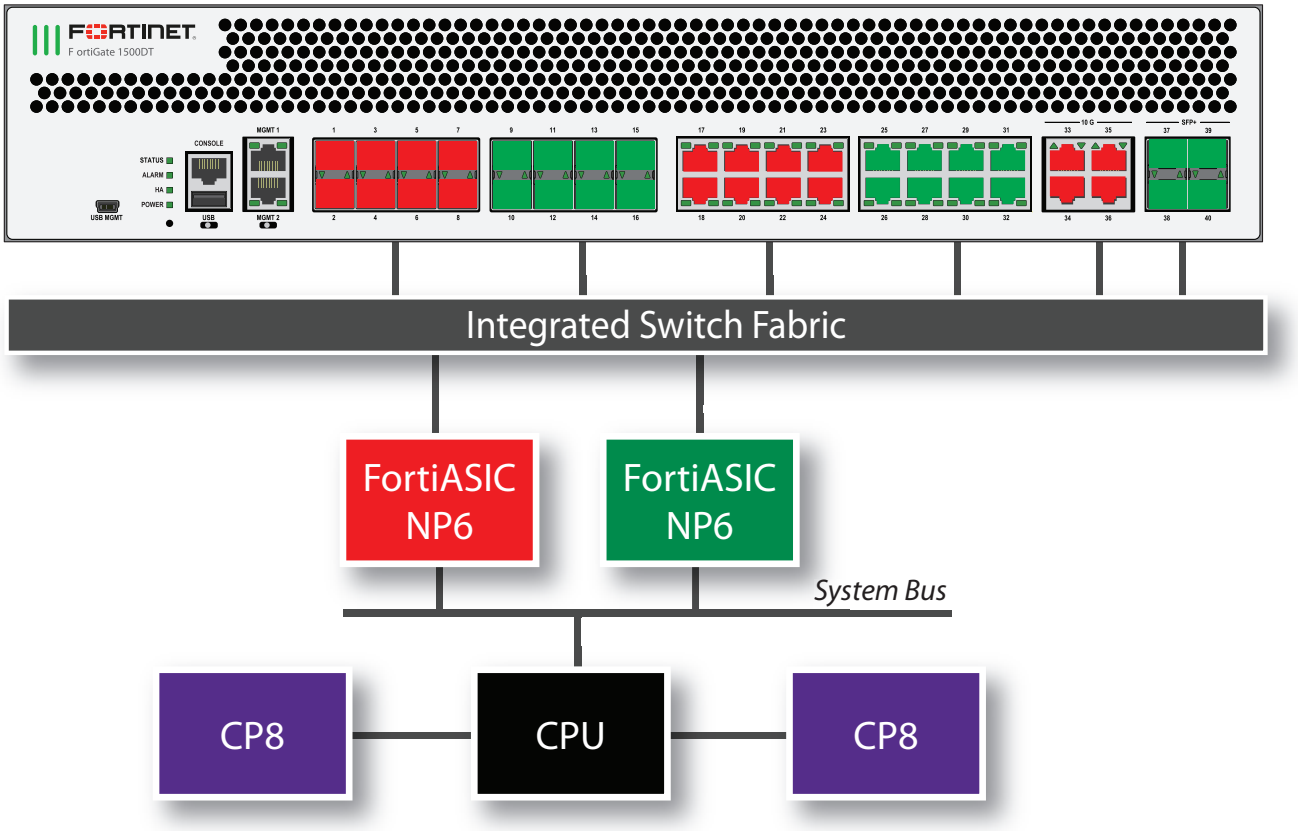
Disabled by default, enabling this option can increase CPS performance by using more CPUs for interrupt processing. If your FortiGate 1500D is processing very large numbers sessions with short life times, you can try enabling this feature to see if performance improves.

FortiGate 1500DT fast path architecture

The FortiGate 1500DT features two NP6 processors both connected to an integrated switch fabric. The FortiGate 1500DT has the same hardware configuration as the FortiGate 1500D, but with the addition of newer CPUs and a slightly different interface configuration.

The FortiGate 1500DT includes the following interfaces and NP6 processors:

- Eight SFP 1Gb interfaces (port1-port8), eight RJ-45 1Gb Ethernet interfaces (port17-24) and four RJ-45 10Gb Ethernet interfaces (port33-port36) share connections to the first NP6 processor.
- Eight SFP 1Gb interfaces (port9-port16), eight RJ-45 1Gb Ethernet ports (port25-32) and four SFP+ 10Gb interfaces (port37-port40) share connections to the second NP6 processor.



You can use the following get command to display the FortiGate 1500DT NP6 configuration. The command output shows two NP6s named NP6_0 and NP6_1. The output also shows the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip    XAUI Ports    Max    Cross-chip
                      Speed  offloading
------  ---- -------  -----  ----------
np6_0   0    port1    1G     Yes
        0    port5    1G     Yes
        0    port17   1G     Yes
        0    port21   1G     Yes
        0    port33   10G    Yes
        1    port2    1G     Yes
        1    port6    1G     Yes
        1    port18   1G     Yes
        1    port22   1G     Yes
        1    port34   10G    Yes
        2    port3    1G     Yes
        2    port7    1G     Yes
        2    port19   1G     Yes
        2    port23   1G     Yes
        2    port35   10G    Yes
        3    port4    1G     Yes
        3    port8    1G     Yes
        3    port20   1G     Yes
        3    port24   1G     Yes
```

```
        3    port36  10G   Yes
------ ---- ------- ----- ----------
np6_1  0    port9   1G    Yes
       0    port13  1G    Yes
       0    port25  1G    Yes
       0    port29  1G    Yes
       0    port37  10G   Yes
       1    port10  1G    Yes
       1    port14  1G    Yes
       1    port26  1G    Yes
       1    port30  1G    Yes
       1    port38  10G   Yes
       2    port11  1G    Yes
       2    port15  1G    Yes
       2    port27  1G    Yes
       2    port31  1G    Yes
       2    port39  10G   Yes
       3    port12  1G    Yes
       3    port16  1G    Yes
       3    port28  1G    Yes
       3    port32  1G    Yes
       3    port40  10G   Yes
------ ---- ------- ----- ----------
```

Improving FortiGate 1500DT connections per second performance

On the FortiGate 1500DT, you can use the following command to potentially improve connections per second (CPS) performance:

```
config system npu
   set np6-cps-optimization-mode {disable | enable}
end
```

Disabled by default, enabling this option can increase CPS performance by using more CPUs for interrupt processing. If your FortiGate 1500DT is processing very large numbers sessions with short life times, you can try enabling this feature to see if performance improves.

FortiGate 2000E fast path architecture

The FortiGate 2000E features the following front panel interfaces:

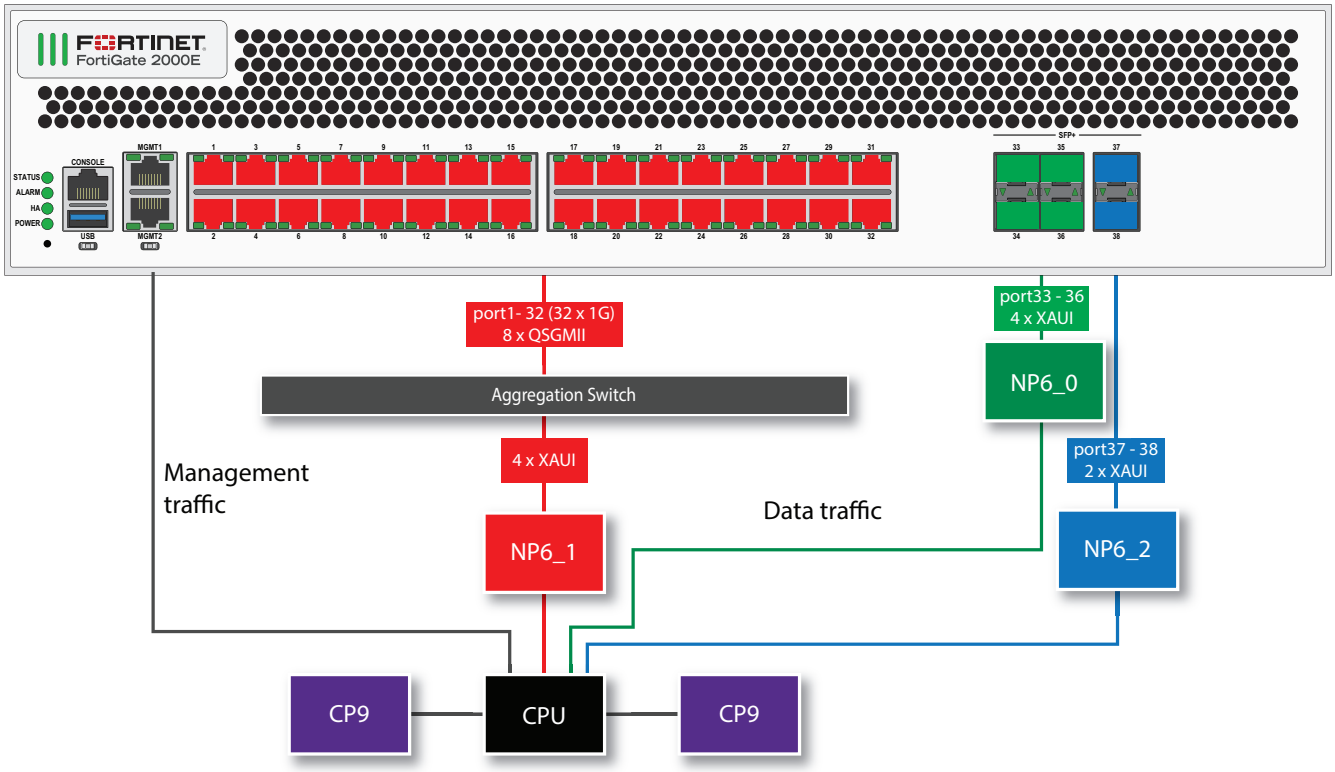
- Two 10/100/1000BASE-T Copper interfaces (MGMT1 and MGMT2, not connected to the NP6 processors)
- Thirty-two 10/100/1000BASE-T interfaces (1 to 32)
- Four 10GigE SFP+ interfaces (33 to 36)
- Two 10GigE SFP+ (37 and 38)

The FortiGate 2000E includes three NP6 processors in an NP Direct configuration. The NP6 processors connected to the 10GigE ports are also in a low latency NP Direct configuration. Because of NP Direct, you cannot create Link Aggregation Groups (LAGs) or redundant interfaces between interfaces connected to different NP6s. As well, traffic will only be offloaded if it enters and exits the FortiGate on interfaces connected to the same NP6.

The NP6s are connected to network interfaces as follows:

- NP6_0 is connected to 33 to 36 in a low latency configuration
- NP6_1 is connected to 1 to 32
- NP6_2 is connected to 37 and 38 n a low latency configuration

The following diagram also shows the XAUI and QSGMII port connections between the NP6 processors and the front panel interfaces and the aggregate switch for the thirty-two 10/100/1000BASE-T interfaces.



All data traffic passes from the data interfaces to the NP6 processors. Data traffic processed by the CPU takes a dedicated data path through the ISF and an NP6 processor to the CPU.

The MGMT interfaces are not connected to the NP6 processors. Management traffic passes to the CPU over a dedicated management path that is separate from the data paths. You can also dedicate separate CPU resources for management traffic to further isolate management processing from data processing (see Dedicated management CPU on page 27). This separation of management traffic from data traffic keeps management traffic from interfering with the stability and performance of data traffic processing.

You can use the following get command to display the FortiGate 2000E NP6 configuration. You can also use the `diagnose npu np6 port-list` command to display this information.

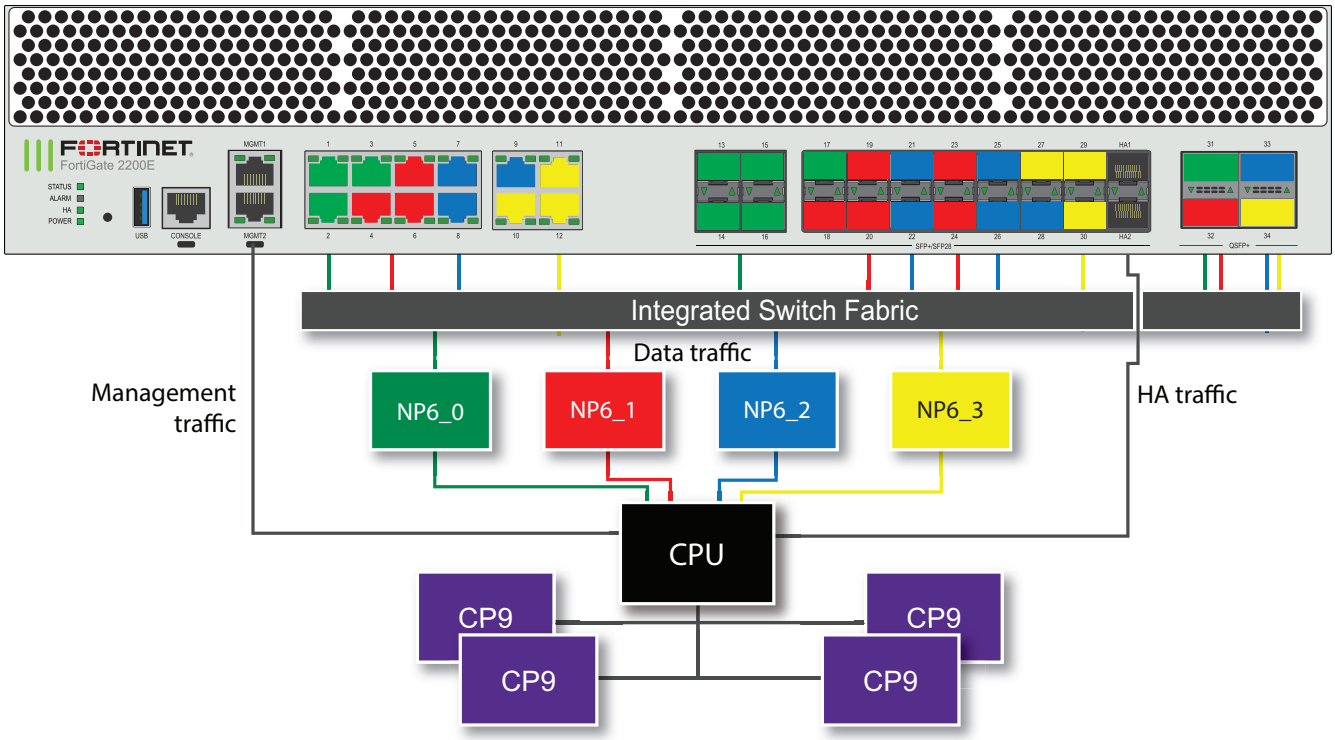
```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                    Speed offloading
------ ---- ------- ----- ----------
np6_1  0    port1   1G    No
       0    port5   1G    No
       0    port9   1G    No
       0    port13  1G    No
       0    port17  1G    No
       0    port21  1G    No
       0    port25  1G    No
```

```
        0    port29  1G    No
        1    port2   1G    No
        1    port6   1G    No
        1    port10  1G    No
        1    port14  1G    No
        1    port18  1G    No
        1    port22  1G    No
        1    port26  1G    No
        1    port30  1G    No
        2    port3   1G    No
        2    port7   1G    No
        2    port11  1G    No
        2    port15  1G    No
        2    port19  1G    No
        2    port23  1G    No
        2    port27  1G    No
        2    port31  1G    No
        3    port4   1G    No
        3    port8   1G    No
        3    port12  1G    No
        3    port16  1G    No
        3    port20  1G    No
        3    port24  1G    No
        3    port28  1G    No
        3    port32  1G    No
------ ---- ------- ----- ----------
np6_0  0    port33  10G   No
       1    port34  10G   No
       2    port35  10G   No
       3    port36  10G   No
------ ---- ------- ----- ----------
np6_2  0    port37  10G   No
       1    port38  10G   No
------ ---- ------- ----- ----------
```

FortiGate 2200E and 2201E fast path architecture

The FortiGate 2200E and 2201E models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (MGMT1 and MGMT2)
- Twelve 10/100/1000BASE-T Copper (1 to 12)
- Eighteen 10/25 GigE SFP+/SFP28 (13 to 28), interface groups: 13 - 16, 17 - 20, 21 - 24, and 25 - 28
- Four 10/25 GigE SFP+/SFP28 (29, 30, HA1 and HA2), interface groups: 29 - HA1 and 30 - HA2 (the HA interfaces are not connected to the NP6 processor)
- Four 40 GigE QSFP+ (31 to 34)



You can use the following command to display the FortiGate 2200E or 2201E NP6 configuration. The command output shows four NP6s named NP6_0, NP6_1, and NP6_2 and the interfaces (ports) connected to each NP6. This interface to NP6 mapping is also shown in the diagram above.

The command output also shows the XAUI configuration for each NP6 processor. Each NP6 processor has a 40-Gigabit bandwidth capacity. Traffic passes to each NP6 processor over four 10-Gigabit XAUI links. The XAUI links are numbered 0 to 3.

You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip    XAUI Ports            Max    Cross-chip
                              Speed  offloading
------  ---- -------          -----  ----------
np6_0   0    port1            1G     Yes
        1    port2            1G     Yes
        2    port3            1G     Yes
        3
        0-3  port13           25G    Yes
        0-3  port14           25G    Yes
        0-3  port15           25G    Yes
        0-3  port16           25G    Yes
        0-3  port17           25G    Yes
        0-3  port31           40G    Yes
------  ---- -------          -----  ----------
np6_1   0    port4            1G     Yes
        1    port5            1G     Yes
        2    port6            1G     Yes
        3
        0-3  port18           25G    Yes
        0-3  port19           25G    Yes
```

```
        0-3  port20           25G   Yes
        0-3  port24           25G   Yes
        0-3  port23           25G   Yes
        0-3  port32           40G   Yes
------ ---- -------          ----- ----------
np6_2  0    port7            1G    Yes
       1    port8            1G    Yes
       2    port9            1G    Yes
       3
       0-3  port22           25G   Yes
       0-3  port21           25G   Yes
       0-3  port26           25G   Yes
       0-3  port25           25G   Yes
       0-3  port28           25G   Yes
       0-3  port33           40G   Yes
------ ---- -------          ----- ----------
np6_3  0    port10           1G    Yes
       1    port11           1G    Yes
       2    port12           1G    Yes
       2    port29           10G   Yes
       3    port30           10G   Yes
       0-3  port27           25G   Yes
       0-3  port34           40G   Yes
------ ---- -------          ----- ----------
```

Distributing traffic evenly among the NP6 processors can optimize performance. For details, see Optimizing NP6 performance by distributing traffic to XAUI links on page 105.

You can also add LAGs to improve performance. For details, see Increasing NP6 offloading capacity using link aggregation groups (LAGs) on page 109.

The HA1 and HA2 interfaces are not connected to the NP6 processors. The HA interfaces are instead mapped to a dedicated control path to prevent HA traffic from interfering with the stability and performance of data traffic processing.

Interface groups and changing data interface speeds

FortiGate-2200E and 2201E front panel data interfaces 13 to 30, HA1, and HA2 are divided into the following groups:

- port13 - port16
- port17 - port20
- port21 - port24
- port25 - port28
- port29 - ha1
- port30 - ha2

All of the interfaces in a group operate at the same speed. Changing the speed of an interface changes the speeds of all of the interfaces in the same group. For example, if you change the speed of port26 from 25Gbps to 10Gbps the speeds of port25 to port28 are also changed to 10Gbps.

Another example, port17 to port24 interfaces are operating at 25Gbps. If you want to install 10GigE transceivers in port17 to port24 to convert all of these data interfaces to connect to 10Gbps networks, you can enter the following from the CLI:

```
config system interface
  edit port17
    set speed 10000full
```

```
  next
  edit port21
    set speed 10000full
  end
```

Every time you change a data interface speed, when you enter the `end` command, the CLI confirms the range of interfaces affected by the change. For example, if you change the speed of port29 the following message appears:

```
config system interface
  edit port29
    set speed 25000full
  end
port29 ha1 speed will be changed to 25000full due to hardware limit.
Do you want to continue? (y/n)
```

FortiGate 2500E fast path architecture

The FortiGate 2500E features the following front panel interfaces:

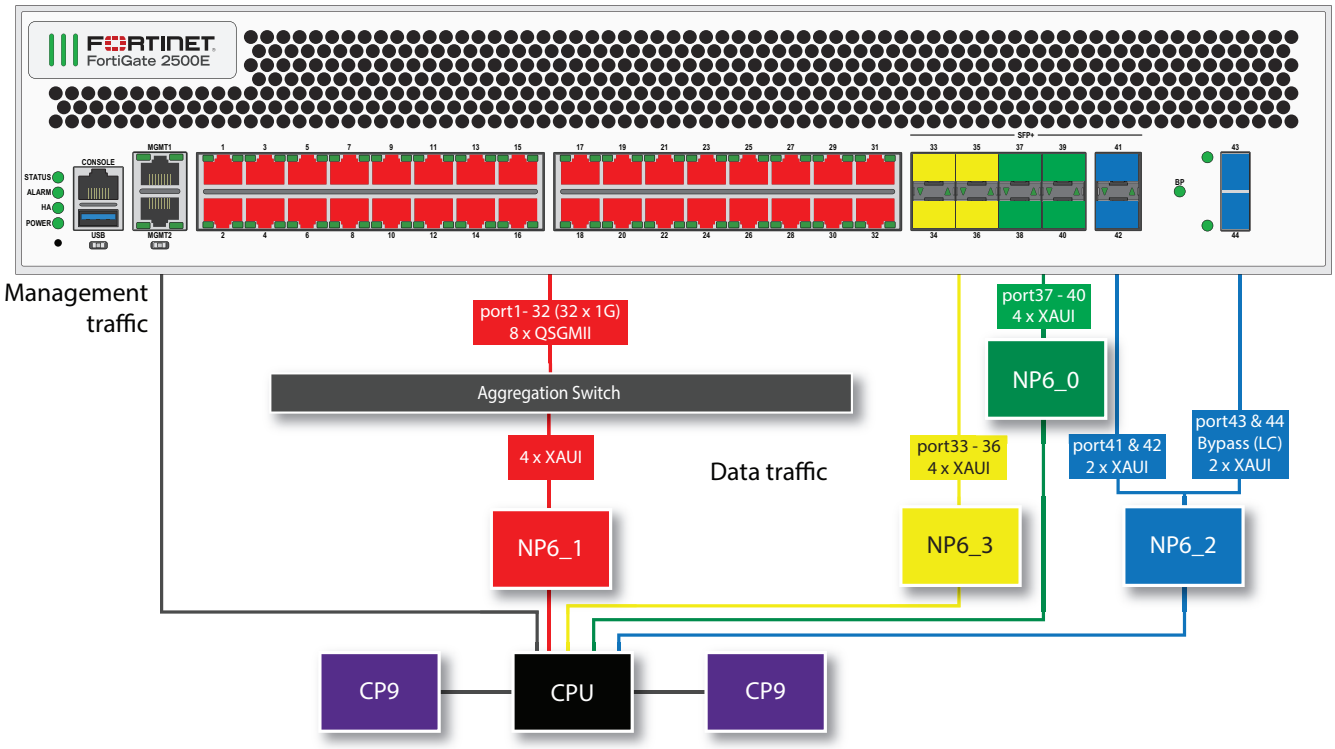
- Two 10/100/1000BASE-T Copper (MGMT1 and MGMT2, not connected to the NP6 processors)
- Thirty-two 10/100/1000BASE-T interfaces (1 to 32)
- Four 10GigE SFP+ interfaces (33 to 36)
- Four 10GigE SFP+ interfaces (37 to 40)
- Two 10GigE SFP+ interfaces (41 and 42)
- Two 10 Gig LC fiber bypass interfaces (43 and 44)

The FortiGate 2500E includes four NP6 processors in an NP Direct configuration. The NP6 processors connected to the 10GigE ports are also in a low latency NP Direct configuration. Because of NP Direct, you cannot create Link Aggregation Groups (LAGs) or redundant interfaces between interfaces connected to different NP6s. As well, traffic will only be offloaded if it enters and exits the FortiGate on interfaces connected to the same NP6.

The NP6s are connected to network interfaces as follows:

- NP6_0 is connected to four 10GigE SFP+ interfaces (port37 to port40) in a low latency configuration.
- NP6_1 is connected to thirty-two 10/100/1000BASE-T interfaces (port1 to port32).
- NP6_2 is connected to two 10GigE SFP+ interfaces (port41 and port42) and two 10 Gig LC fiber bypass interfaces (port43 and port44) in a low latency configuration.
- NP6_3 is connected to four 10GigE SFP+ interfaces (port33 to port36) in a low latency configuration.

The following diagram also shows the XAUI and QSGMII port connections between the NP6 processors and the front panel interfaces and the aggregate switch for the thirty-two 10/100/1000BASE-T interfaces.



All data traffic passes from the data interfaces to the NP6 processors. Data traffic processed by the CPU takes a dedicated data path through the ISF and an NP6 processor to the CPU.

The MGMT interfaces are not connected to the NP6 processors. Management traffic passes to the CPU over a dedicated management path that is separate from the data paths. You can also dedicate separate CPU resources for management traffic to further isolate management processing from data processing (see Dedicated management CPU on page 27). This separation of management traffic from data traffic keeps management traffic from interfering with the stability and performance of data traffic processing.

You can use the following get command to display the FortiGate 2500E NP6 configuration. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip    XAUI Ports    Max    Cross-chip
                      Speed  offloading
------  ---- -------  -----  ----------
np6_1   0    port1    1G     No
        0    port5    1G     No
        0    port9    1G     No
        0    port13   1G     No
        0    port17   1G     No
        0    port21   1G     No
        0    port25   1G     No
        0    port29   1G     No
        1    port2    1G     No
        1    port6    1G     No
        1    port10   1G     No
        1    port14   1G     No
        1    port18   1G     No
        1    port22   1G     No
        1    port26   1G     No
```

```
        1    port30  1G    No
        2    port3   1G    No
        2    port7   1G    No
        2    port11  1G    No
        2    port15  1G    No
        2    port19  1G    No
        2    port23  1G    No
        2    port27  1G    No
        2    port31  1G    No
        3    port4   1G    No
        3    port8   1G    No
        3    port12  1G    No
        3    port16  1G    No
        3    port20  1G    No
        3    port24  1G    No
        3    port28  1G    No
        3    port32  1G    No
------ ---- ------- ----- ----------
np6_0   0    port37  10G   No
        1    port38  10G   No
        2    port39  10G   No
        3    port40  10G   No
------ ---- ------- ----- ----------
np6_2   0    port43  10G   No
        1    port44  10G   No
        2    port41  10G   No
        3    port42  10G   No
------ ---- ------- ----- ----------
np6_3   0    port33  10G   No
        1    port34  10G   No
        2    port35  10G   No
        3    port36  10G   No
------ ---- ------- ----- ----------
```

Bypass interfaces (port43 and port44)

The FortiGate 2500E includes an internal optical bypass module between interfaces 43 and 44 that provides fail open support. On these two interfaces, LC connectors connect directly to internal short-range (SR) lasers. No transceivers are required. When the FortiGate- 2500E experiences a hardware failure or loses power, or when bypass mode is enabled, these interfaces operate in bypass mode. In bypass mode, interfaces 43 and 44 are optically shunted and all traffic can pass between them, bypassing the FortiOS firewall and the NP6_2 processor.

Interfaces 43 and 44 use an internal short-range (SR) laser, so interfaces 43 and 44 only support SR multi-mode fiber. You cannot use LR or single-mode fiber connections with these interfaces.

When the interfaces switch to bypass mode the FortiGate 2500E acts like an optical patch cable so if packets going through these interfaces use VLANs or other network extensions, the attached upstream or downstream network equipment must be configured for these features.

The FortiGate 2500E will continue to operate in bypass mode until the failed FortiGate 2500E is replaced, power is restored, or bypass mode is disabled. If power is restored or bypass mode is disabled, the FortiGate 2500E resumes operating as a FortiGate device without interrupting traffic flow. Replacing a failed FortiGate 800D disrupts traffic as a technician physically replaces the failed FortiGate 800D with a new one.

During normal operation, the bypass status (B/P) LED glows green. When bypass mode is enabled, this LED glows amber.

Manually enabling bypass-mode

You can manually enable bypass mode if the FortiGate 2500E is operating in transparent mode. You can also manually enable bypass mode for a VDOM if interfaces 43 and 44 are both connected to the same VDOM operating in transparent mode.

Use the following command to enable bypass mode:

```
execute bypass-mode enable
```

This command changes the configuration, so bypass mode will still be enabled if the FortiGate-2500E restarts.

You can use the following command to disable bypass mode:

```
execute bypass-mode disable
```

Configuring bypass settings

You can use the following command to configure how bypass operates.

```
config system bypass
   set bypass-watchdog {disable | enable}
   set poweroff-bypass {disable | enable}
end
```

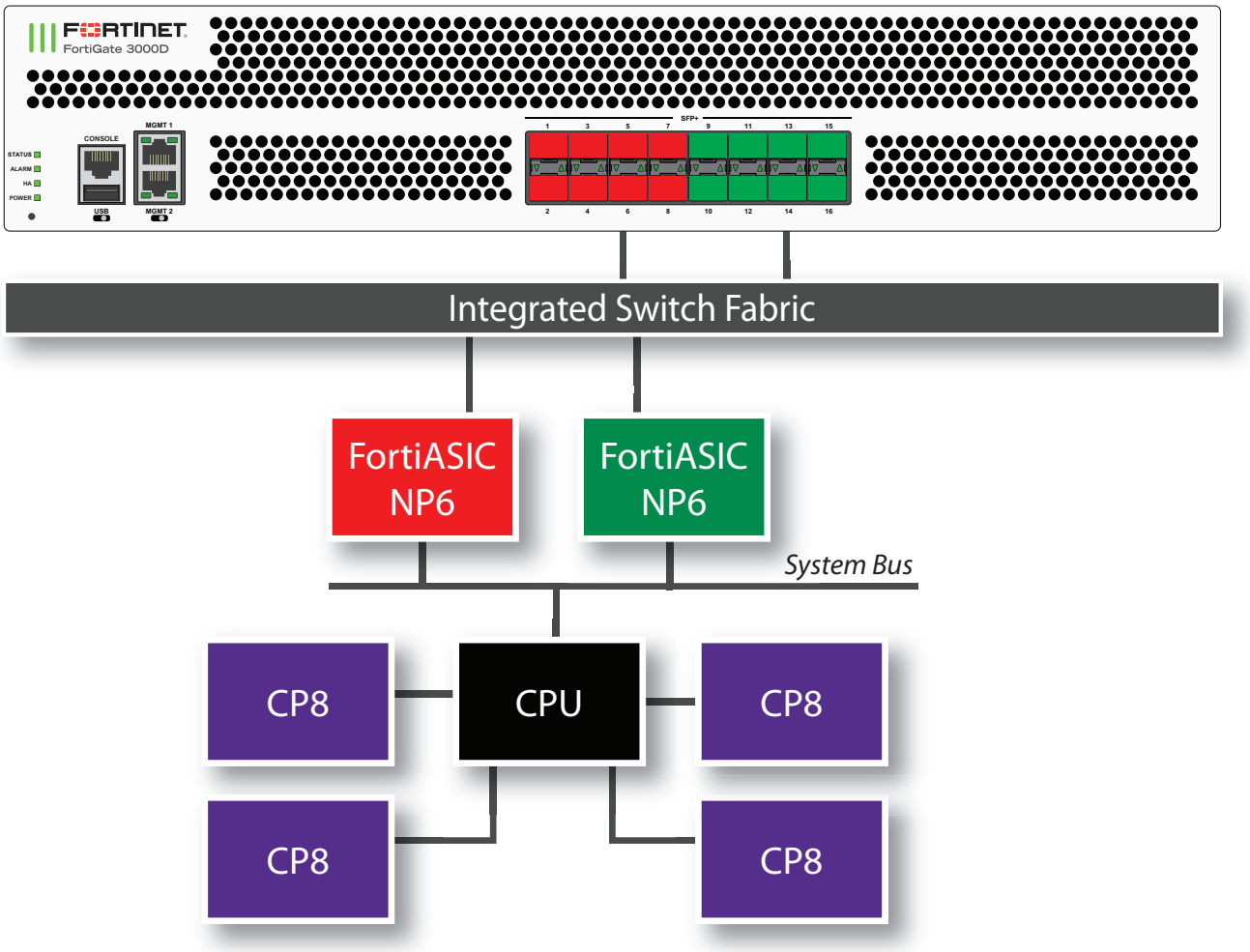
`bypass-watchdog` enable to turn on bypass mode. When bypass mode is turned on, if the bypass watchdog detects a software or hardware failure, bypass mode will be activated.

`poweroff-bypass` if enabled, traffic will be able to pass between the port43 and port44 interfaces if the FortiGate 2500E is powered off.

FortiGate 3000D fast path architecture

The FortiGate 3000D features 16 front panel SFP+ 10Gb interfaces connected to two NP6 processors through an Integrated Switch Fabric (ISF). The FortiGate 3000D has the following fastpath architecture:

- 8 SFP+ 10Gb interfaces, port1 through port8 share connections to the first NP6 processor (np6_0).
- 8 SFP+ 10Gb interfaces, port9 through port16 share connections to the second NP6 processor (np6_1).



You can use the following get command to display the FortiGate 3000D NP6 configuration. The command output shows two NP6s named NP6_0 and NP6_1 and the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

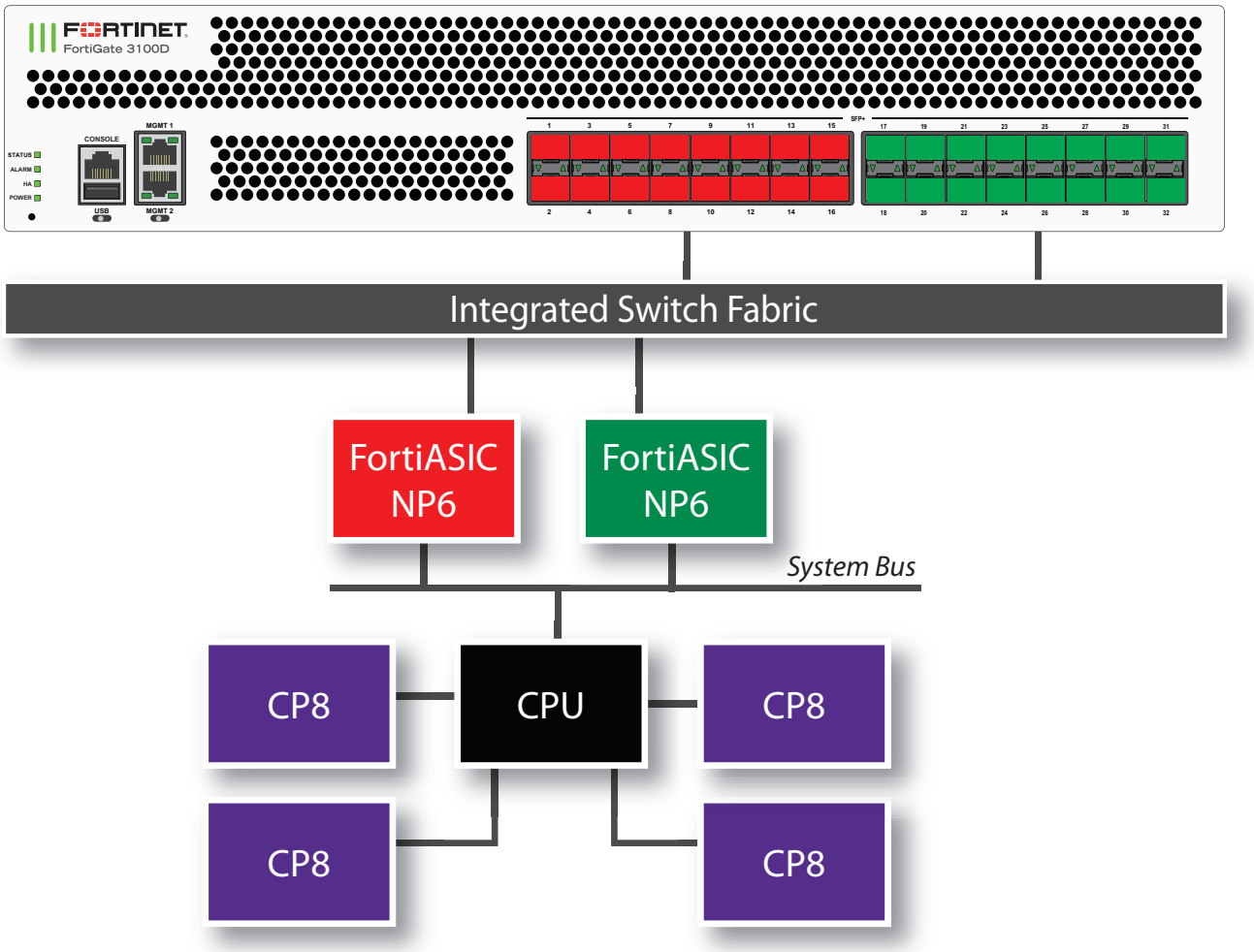
```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                    Speed offloading
------ ---- ------- ----- ----------
np6_0  0    port1   10G   Yes
       0    port6   10G   Yes
       1    port2   10G   Yes
       1    port5   10G   Yes
       2    port3   10G   Yes
       2    port8   10G   Yes
       3    port4   10G   Yes
       3    port7   10G   Yes
------ ---- ------- ----- ----------
np6_1  0    port10  10G   Yes
       0    port13  10G   Yes
       1    port9   10G   Yes
       1    port14  10G   Yes
       2    port12  10G   Yes
```

```
        2    port15  10G   Yes
        3    port11  10G   Yes
        3    port16  10G   Yes
------ ---- ------- ----- ----------
```

FortiGate 3100D fast path architecture

The FortiGate 3100D features 32 SFP+ 10Gb interfaces connected to two NP6 processors through an Integrated Switch Fabric (ISF). The FortiGate 3100D has the following fastpath architecture:

- 16 SFP+ 10Gb interfaces, port1 through port16 share connections to the first NP6 processor (np6_0).
- 16 SFP+ 10Gb interfaces, port27 through port32 share connections to the second NP6 processor (np6_1).



You can use the following get command to display the FortiGate 3100D NP6 configuration. The command output shows two NP6s named NP6_0 and NP6_1 and the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

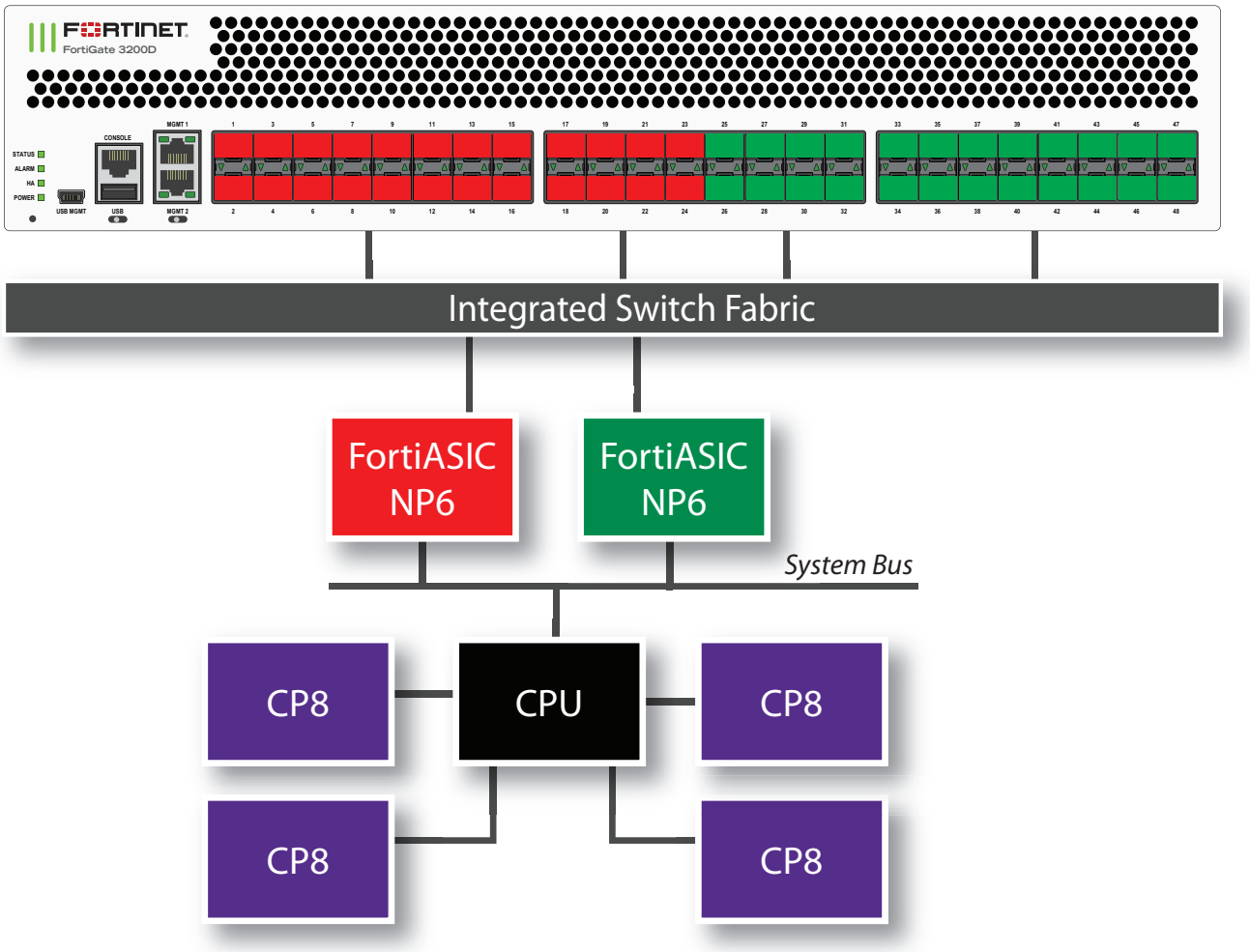
```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
```

```
                    Speed offloading
------ ---- ------- ----- ----------
np6_0  0    port1   10G   Yes
       0    port6   10G   Yes
       0    port10  10G   Yes
       0    port13  10G   Yes
       1    port2   10G   Yes
       1    port5   10G   Yes
       1    port9   10G   Yes
       1    port14  10G   Yes
       2    port3   10G   Yes
       2    port8   10G   Yes
       2    port12  10G   Yes
       2    port15  10G   Yes
       3    port4   10G   Yes
       3    port7   10G   Yes
       3    port11  10G   Yes
       3    port16  10G   Yes
------ ---- ------- ----- ----------
np6_1  0    port17  10G   Yes
       0    port21  10G   Yes
       0    port25  10G   Yes
       0    port29  10G   Yes
       1    port18  10G   Yes
       1    port22  10G   Yes
       1    port26  10G   Yes
       1    port30  10G   Yes
       2    port19  10G   Yes
       2    port23  10G   Yes
       2    port27  10G   Yes
       2    port31  10G   Yes
       3    port20  10G   Yes
       3    port24  10G   Yes
       3    port28  10G   Yes
       3    port32  10G   Yes
------ ---- ------- ----- ----------
```

FortiGate 3200D fast path architecture

The FortiGate 3200D features two NP6 processors connected to an Integrated Switch Fabric (ISF). The FortiGate 3200D has the following fastpath architecture:

- 24 SFP+ 10Gb interfaces, port1 through port24 share connections to the first NP6 processor (np6_0).
- 24 SFP+ 10Gb interfaces, port25 through port48 share connections to the second NP6 processor (np6_1).



You can use the following get command to display the FortiGate 3200D NP6 configuration. The command output shows two NP6s named NP6_0 and NP6_1 and the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

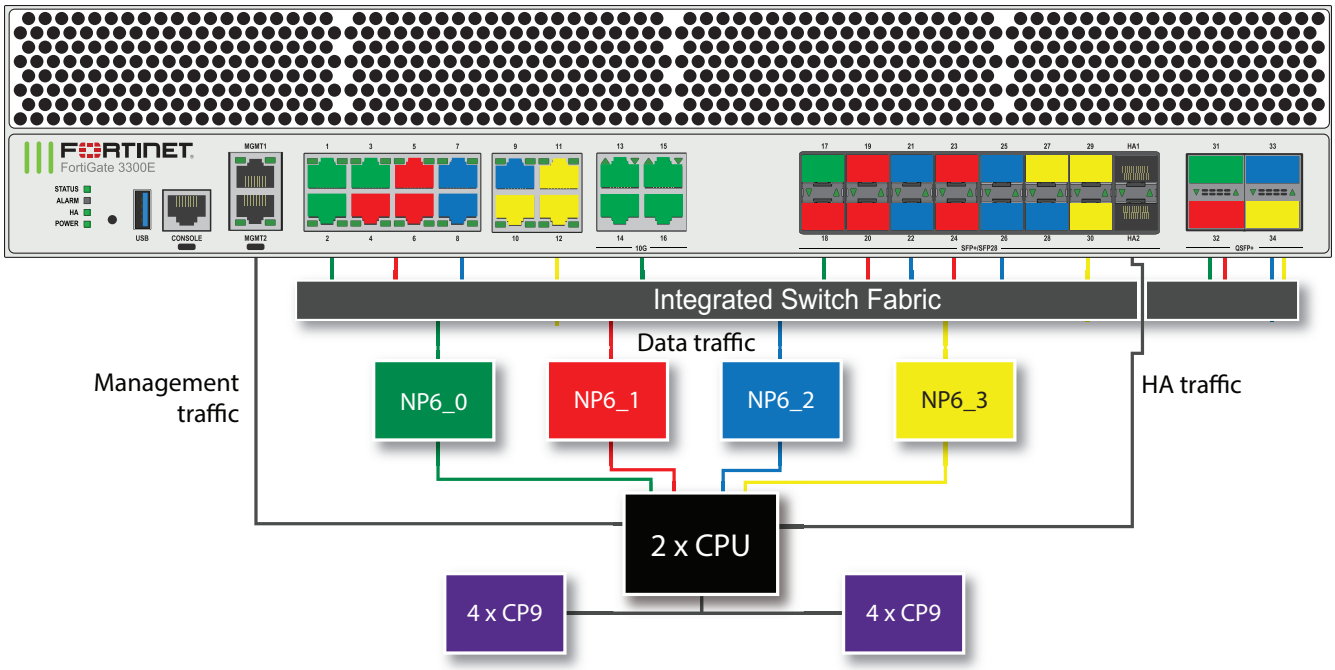
```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                    Speed offloading
------ ---- ------- ----- ----------
np6_0  0    port1   10G   Yes
       0    port5   10G   Yes
       0    port10  10G   Yes
       0    port13  10G   Yes
       0    port17  10G   Yes
       0    port22  10G   Yes
       1    port2   10G   Yes
       1    port6   10G   Yes
       1    port9   10G   Yes
       1    port14  10G   Yes
       1    port18  10G   Yes
       1    port21  10G   Yes
       2    port3   10G   Yes
       2    port7   10G   Yes
```

```
        2    port12  10G   Yes
        2    port15  10G   Yes
        2    port19  10G   Yes
        2    port24  10G   Yes
        3    port4   10G   Yes
        3    port8   10G   Yes
        3    port11  10G   Yes
        3    port16  10G   Yes
        3    port20  10G   Yes
        3    port23  10G   Yes
------ ---- ------- ----- ----------
np6_1  0    port26  10G   Yes
       0    port29  10G   Yes
       0    port33  10G   Yes
       0    port37  10G   Yes
       0    port41  10G   Yes
       0    port45  10G   Yes
       1    port25  10G   Yes
       1    port30  10G   Yes
       1    port34  10G   Yes
       1    port38  10G   Yes
       1    port42  10G   Yes
       1    port46  10G   Yes
       2    port28  10G   Yes
       2    port31  10G   Yes
       2    port35  10G   Yes
       2    port39  10G   Yes
       2    port43  10G   Yes
       2    port47  10G   Yes
       3    port27  10G   Yes
       3    port32  10G   Yes
       3    port36  10G   Yes
       3    port40  10G   Yes
       3    port44  10G   Yes
       3    port48  10G   Yes
------ ---- ------- ----- ----------
```

FortiGate 3300E and 3301E fast path architecture

The FortiGate 3300E and 3301E models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (MGMT1 and MGMT2).
- Twelve 10/100/1000BASE-T Copper (1 to 12).
- Four 1/10 GigE BASE-T Copper (13 to 16).
- Fourteen 10/25 GigE SFP+/SFP28 (17 to 30), interface groups: 17 - 20, 21 - 24, 25 - 28, 29-HA1, and 30 - HA2.
- Two 10/25 GigE SFP+/SFP28 (HA1 and HA2, not connected to the NP6 processors).
- Four 40 GigE QSFP+ (31 to 34).



The FortiGate 3300E and 3301E each include four NP6 processors. All front panel data interfaces and all of the NP6 processors connect to the integrated switch fabric (ISF). All data traffic passes from the data interfaces through the ISF to the NP6 processors. Because of the ISF, all supported traffic passing between any two data interfaces can be offloaded by the NP6 processors. Data traffic processed by the CPU takes a dedicated data path through the ISF and an NP6 processor to the CPU.

The MGMT interfaces are not connected to the NP6 processors. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. You can also dedicate separate CPU resources for management traffic to further isolate management processing from data processing (see Dedicated management CPU on page 27).

The HA interfaces are also not connected to the NP6 processors. To help provide better HA stability and resiliency, the HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing.

The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following command to display the FortiGate 3300E or 3301E NP6 configuration. The command output shows four NP6s named NP6_0, NP6_1, NP6_2, and NP6_3 and the interfaces (ports) connected to each NP6. This interface to NP6 mapping is also shown in the diagram above.

The command output also shows the XAUI configuration for each NP6 processor. Each NP6 processor has a 40-Gigabit bandwidth capacity. Traffic passes to each NP6 processor over four 10-Gigabit XAUI links. The XAUI links are numbered 0 to 3.

You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports            Max   Cross-chip
                             Speed offloading
------ ---- -------          ----- ----------
np6_0  0    port1            1G    Yes
```

```
        0    port14           10G   Yes
        1    port2            1G    Yes
        1    port15           10G   Yes
        2    port3            1G    Yes
        2    port16           10G   Yes
        3    port13           10G   Yes
        0-3  port17           25G   Yes
        0-3  port31           40G   Yes
------ ---- -------          ----- ----------
np6_1   0    port4            1G    Yes
        1    port5            1G    Yes
        2    port6            1G    Yes
        3
        0-3  port18           25G   Yes
        0-3  port19           25G   Yes
        0-3  port20           25G   Yes
        0-3  port24           25G   Yes
        0-3  port23           25G   Yes
        0-3  port32           40G   Yes
------ ---- -------          ----- ----------
np6_2   0    port7            1G    Yes
        1    port8            1G    Yes
        2    port9            1G    Yes
        3
        0-3  port22           25G   Yes
        0-3  port21           25G   Yes
        0-3  port26           25G   Yes
        0-3  port25           25G   Yes
        0-3  port28           25G   Yes
        0-3  port33           40G   Yes
------ ---- -------          ----- ----------
np6_3   0    port10           1G    Yes
        1    port11           1G    Yes
        2    port12           1G    Yes
        2    port29           10G   Yes
        3    port30           10G   Yes
        0-3  port27           25G   Yes
        0-3  port34           40G   Yes
------ ---- -------          ----- ----------
```

Distributing traffic evenly among the NP6 processors can optimize performance. For details, see Optimizing NP6 performance by distributing traffic to XAUI links on page 105.

You can also add LAGs to improve performance. For details, see Increasing NP6 offloading capacity using link aggregation groups (LAGs) on page 109.

Interface groups and changing data interface speeds

FortiGate-3300E and 3301E front panel data interfaces 17 to 30, HA1, and HA2 are divided into the following groups:

- port17 - port20
- port21 - port24
- port25 - port28
- port29 - ha1
- port30 - ha2

All of the interfaces in a group operate at the same speed. Changing the speed of an interface changes the speeds of all of the interfaces in the same group. For example, if you change the speed of port17 from 25Gbps to 10Gbps the speeds of port18 to port20 are also changed to 10Gbps.

Another example, port21 to port28 are operating at 25Gbps. If you want to install 10GigE transceivers in port21 to port28 to convert all of these data interfaces to connect to 10Gbps networks, you can enter the following from the CLI:

```
config system interface
   edit port21
      set speed 10000full
   next
   edit port25
      set speed 10000full
   end
```

Every time you change a data interface speed, when you enter the `end` command, the CLI confirms the range of interfaces affected by the change. For example, if you change the speed of port25 the following message appears:

```
config system interface
   edit port25
      set speed 10000full
   end
port25-port28 speed will be changed to 10000full due to hardware limit.
Do you want to continue? (y/n)
```

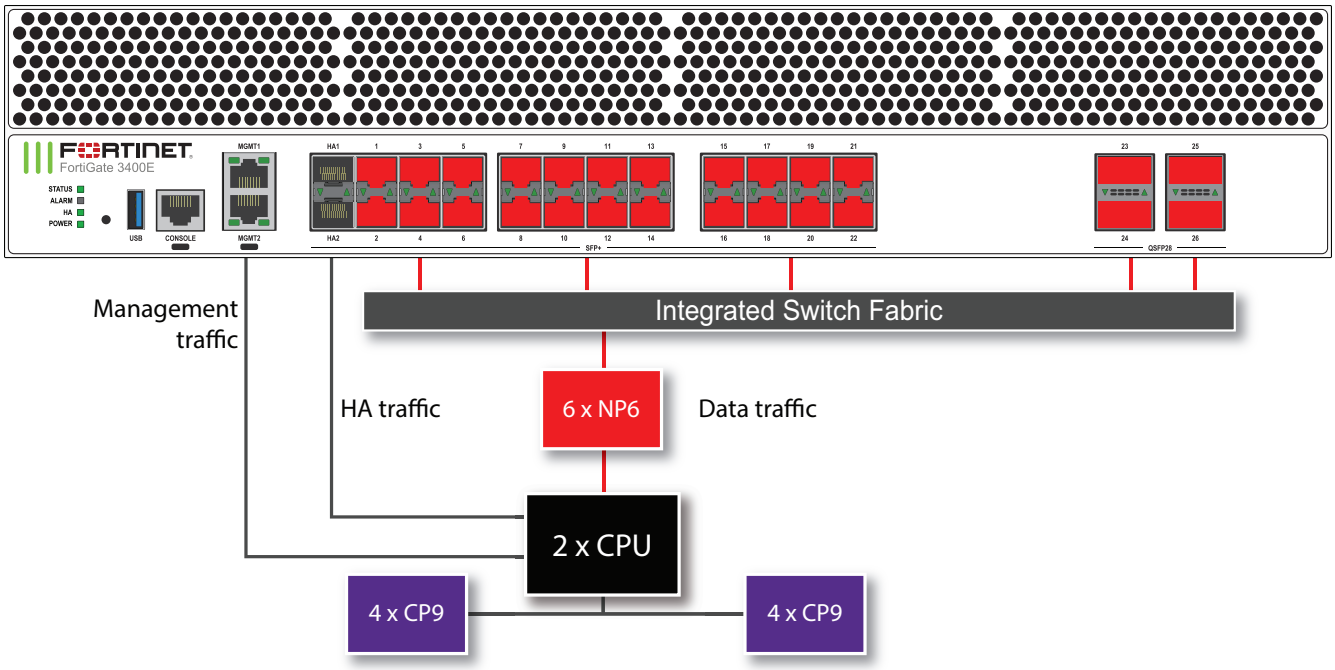
FortiGate 3400E and 3401E fast path architecture

The FortiGate 3400E and 3401E models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (MGMT1 and MGMT2).
- Two 10/25 GigE SFP+/SFP28 (HA1 and HA2, not connected to the NP6 processors).
- Twenty-two 10/25 GigE SFP+/SFP28 (1 to 22), interface groups: HA1 - HA2 - 1 - 2, 3 - 6, 7 - 10, 11 - 14, 15 - 18, and 19 - 22.
- Four 100 GigE QSFP28 (23 to 26).

The FortiGate-3400 and 3401 do not support auto-negotiation when setting interface speeds. Always set a specific interface speed. For example:

```
config system interface
   edit port23
      set speed {40000full | 100Gfull}
   end
```



The FortiGate 3400E and 3401E each include six NP6 processors (NP6_0 to NP6_5). All front panel data interfaces and all of the NP6 processors connect to the integrated switch fabric (ISF). All data traffic passes from the data interfaces through the ISF to the NP6 processors. Because of the ISF, all supported traffic passing between any two data interfaces can be offloaded by the NP6 processors. No special mapping is required for fast path offloading or aggregate interfaces. Data traffic processed by the CPU takes a dedicated data path through the ISF and an NP6 processor to the CPU.

The MGMT interfaces are not connected to the NP6 processors. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. You can also dedicate separate CPU resources for management traffic to further isolate management processing from data processing (see Dedicated management CPU on page 27).

The HA interfaces are also not connected to the NP6 processors. To help provide better HA stability and resiliency, the HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing.

The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following get command to display the FortiGate 3400E or 3401E NP6 configuration. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip                  XAUI Ports   Max      Cross-chip
                                   Speed    offloading
--------------------  ---- ------  -------  ----------
NP#0-5                0-3  port1   25000M   Yes
NP#0-5                0-3  port2   25000M   Yes
NP#0-5                0-3  port3   25000M   Yes
NP#0-5                0-3  port4   25000M   Yes
NP#0-5                0-3  port5   25000M   Yes
NP#0-5                0-3  port6   25000M   Yes
NP#0-5                0-3  port7   25000M   Yes
NP#0-5                0-3  port8   25000M   Yes
NP#0-5                0-3  port9   25000M   Yes
```

```
NP#0-5                0-3  port10  25000M  Yes
NP#0-5                0-3  port11  25000M  Yes
NP#0-5                0-3  port12  25000M  Yes
NP#0-5                0-3  port13  25000M  Yes
NP#0-5                0-3  port14  25000M  Yes
NP#0-5                0-3  port15  25000M  Yes
NP#0-5                0-3  port16  25000M  Yes
NP#0-5                0-3  port17  25000M  Yes
NP#0-5                0-3  port18  25000M  Yes
NP#0-5                0-3  port19  25000M  Yes
NP#0-5                0-3  port20  25000M  Yes
NP#0-5                0-3  port21  25000M  Yes
NP#0-5                0-3  port22  25000M  Yes
NP#0-5                0-3  port23  100000M Yes
NP#0-5                0-3  port24  100000M Yes
NP#0-5                0-3  port25  100000M Yes
NP#0-5                0-3  port26  100000M Yes
--------------------  ---- ------  ------- ----------
```

Interface groups and changing data interface speeds

FortiGate-3400E and 3401E front panel interfaces HA1, HA2, and 1 to 22 are divided into the following groups:

- ha1 - ha2 - port1 - port2
- port3 - port6
- port7 - port10
- port11 - port14
- port15 - port18
- port19 - port22

All of the interfaces in a group operate at the same speed. Changing the speed of an interface changes the speeds of all of the interfaces in the same group. For example, if you change the speed of port12 from 25Gbps to 10Gbps the speeds of port11 to port14 are also changed to 10Gbps.

Another example, port15 to port22 are operating at 25Gbps. If you want to install 10GigE transceivers in port15 to port22 to convert all of these data interfaces to connect to 10Gbps networks, you can enter the following from the CLI:

```
config system interface
   edit port15
      set speed 10000full
   next
   edit port19
      set speed 10000full
   end
```

Every time you change a data interface speed, when you enter the `end` command, the CLI confirms the range of interfaces affected by the change. For example, if you change the speed of port19 the following message appears:

```
config system interface
   edit port19
      set speed 10000full
   end
port19-port22 speed will be changed to 10000full due to hardware limit.
Do you want to continue? (y/n)
```

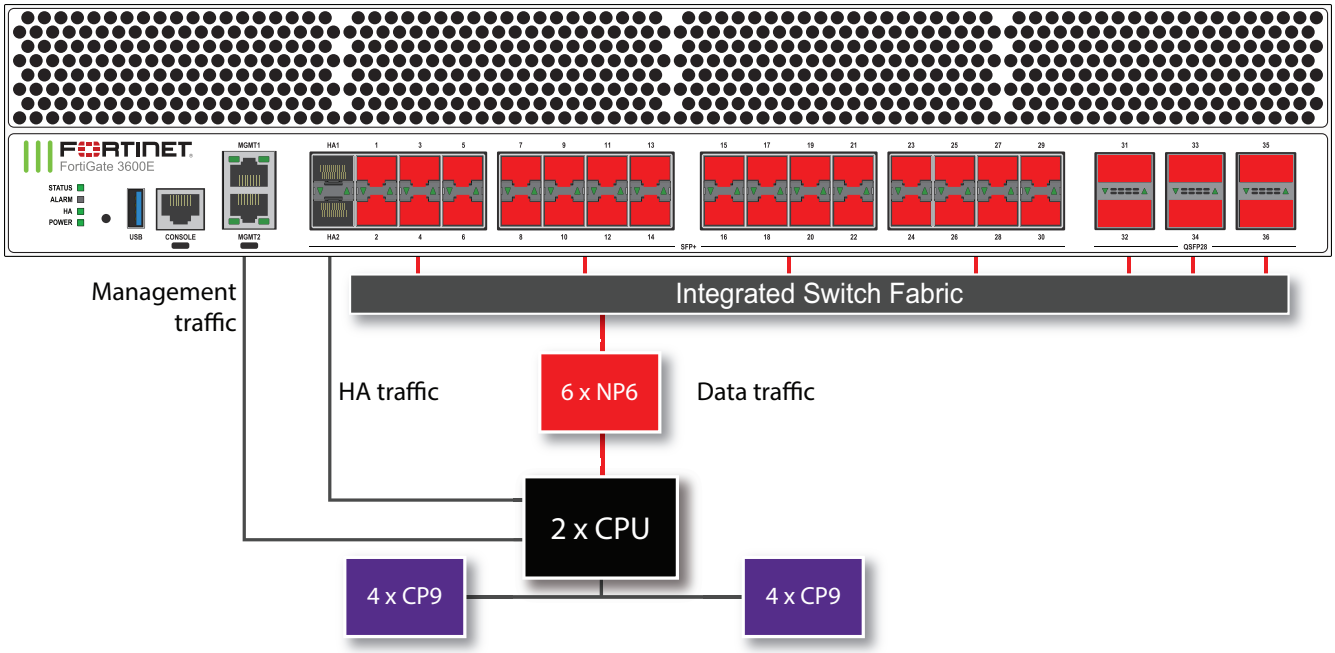
FortiGate 3600E and 3601E fast path architecture

The FortiGate 3600E and 3601E models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (MGMT1 and MGMT2)
- Two 10/25 GigE SFP+/SFP28 (HA1 and HA2, not connected to the NP6 processors)
- Thirty 10/25 GigE SFP+/SFP28 (1 to 30) interface groups: HA1 - HA2 - 1 - 2, 3 - 6, 7 - 10, 11 - 14, 15 - 18, 19 - 22, 23 - 26, and 27 - 30
- Six 100 GigE QSFP28 (31 to 36)

The FortiGate-3600 and 3601 do not support auto-negotiation when setting interface speeds. Always set a specific interface speed. For example:

```
config system interface
   edit port31
      set speed {40000full | 100Gfull}
   end
```



The FortiGate 3600E and 3601E each include six NP6 processors (NP6_0 to NP6_5). All front panel data interfaces and all of the NP6 processors connect to the integrated switch fabric (ISF). All data traffic passes from the data interfaces through the ISF to the NP6 processors. Because of the ISF, all supported traffic passing between any two data interfaces can be offloaded by the NP6 processors. No special mapping is required for fast path offloading or aggregate interfaces. Data traffic processed by the CPU takes a dedicated data path through the ISF and an NP6 processor to the CPU.

The MGMT interfaces are not connected to the NP6 processors. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. You can also dedicate separate CPU resources for management traffic to further isolate management processing from data processing (see Dedicated management CPU on page 27).

The HA interfaces are also not connected to the NP6 processors. To help provide better HA stability and resiliency, the HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing.

The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following command to display the FortiGate 3600E or 3601E NP6 configuration. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip                  XAUI Ports   Max      Cross-chip
                                   Speed    offloading
--------------------  ---- ------  -------- ----------
NP#0-5                0-3  port1   25000M   Yes
NP#0-5                0-3  port2   25000M   Yes
NP#0-5                0-3  port3   25000M   Yes
NP#0-5                0-3  port4   25000M   Yes
NP#0-5                0-3  port5   25000M   Yes
NP#0-5                0-3  port6   25000M   Yes
NP#0-5                0-3  port7   25000M   Yes
NP#0-5                0-3  port8   25000M   Yes
NP#0-5                0-3  port9   25000M   Yes
NP#0-5                0-3  port10  25000M   Yes
NP#0-5                0-3  port11  25000M   Yes
NP#0-5                0-3  port12  25000M   Yes
NP#0-5                0-3  port13  25000M   Yes
NP#0-5                0-3  port14  25000M   Yes
NP#0-5                0-3  port15  25000M   Yes
NP#0-5                0-3  port16  25000M   Yes
NP#0-5                0-3  port17  25000M   Yes
NP#0-5                0-3  port18  25000M   Yes
NP#0-5                0-3  port19  25000M   Yes
NP#0-5                0-3  port20  25000M   Yes
NP#0-5                0-3  port21  25000M   Yes
NP#0-5                0-3  port22  25000M   Yes
NP#0-5                0-3  port23  25000M   Yes
NP#0-5                0-3  port24  25000M   Yes
NP#0-5                0-3  port25  25000M   Yes
NP#0-5                0-3  port26  25000M   Yes
NP#0-5                0-3  port27  25000M   Yes
NP#0-5                0-3  port28  25000M   Yes
NP#0-5                0-3  port29  25000M   Yes
NP#0-5                0-3  port30  25000M   Yes
NP#0-5                0-3  port31  100000M  Yes
NP#0-5                0-3  port32  100000M  Yes
NP#0-5                0-3  port33  100000M  Yes
NP#0-5                0-3  port34  100000M  Yes
NP#0-5                0-3  port35  100000M  Yes
NP#0-5                0-3  port36  100000M  Yes
--------------------  ---- ------  -------- ----------
```

Interface groups and changing data interface speeds

FortiGate-3600E and 3601E front panel interfaces HA1, HA2, and 1 to 30 are divided into the following groups:

- ha1 - ha2 - port1 - port2
- port3 - port6
- port7 - port10
- port11 - port14
- port15 - port18
- port19 - port22
- port23 - port26
- port27 - port30

All of the interfaces in a group operate at the same speed. Changing the speed of an interface changes the speeds of all of the interfaces in the same group. For example, if you change the speed of port12 from 25Gbps to 10Gbps the speeds of port11 to port14 are also changed to 10Gbps.

Another example, port15 to port22 are operating at 25Gbps. If you want to install 10GigE transceivers in port15 to port22 to convert all of these data interfaces to connect to 10Gbps networks, you can enter the following from the CLI:

```
config system interface
   edit port15
      set speed 10000full
   next
   edit port19
      set speed 10000full
   end
```

Every time you change a data interface speed, when you enter the `end` command, the CLI confirms the range of interfaces affected by the change. For example, if you change the speed of port7 the following message appears:

```
config system interface
   edit port7
      set speed 10000full
   end
port7-port10 speed will be changed to 10000full due to hardware limit.
Do you want to continue? (y/n)
```

FortiGate 3700D fast path architecture

The FortiGate 3700D features four NP6 processors.The first two NP6 processors (np6_0 and np6_1) can be configured for low latency operation. The low latency configuration changes the FortiGate 3700D fast path architecture.

FortiGate 3700D low latency fast path architecture

Ports 25 to 32 can be used for low latency offloading. As long as traffic enters and exits the FortiGate 3700D through ports connected to the same NP6 processor and using these low latency ports the traffic will be offloaded and have lower latency that other NP6 offloaded traffic. Latency is reduced by bypassing the integrated switch fabric (ISF).

You can use the following command to turn on low latency mode for np6_0 and np6_1:

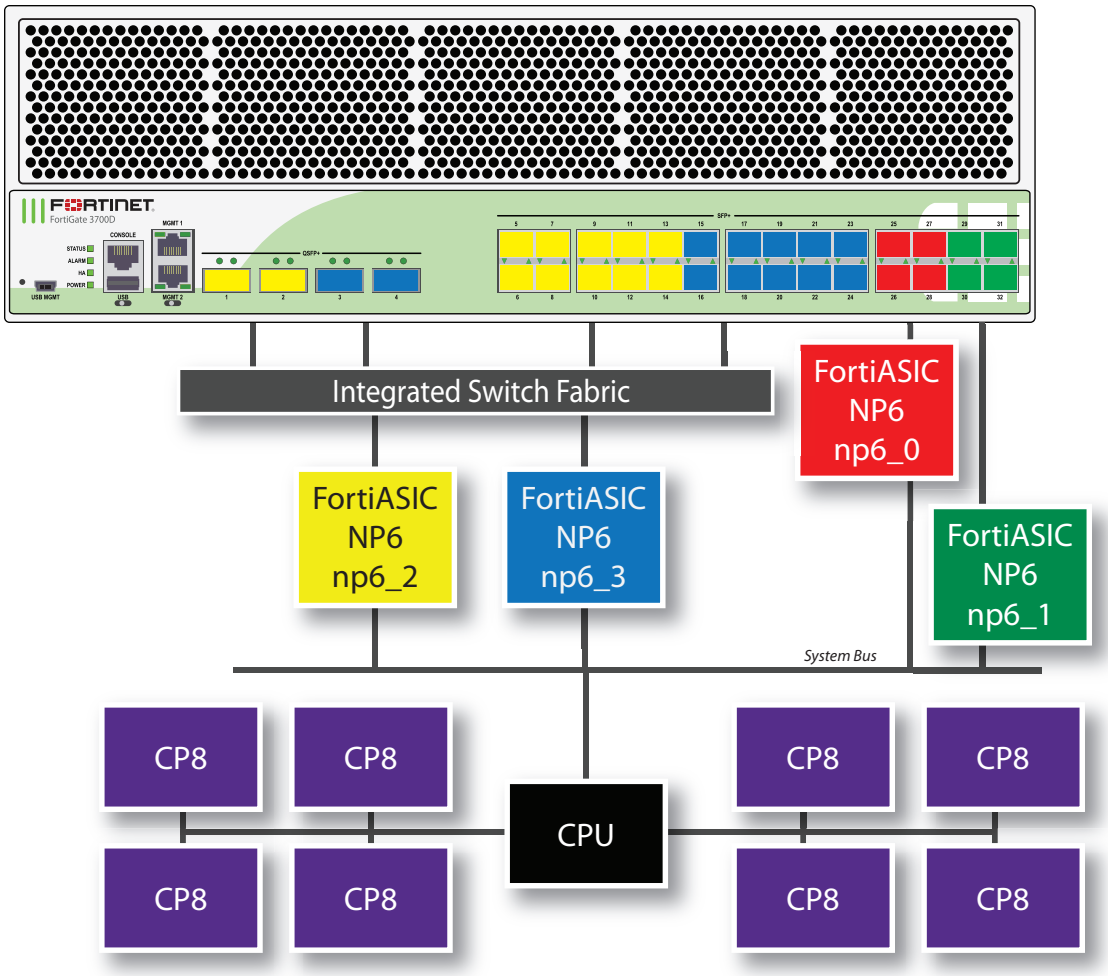
```
config system np6
   edit np6_0
      set low-latency-mode enable
   next
   edit np6_1
```

```
    set low-latency-mode enable
end
```

You do not have to turn on low latency to both np6_0 and np6_1. If you turn on low latency for just one NP6, the other NP6 will still be mapped according to the normal latency configuration.

With low latency enabled for both np6_0 and np6_1 the FortiGate 3700D has the following fastpath architecture:

- Four SFP+ 10Gb interfaces, port25 to port28, share connections to the first NP6 processor (np6_0) so sessions entering one of these ports and exiting through another will experience low latency
- Four SFP+ 10Gb interfaces, port29 to port32, share connections to the second NP6 processor (np6_1) so sessions entering one of these ports and exiting through another will experience low latency
- Ten SFP+ 10Gb interfaces, port5 to port14, and two 40Gb QSFP interfaces, port1 and port2, share connections to the third NP6 processor (np6_2).
- Ten SFP+ 10Gb interfaces, port15 to port24, and two 40Gb QSFP interfaces, port3 and port4, share connections to the fourth NP6 processor (np6_3).



You can use the following get command to display the FortiGate 3700D NP6 configuration. In this output example, the first two NP6s (np6_0 and np6_1) are configured for low latency. The command output shows four NP6s named NP6_0,

NP6_1, NP6_2, and NP6_3 and the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports   Max   Cross-chip
                    Speed offloading
------ ---- ------- ----- ----------
np6_2  0    port5   10G   Yes
       0    port9   10G   Yes
       0    port13  10G   Yes
       1    port6   10G   Yes
       1    port10  10G   Yes
       1    port14  10G   Yes
       2    port7   10G   Yes
       2    port11  10G   Yes
       3    port8   10G   Yes
       3    port12  10G   Yes
       0-3  port1   40G   Yes
       0-3  port2   40G   Yes
------ ---- ------- ----- ----------
np6_3  0    port15  10G   Yes
       0    port19  10G   Yes
       0    port23  10G   Yes
       1    port16  10G   Yes
       1    port20  10G   Yes
       1    port24  10G   Yes
       2    port17  10G   Yes
       2    port21  10G   Yes
       3    port18  10G   Yes
       3    port22  10G   Yes
       0-3  port3   40G   Yes
       0-3  port4   40G   Yes
------ ---- ------- ----- ----------
np6_0  0    port26  10G   No
       1    port25  10G   No
       2    port28  10G   No
       3    port27  10G   No
------ ---- ------- ----- ----------
np6_1  0    port30  10G   No
       1    port29  10G   No
       2    port32  10G   No
       3    port31  10G   No
------ ---- ------- ----- ----------
```

FortiGate 3700D normal latency fast path architecture

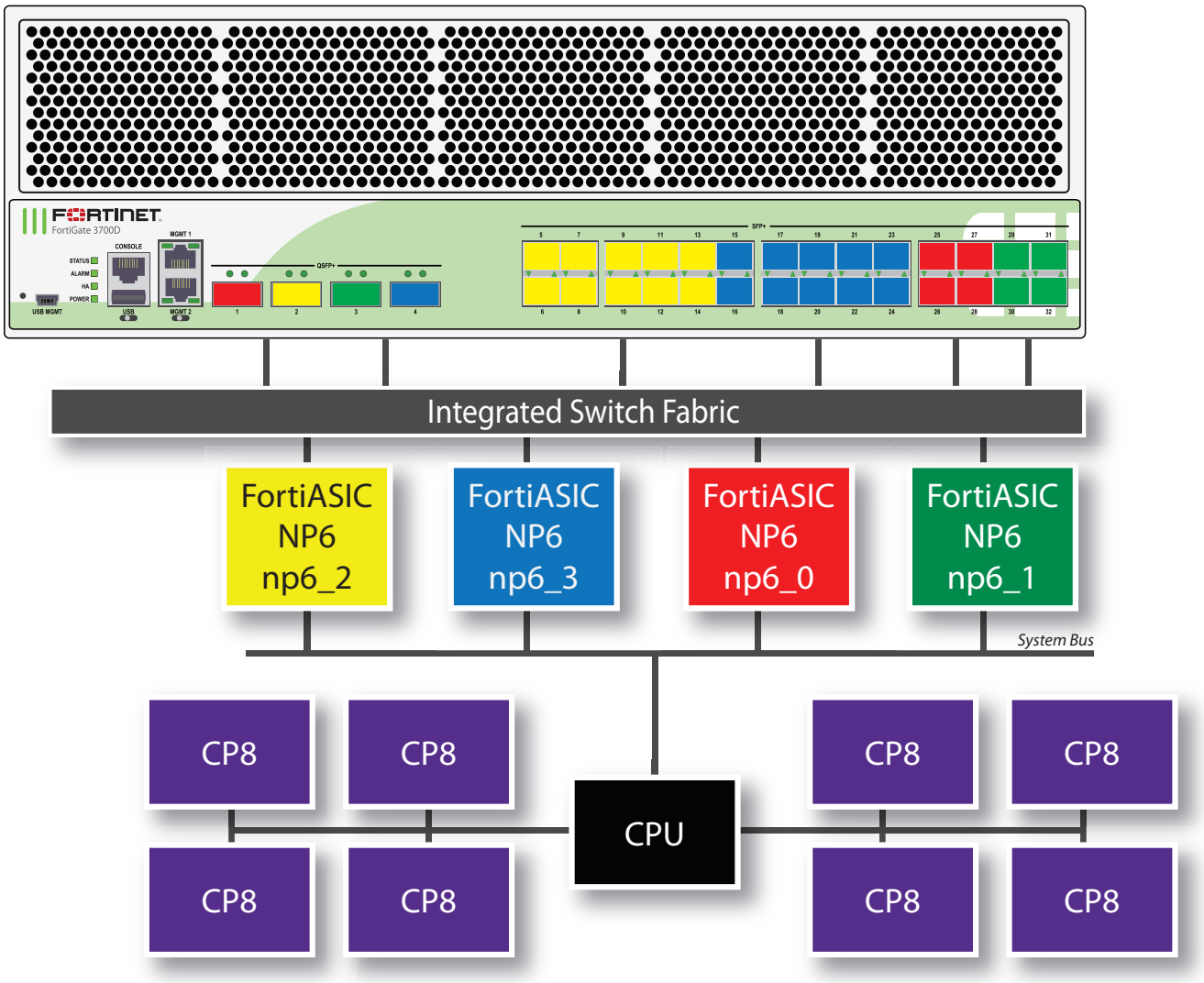
You can use the following command to turn off low latency mode for np6_0 and np6_1:

```
config system np6
   edit np6_0
      set low-latency-mode disable
   next
   edit np6_1
      set low-latency-mode disable
   end
```

You do not have to turn off low latency to both np6_0 and np6_1. If you turn off low latency to just one NP6, the other NP6 will still be mapped according to the normal configuration.

In addition to turning off low latency, entering these commands also changes how ports are mapped to NP6s. Port1 is now mapped to np6_0 and port 3 is not mapped to np6_1. The FortiGate 3700D has the following fastpath architecture:

- One 40Gb QSFP interface, port1, and four SFP+ 10Gb interfaces, port25 to port28 share connections to the first NP6 processor (np6_0).
- One 40Gb QSFP interface, port3, and four SFP+ 10Gb interfaces, port29 to port32 share connections to the second NP6 processor (np6_1).
- One 40Gb QSFP interface, port2 and ten SFP+ 10Gb interfaces, port5 to port14 share connections to the third NP6 processor (np6_2).
- One 40Gb QSFP interface, port4, and ten SFP+ 10Gb interfaces, port15 to port24 share connections to the fourth NP6 processor (np6_3).



You can use the following get command to display the FortiGate 3700D NP6 configuration with low latency turned off for np6_0 and np6_1. The command output shows four NP6s named NP6_0, NP6_1, NP6_2, and NP6_3 and the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports            Max   Cross-chip
                             Speed offloading
------ ---- -------          ----- ----------
np6_0  0    port26           10G   Yes
       1    port25           10G   Yes
       2    port28           10G   Yes
       3    port27           10G   Yes
       0-3  port1            40G   Yes
------ ---- -------          ----- ----------
np6_1  0    port30           10G   Yes
       1    port29           10G   Yes
       2    port32           10G   Yes
       3    port31           10G   Yes
       0-3  port3            40G   Yes
------ ---- -------          ----- ----------
np6_2  0    port5            10G   Yes
       0    port9            10G   Yes
       0    port13           10G   Yes
       1    port6            10G   Yes
       1    port10           10G   Yes
       1    port14           10G   Yes
       2    port7            10G   Yes
       2    port11           10G   Yes
       3    port8            10G   Yes
       3    port12           10G   Yes
       0-3  port2            40G   Yes
------ ---- -------          ----- ----------
np6_3  0    port15           10G   Yes
       0    port19           10G   Yes
       0    port23           10G   Yes
       1    port16           10G   Yes
       1    port20           10G   Yes
       1    port24           10G   Yes
       2    port17           10G   Yes
       2    port21           10G   Yes
       3    port18           10G   Yes
       3    port22           10G   Yes
       0-3  port4            40G   Yes
------ ---- -------          ----- ----------
```

FortiGate 3700DX fast path architecture

The FortiGate 3700DX features four NP6 processors.The first two NP6 processors (np6_0 and np6_1) can be configured for low latency operation. The low latency configuration changes the FortiGate 3700D fast path architecture. The FortiGate 3700DX also includes two TP2 cards that offload GTPu sessions.

FortiGate 3700DX low latency fast path architecture

Ports 25 to 32 can be used for low latency offloading. As long as traffic enters and exits the FortiGate 3700D through ports connected to the same NP6 processor and using these low latency ports the traffic will be offloaded and have lower latency that other NP6 offloaded traffic. Latency is reduced by bypassing the integrated switch fabric (ISF).

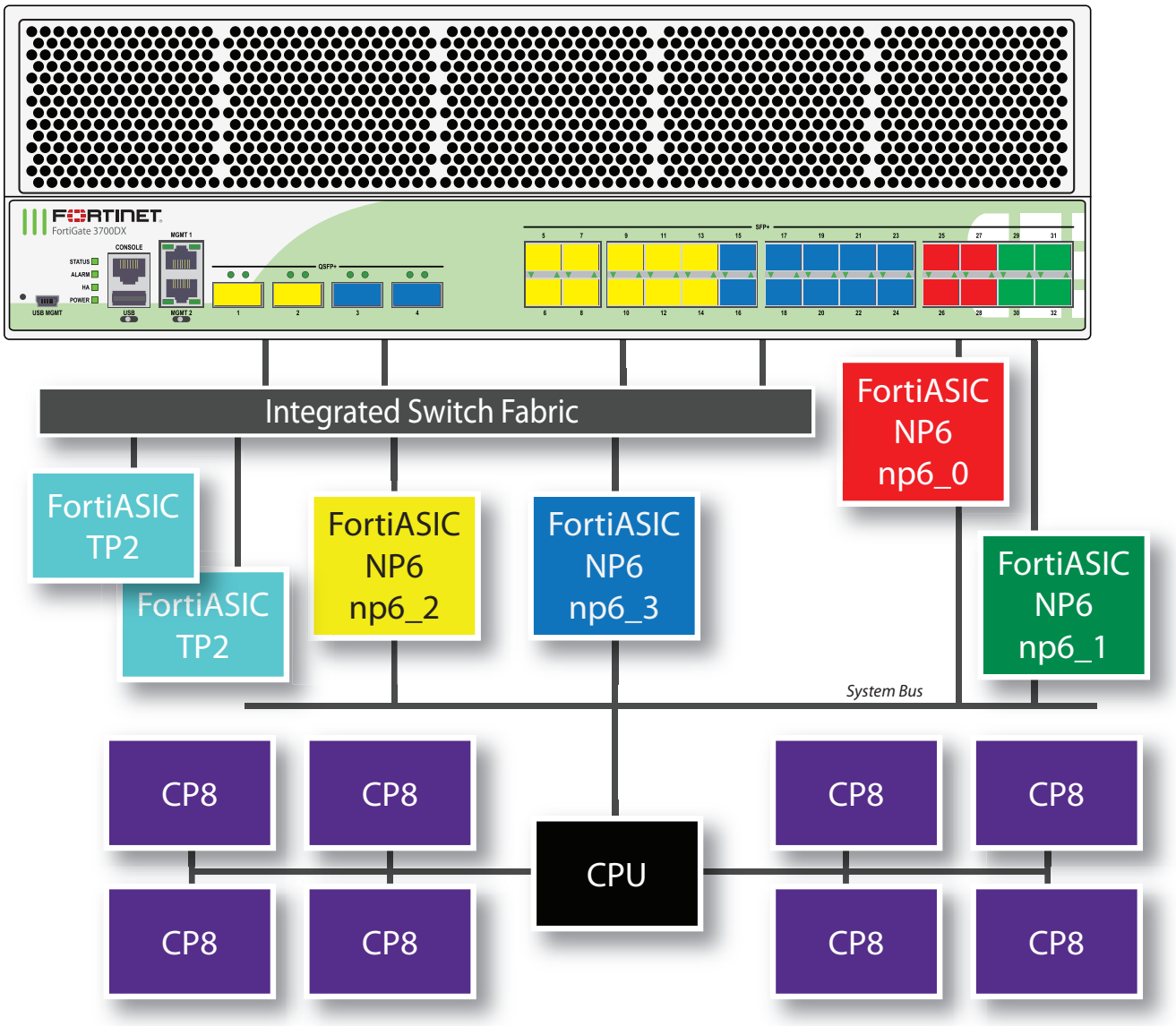
You can use the following command to turn on low latency mode for np6_0 and np6_1:

```
config system np6
   edit np6_0
      set low-latency-mode enable
   next
   edit np6_1
      set low-latency-mode enable
   end
```

You do not have to turn on low latency to both np6_0 and np6_1. If you turn on low latency for just one NP6, the other NP6 will still be mapped according to the normal latency configuration.

With low latency enabled for both np6_0 and np6_1 the FortiGate 3700D has the following fastpath architecture:

- Four SFP+ 10Gb interfaces, port25 to port28, share connections to the first NP6 processor (np6_0) so sessions entering one of these ports and exiting through another will experience low latency
- Four SFP+ 10Gb interfaces, port29 to port32, share connections to the second NP6 processor (np6_1) so sessions entering one of these ports and exiting through another will experience low latency
- Ten SFP+ 10Gb interfaces, port5 to port14, and two 40Gb QSFP interfaces, port1 and port2, share connections to the third NP6 processor (np6_2).
- Ten SFP+ 10Gb interfaces, port15 to port24, and two 40Gb QSFP interfaces, port3 and port4, share connections to the fourth NP6 processor (np6_3).



You can use the following get command to display the FortiGate 3700D NP6 configuration. In this output example, the first two NP6s (np6_0 and np6_1) are configured for low latency. The command output shows four NP6s named NP6_0, NP6_1, NP6_2, and NP6_3 and the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip    XAUI Ports    Max    Cross-chip
                      Speed  offloading
------  ---- -------  -----  ----------
np6_2   0    port5    10G    Yes
        0    port9    10G    Yes
        0    port13   10G    Yes
        1    port6    10G    Yes
        1    port10   10G    Yes
        1    port14   10G    Yes
        2    port7    10G    Yes
        2    port11   10G    Yes
```

```
        3    port8   10G   Yes
        3    port12  10G   Yes
        0-3  port1   40G   Yes
        0-3  port2   40G   Yes
------ ---- ------- ----- ----------
np6_3   0    port15  10G   Yes
        0    port19  10G   Yes
        0    port23  10G   Yes
        1    port16  10G   Yes
        1    port20  10G   Yes
        1    port24  10G   Yes
        2    port17  10G   Yes
        2    port21  10G   Yes
        3    port18  10G   Yes
        3    port22  10G   Yes
        0-3  port3   40G   Yes
        0-3  port4   40G   Yes
------ ---- ------- ----- ----------
np6_0   0    port26  10G   No
        1    port25  10G   No
        2    port28  10G   No
        3    port27  10G   No
------ ---- ------- ----- ----------
np6_1   0    port30  10G   No
        1    port29  10G   No
        2    port32  10G   No
        3    port31  10G   No
------ ---- ------- ----- ----------
```

FortiGate 3700D normal latency fast path architecture

You can use the following command to turn off low latency mode for np6_0 and np6_1:

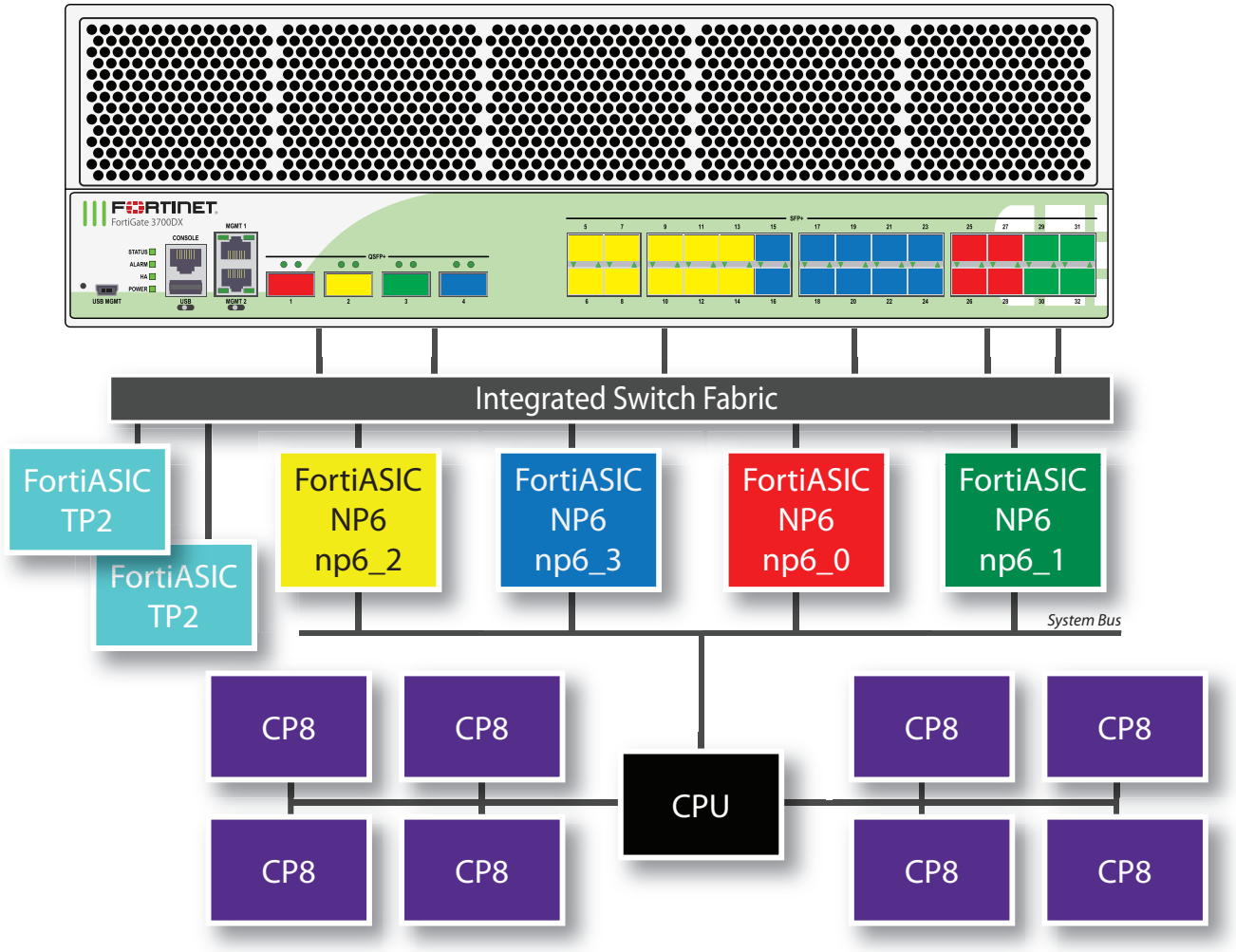
```
config system np6
   edit np6_0
      set low-latency-mode disable
   next
   edit np6_1
      set low-latency-mode disable
   end
```

You do not have to turn off low latency to both np6_0 and np6_1. If you turn off low latency to just one NP6, the other NP6 will still be mapped according to the normal configuration.

In addition to turning off low latency, entering these commands also changes how ports are mapped to NP6s. Port1 is now mapped to np6_0 and port 3 is not mapped to np6_1. The FortiGate 3700D has the following fastpath architecture:

- One 40Gb QSFP interface, port1, and four SFP+ 10Gb interfaces, port25 to port28 share connections to the first NP6 processor (np6_0).
- One 40Gb QSFP interface, port3, and four SFP+ 10Gb interfaces, port29 to port32 share connections to the second NP6 processor (np6_1).
- One 40Gb QSFP interface, port2 and ten SFP+ 10Gb interfaces, port5 to port14 share connections to the third NP6 processor (np6_2).

- One 40Gb QSFP interface, port4, and ten SFP+ 10Gb interfaces, port15 to port24 share connections to the fourth NP6 processor (np6_3).



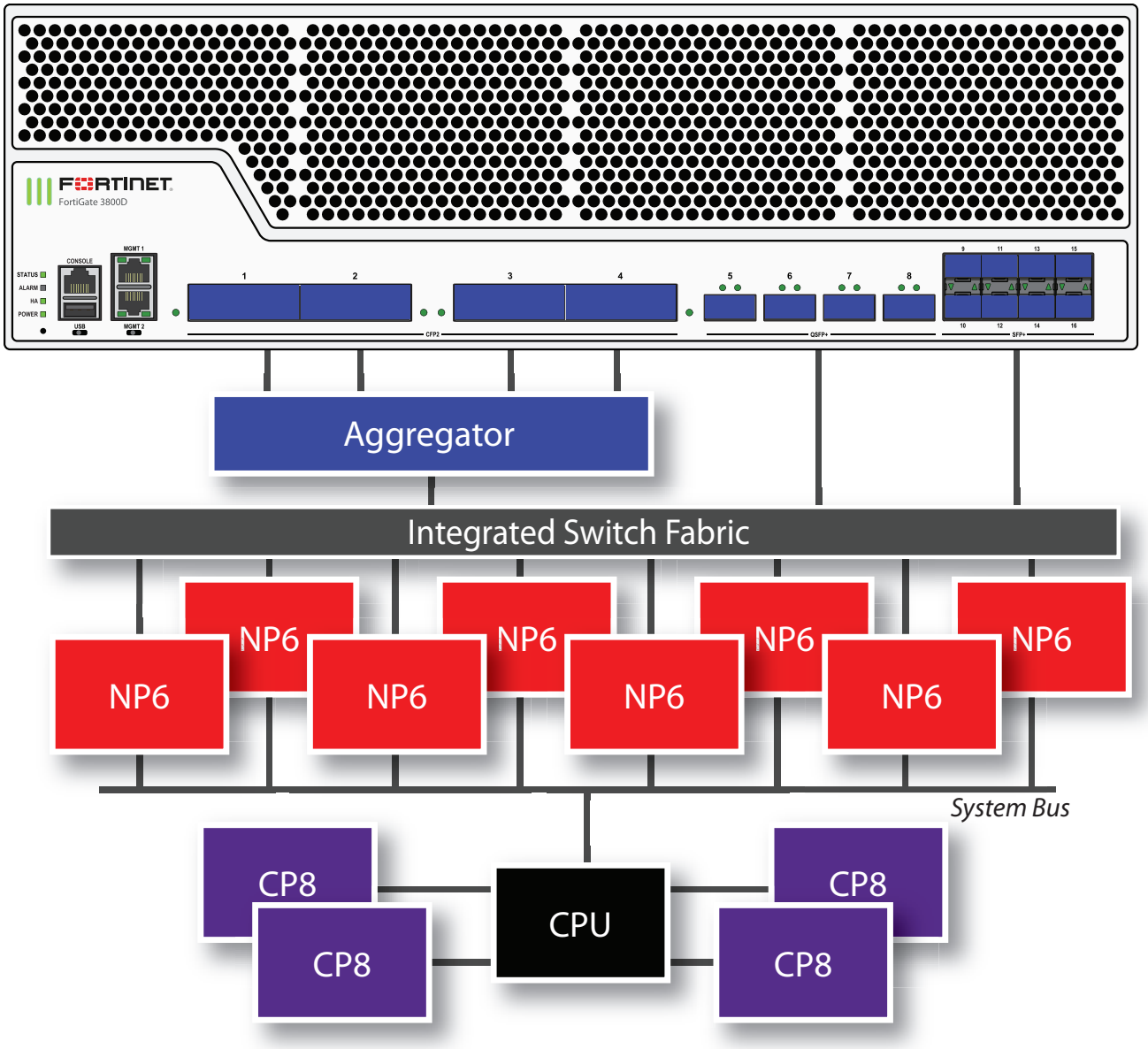
You can use the following get command to display the FortiGate 3700D NP6 configuration with low latency turned off for np6_0 and np6_1. The command output shows four NP6s named NP6_0, NP6_1, NP6_2, and NP6_3 and the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports            Max   Cross-chip
                             Speed offloading
------ ---- -------          ----- ----------
np6_0  0    port26           10G   Yes
       1    port25           10G   Yes
       2    port28           10G   Yes
       3    port27           10G   Yes
       0-3  port1            40G   Yes
------ ---- -------          ----- ----------
np6_1  0    port30           10G   Yes
       1    port29           10G   Yes
       2    port32           10G   Yes
       3    port31           10G   Yes
```

```
        0-3  port3            40G   Yes
------ ---- -------          ----- ----------
np6_2   0    port5            10G   Yes
        0    port9            10G   Yes
        0    port13           10G   Yes
        1    port6            10G   Yes
        1    port10           10G   Yes
        1    port14           10G   Yes
        2    port7            10G   Yes
        2    port11           10G   Yes
        3    port8            10G   Yes
        3    port12           10G   Yes
        0-3  port2            40G   Yes
------ ---- -------          ----- ----------
np6_3   0    port15           10G   Yes
        0    port19           10G   Yes
        0    port23           10G   Yes
        1    port16           10G   Yes
        1    port20           10G   Yes
        1    port24           10G   Yes
        2    port17           10G   Yes
        2    port21           10G   Yes
        3    port18           10G   Yes
        3    port22           10G   Yes
        0-3  port4            40G   Yes
------ ---- -------          ----- ----------
```

FortiGate 3800D fast path architecture

The FortiGate 3800D features four front panel 100GigE CFP2 interfaces, four 40GigE QSFP+ interfaces, and eight 10GigE SFP+ interfaces connected to eight NP6 processors through an Integrated Switch Fabric (ISF). Individual interfaces are not mapped to NP6 processors because of the integrated switch fabric. No special mapping is required for fastpath offloading or aggregate interfaces.



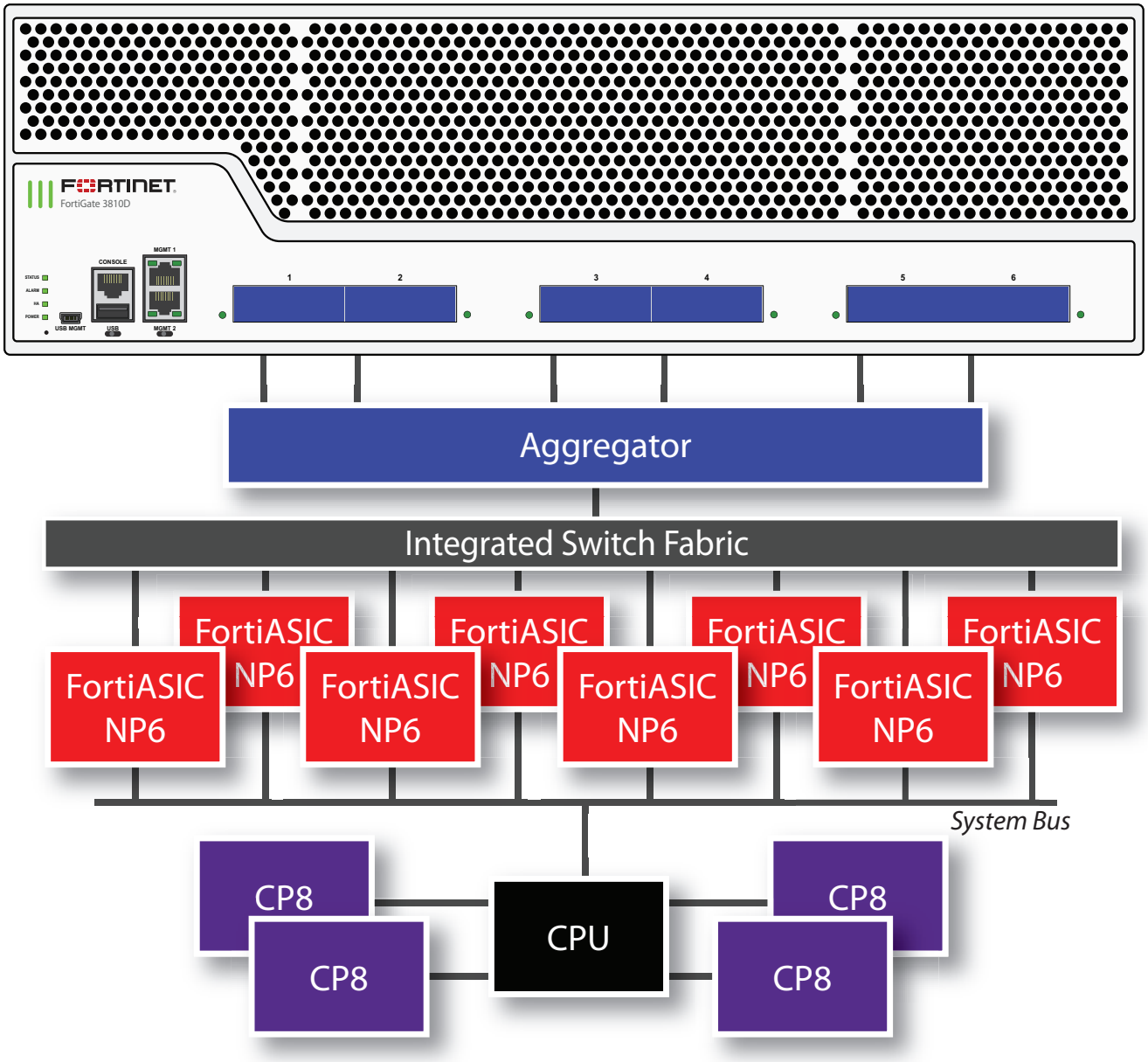
You can use the following get command to display the FortiGate 3800D NP6 configuration. The command output shows all NP6s connected to each interface (port) with cross-chip offloading supported for each port. You can also use the `diagnose npu np6 port-list` command to display this information.

```
Chip                XAUI  Ports    Max      Cross-chip
                                   Speed    offloading
------              ----  -------  ------   ----------
NP#0-7              0-3   port1    100000M  Yes
NP#0-7              0-3   port2    100000M  Yes
NP#0-7              0-3   port3    100000M  Yes
NP#0-7              0-3   port4    100000M  Yes
NP#0-7              0-3   port5    40000M   Yes
NP#0-7              0-3   port6    40000M   Yes
NP#0-7              0-3   port7    40000M   Yes
NP#0-7              0-3   port8    40000M   Yes
NP#0-7              0-3   port9    10000M   Yes
```

```
NP#0-7              0-3  port10  10000M  Yes
NP#0-7              0-3  port11  10000M  Yes
NP#0-7              0-3  port12  10000M  Yes
NP#0-7              0-3  port13  10000M  Yes
NP#0-7              0-3  port14  10000M  Yes
NP#0-7              0-3  port15  10000M  Yes
NP#0-7              0-3  port16  10000M  Yes
------              ---- ------- ------  ----------
```

FortiGate 3810D fast path architecture

The FortiGate 3810D features six front panel 100GigE CFP2 interfaces connected to eight NP6 processors through an Integrated Switch Fabric (ISF). Individual interfaces are not mapped to NP6 processors because of the integrated switch fabric. No special mapping is required for fastpath offloading or aggregate interfaces.

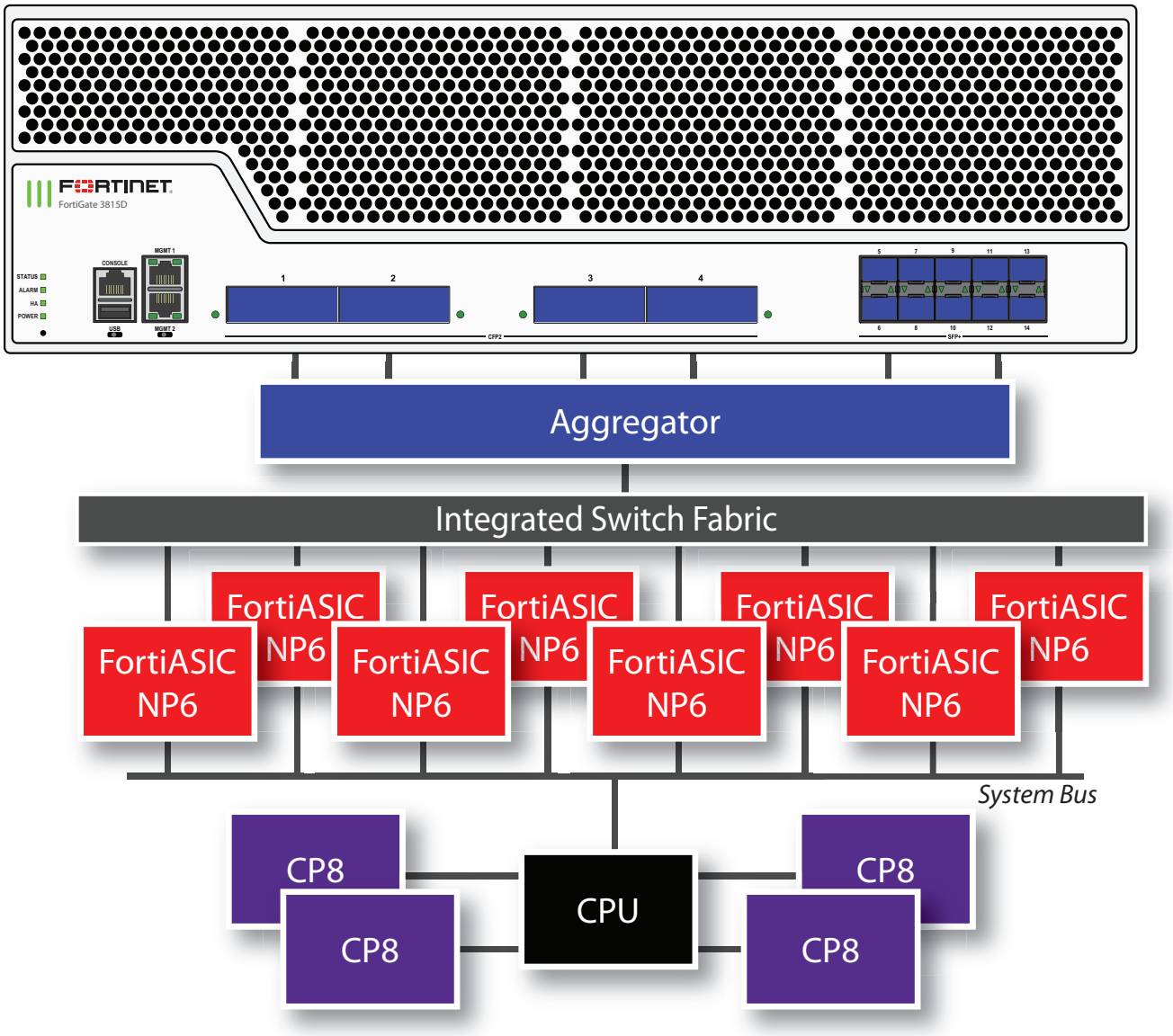


You can use the following get command to display the FortiGate 3810D NP6 configuration. The command output shows all NP6s connected to each interface (port) with cross-chip offloading supported for each port. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports   Max      Cross-chip
                    Speed    offloading
------ ---- ------- ------   ----------
all    0-3  port1   100000M Yes
all    0-3  port2   100000M Yes
all    0-3  port3   100000M Yes
all    0-3  port4   100000M Yes
all    0-3  port5   100000M Yes
all    0-3  port6   100000M Yes
------ ---- ------- ------   ----------
```

FortiGate 3815D fast path architecture

The FortiGate 3815D features four front panel 100GigE CFP2 interfaces and eight 10GigE SFP+ interfaces connected to eight NP6 processors through an Integrated Switch Fabric (ISF). Individual interfaces are not mapped to NP6 processors because of the integrated switch fabric. No special mapping is required for fastpath offloading or aggregate interfaces.



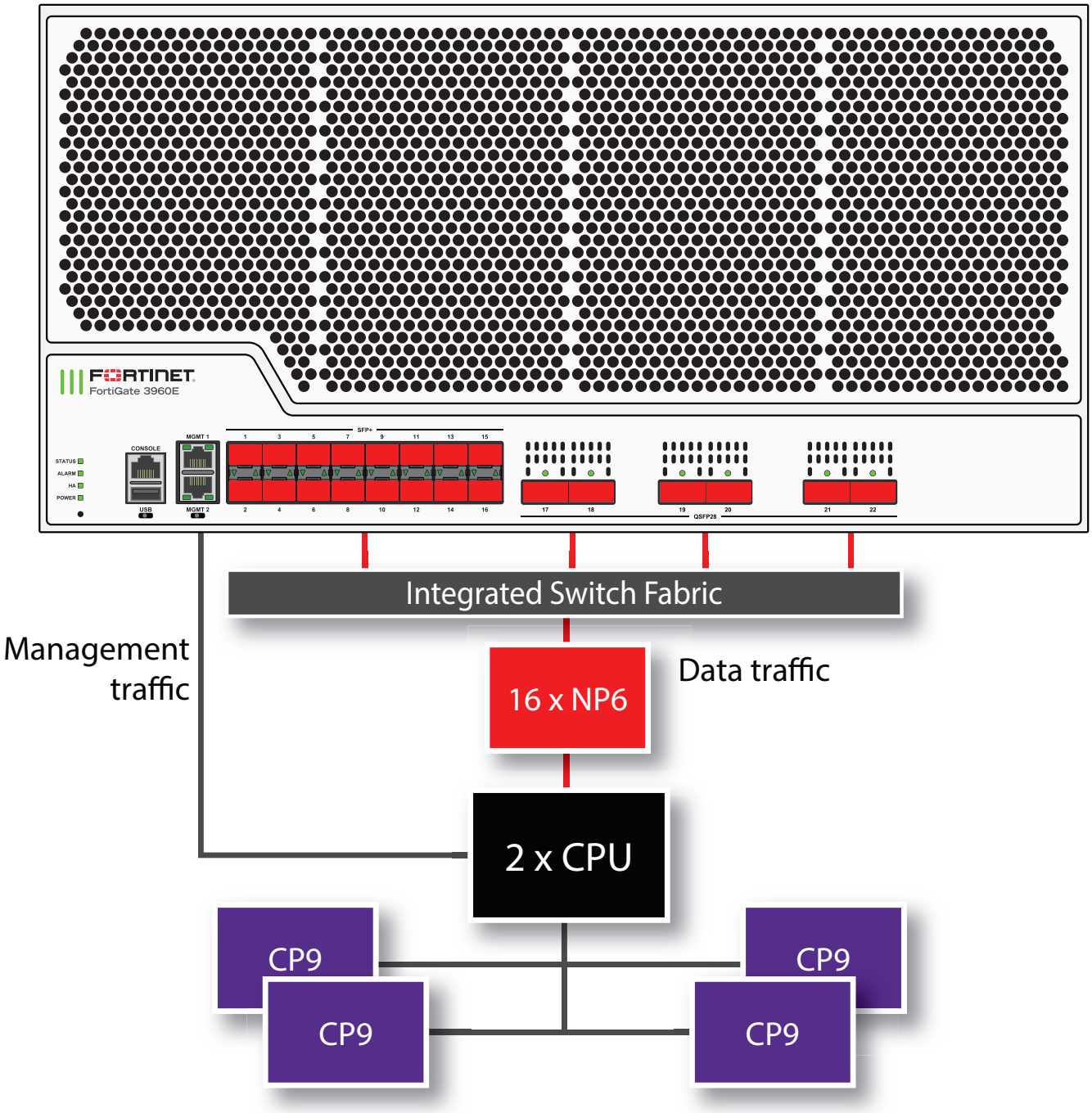
You can use the following get command to display the FortiGate 3815D NP6 configuration. The command output shows all NP6s connected to each interface (port) with cross-chip offloading supported for each port. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip   XAUI Ports   Max     Cross-chip
```

```
                    Speed   offloading
------ ---- ------- ------  ----------
all    0-3  port1   100000M Yes
all    0-3  port2   100000M Yes
all    0-3  port3   100000M Yes
all    0-3  port4   100000M Yes
all    0-3  port11  10000M  Yes
all    0-3  port12  10000M  Yes
all    0-3  port13  10000M  Yes
all    0-3  port14  10000M  Yes
all    0-3  port10  10000M  Yes
all    0-3  port9   10000M  Yes
all    0-3  port8   10000M  Yes
all    0-3  port7   10000M  Yes
all    0-3  port5   10000M  Yes
all    0-3  port6   10000M  Yes
```

FortiGate 3960E fast path architecture

The FortiGate 3960E features sixteen front panel 10GigE SFP+ interfaces (1 to 16) and six 100GigE QSFP+ interfaces (17 to 22) connected to sixteen NP6 processors through an Integrated Switch Fabric (ISF).



The FortiGate 3960E includes sixteen NP6 processors (NP6_0 to NP6_15). All front panel data interfaces and all of the NP6 processors connect to the integrated switch fabric (ISF). All data traffic passes from the data interfaces through the ISF to the NP6 processors. Because of the ISF, all supported traffic passing between any two data interfaces can be offloaded by the NP6 processors. No special mapping is required for fast path offloading or aggregate interfaces. Data traffic processed by the CPU takes a dedicated data path through the ISF and an NP6 processor to the CPU.

The MGMT interfaces are not connected to the NP6 processors. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. You can also dedicate separate CPU resources for management traffic to further isolate management processing from data processing (see Dedicated management CPU

on page 27). The separation of management traffic from data traffic keeps management traffic from affecting the stability and performance of data traffic processing.

You can use the following get command to display the FortiGate 3960E NP6 configuration. The command output shows all NP6s connected to each interface (port) with cross-chip offloading supported for each port. You can also use the `diagnose npu np6 port-list` command to display this information.

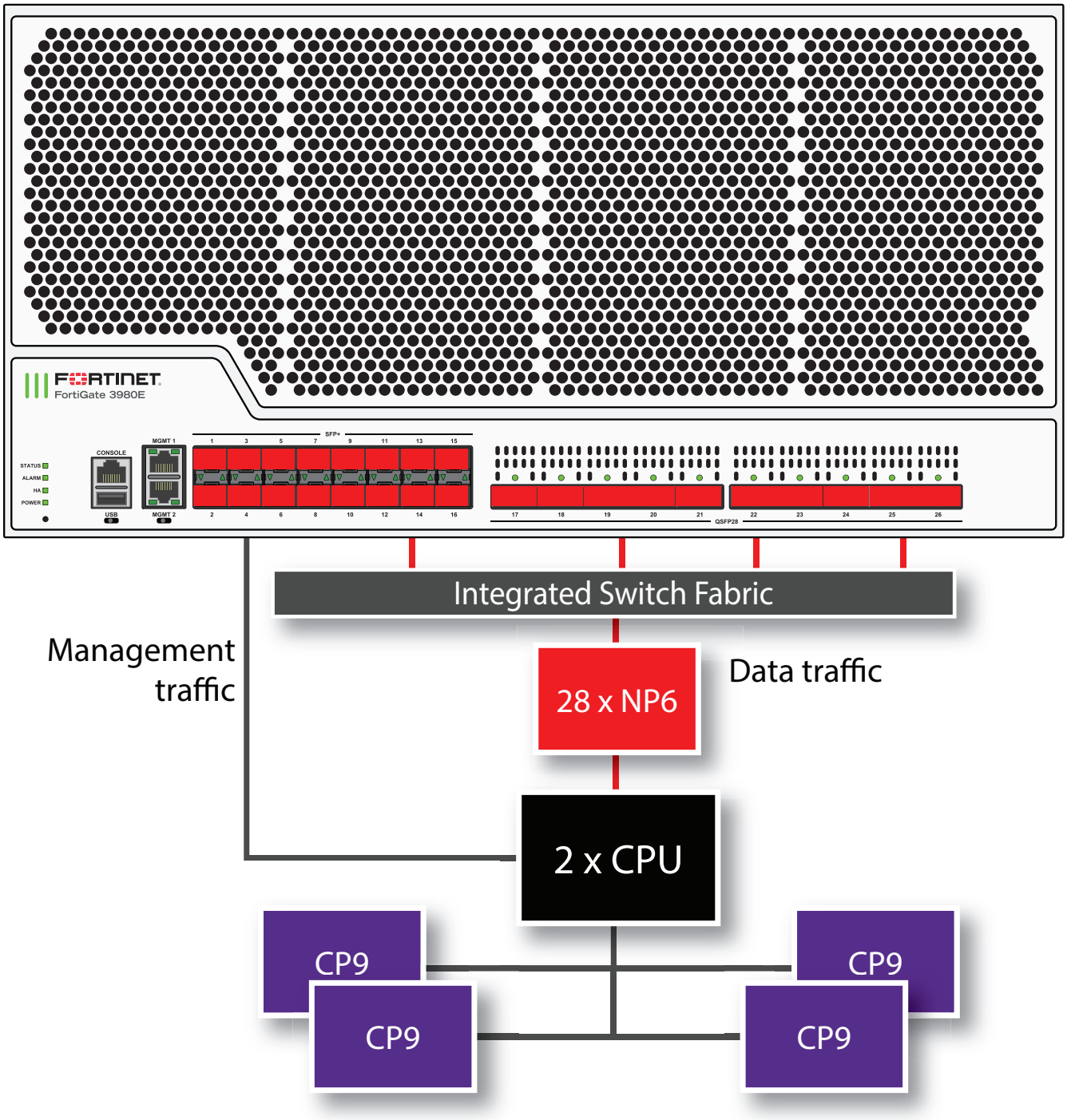
```
diagnose npu np6 port-list
Chip   XAUI Ports    Max      Cross-chip
                    Speed    offloading
------ ---- -------  ------   ----------
NP#0-7  0-3  port1   10000M   Yes
NP#0-7  0-3  port2   10000M   Yes
NP#0-7  0-3  port3   10000M   Yes
NP#0-7  0-3  port4   10000M   Yes
NP#0-7  0-3  port5   10000M   Yes
NP#0-7  0-3  port6   10000M   Yes
NP#0-7  0-3  port7   10000M   Yes
NP#0-7  0-3  port8   10000M   Yes
NP#0-7  0-3  port9   10000M   Yes
NP#0-7  0-3  port10  10000M   Yes
NP#0-7  0-3  port11  10000M   Yes
NP#0-7  0-3  port12  10000M   Yes
NP#0-7  0-3  port13  10000M   Yes
NP#0-7  0-3  port14  10000M   Yes
NP#0-7  0-3  port15  10000M   Yes
NP#0-7  0-3  port16  10000M   Yes
NP#0-7  0-3  port17  100000M  Yes
NP#0-7  0-3  port18  100000M  Yes
NP#8-15 0-3  port19  100000M  Yes
NP#8-15 0-3  port20  100000M  Yes
NP#8-15 0-3  port21  100000M  Yes
NP#8-15 0-3  port22  100000M  Yes
-------------------- ---- ------ ------- ----------
```

For information about optimizing FortiGate 3960E IPsec VPN performance, see Optimizing FortiGate 3960E and 3980E IPsec VPN performance on page 134.

For information about supporting large traffic streams, see FortiGate 3960E and 3980E support for high throughput traffic streams on page 134

FortiGate 3980E fast path architecture

The FortiGate 3980E features sixteen front panel 10GigE SFP+ interfaces (1 to 16) and ten 100GigE QSFP28 interfaces (17 to 26) connected to twenty-eight NP6 processors through an Integrated Switch Fabric (ISF).



The FortiGate 3980E includes twenty-eight NP6 processors (NP6_0 to NP6_27). All front panel data interfaces and all of the NP6 processors connect to the integrated switch fabric (ISF). All data traffic passes from the data interfaces through the ISF to the NP6 processors. Because of the ISF, all supported traffic passing between any two data interfaces can be offloaded by the NP6 processors. No special mapping is required for fast path offloading or aggregate interfaces. Data traffic processed by the CPU takes a dedicated data path through the ISF and an NP6 processor to the CPU.

The MGMT interfaces are not connected to the NP6 processors. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. You can also dedicate separate CPU resources for

management traffic to further isolate management processing from data processing (see Dedicated management CPU on page 27). The separation of management traffic from data traffic keeps management traffic from affecting the stability and performance of data traffic processing.

You can use the following get command to display the FortiGate 3980E NP6 configuration. The command output shows all NP6s connected to each interface (port) with cross-chip offloading supported for each port. You can also use the `diagnose npu np6 port-list` command to display this information.

```
diagnose npu np6 port-list
Chip   XAUI Ports   Max     Cross-chip
                    Speed   offloading
------ ---- ------- ------  ----------
NP#0-7              0-3  port1   10000M  Yes
NP#0-7              0-3  port2   10000M  Yes
NP#0-7              0-3  port3   10000M  Yes
NP#0-7              0-3  port4   10000M  Yes
NP#0-7              0-3  port5   10000M  Yes
NP#0-7              0-3  port6   10000M  Yes
NP#0-7              0-3  port7   10000M  Yes
NP#0-7              0-3  port8   10000M  Yes
NP#0-7              0-3  port9   10000M  Yes
NP#0-7              0-3  port10  10000M  Yes
NP#0-7              0-3  port11  10000M  Yes
NP#0-7              0-3  port12  10000M  Yes
NP#0-7              0-3  port13  10000M  Yes
NP#0-7              0-3  port14  10000M  Yes
NP#0-7              0-3  port15  10000M  Yes
NP#0-7              0-3  port16  10000M  Yes
NP#0-7              0-3  port17  100000M Yes
NP#0-7              0-3  port18  100000M Yes
NP#8-27             0-3  port19  100000M Yes
NP#8-27             0-3  port20  100000M Yes
NP#8-27             0-3  port21  100000M Yes
NP#8-27             0-3  port22  100000M Yes
NP#8-27             0-3  port23  100000M Yes
NP#8-27             0-3  port24  100000M Yes
NP#8-27             0-3  port25  100000M Yes
NP#8-27             0-3  port26  100000M Yes
```

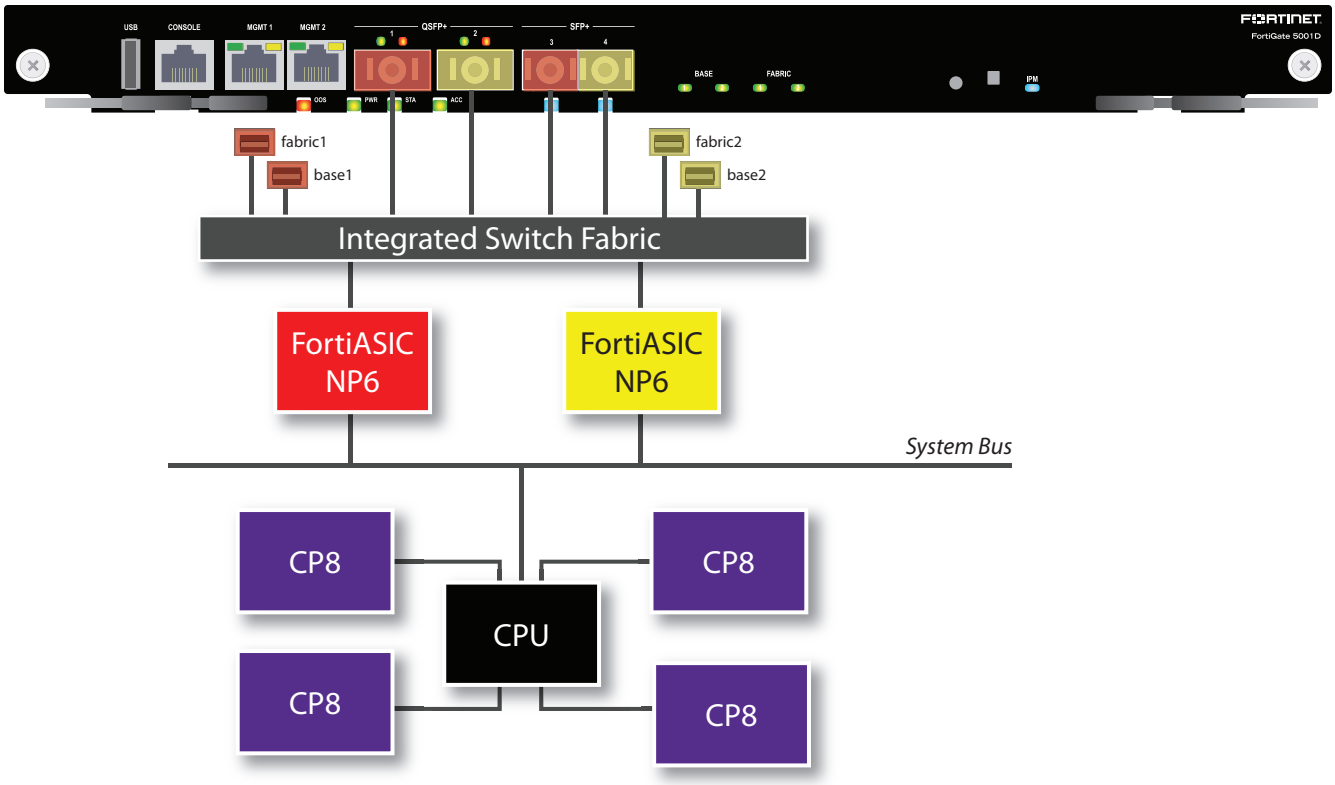
For information about optimizing FortiGate 3980E IPsec VPN performance, see Optimizing FortiGate 3960E and 3980E IPsec VPN performance on page 134.

For information about supporting large traffic streams, see FortiGate 3960E and 3980E support for high throughput traffic streams on page 134

FortiGate-5001D fast path architecture

The FortiGate5001D features two NP6 processors.

- port1, port3, fabric1 and base1 share connections to the first NP6 processor.
- port2, port4, fabric2 and base2 share connections to the second NP6 processor.



NP6 default interface mapping

You can use the following get command to display the FortiGate-5001D NP6 configuration. The command output shows two NP6s named NP6_0 and NP6_1. The output also shows the interfaces (ports) connected to each NP6. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip    XAUI Ports            Max   Cross-chip
                              Speed offloading
------  ---- -------          ----- ----------

np6_0   0    port3            10G   Yes
        1
        2    base1            1G    Yes
        3
        0-3  port1            40G   Yes
        0-3  fabric1          40G   Yes
        0-3  fabric3          40G   Yes
        0-3  fabric5          40G   Yes
------  ---- -------          ----- ----------
np6_1   0
        1    port4            10G   Yes
        2
        3    base2            1G    Yes
        0-3  port2            40G   Yes
        0-3  fabric2          40G   Yes
```

```
       0-3  fabric4          40G   Yes
------ ---- -------          ----- ----------
```

NP6 interface mapping with split ports

If you use the following CLI command to split port1:

```
config system global
   set split-port port1
end
```

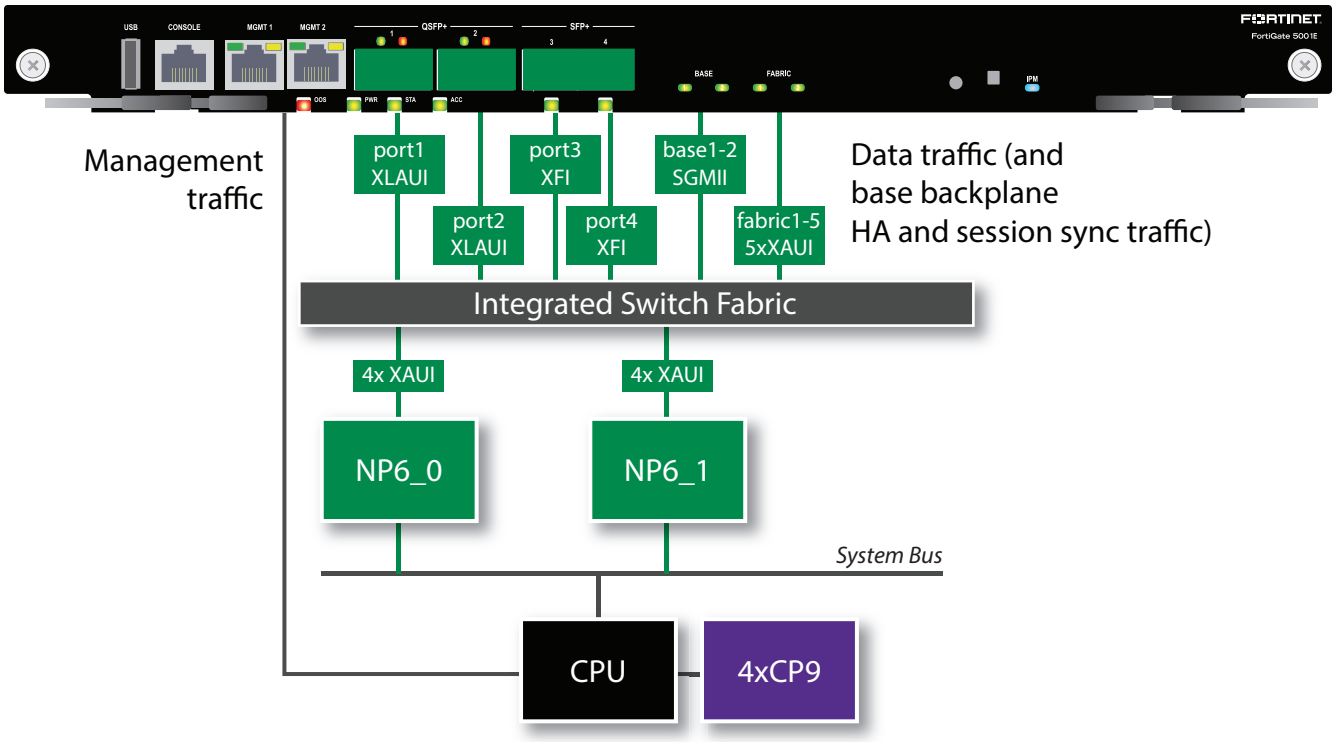
The new split ports (port1/1 to port 1/4) are mapped to the same NP6 as the port1 interface:

```
diagnose npu np6 port-list
Chip   XAUI Ports            Max   Cross-chip
                             Speed offloading
------ ---- -------          ----- ----------
np6_0  0    port3            10G   Yes
       0    port1/1          10G   Yes
       1    port1/2          10G   Yes
       2    base1            1G    Yes
       2    port1/3          10G   Yes
       3    port1/4          10G   Yes
       0-3  fabric1          40G   Yes
       0-3  fabric3          40G   Yes
       0-3  fabric5          40G   Yes
------ ---- -------          ----- ----------
np6_1  0
       1    port4            10G   Yes
       2
       3    base2            1G    Yes
       0-3  port2            40G   Yes
       0-3  fabric2          40G   Yes
       0-3  fabric4          40G   Yes
------ ---- -------          ----- ----------
```

FortiGate-5001E and 5001E1 fast path architecture

The FortiGate 5001E and 5001E1 models feature the following interfaces:

- Two 10/100/1000BASE-T Copper (MGMT1 and MGMT2) (not connected to the NP6 processors)
- Two 40 GigE QSFP+ Fabric Channel (1 and 2)
- Two 10 GigE SFP+ Fabric Channel (3 and 4)
- Two base backplane 1Gbps interfaces (base1 and base2) for HA heartbeat communications across the FortiGate-5000 chassis base backplane.
- Five fabric backplane 40Gbps interfaces (fabric1 to fabric5) for data communications across the FortiGate-5000 chassis fabric backplane



You can use the following get command to display the FortiGate-5001E NP6 configuration. The command output shows both NP6s connected to each interface with cross-chip offloading supported for all interfaces connected to the NP6 processors. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list
Chip                  XAUI Ports   Max     Cross-chip
                                   Speed   offloading
--------------------  ---- ------  ------- ----------
NP#0-1                0-3  port1   40000M  Yes
NP#0-1                0-3  port2   40000M  Yes
NP#0-1                0-3  port3   10000M  Yes
NP#0-1                0-3  port4   10000M  Yes
NP#0-1                0-3  base1   1000M   Yes
NP#0-1                0-3  base2   1000M   Yes
NP#0-1                0-3  fabric1 40000M  Yes
NP#0-1                0-3  fabric2 40000M  Yes
NP#0-1                0-3  fabric3 40000M  Yes
NP#0-1                0-3  fabric4 40000M  Yes
NP#0-1                0-3  fabric5 40000M  Yes
--------------------  ---- ------  ------- ----------
```

Distributing traffic evenly among the NP6 processors can optimize performance. For details, see Optimizing NP6 performance by distributing traffic to XAUI links on page 105.

You can also add LAGs to improve performance. For details, see Increasing NP6 offloading capacity using link aggregation groups (LAGs) on page 109.

If the FortiGate-5001E or 5001E1 is operating as part of an SLBC system, the output of the `get hardware npu np6 port-list` command shows links to FortiController front panel interfaces, FortiController trunk interfaces, and to the NP6 processors in other FortiGate-5001Es or 5001E1s in the chassis:

```
get hardware npu np6 port-list
Chip                  XAUI Ports    Max     Cross-chip
                                              Speed   offloading
--------------------  ---- ------   ------- ----------
NP#0-1                0-3  port1    40000M  Yes
NP#0-1                0-3  port2    40000M  Yes
NP#0-1                0-3  port3    10000M  Yes
NP#0-1                0-3  port4    10000M  Yes
NP#0-1                0-3  base1    1000M   Yes
NP#0-1                0-3  base2    1000M   Yes
NP#0-1                0-3  elbc-ctrl/1 40000M Yes
NP#0-1                0-3  elbc-ctrl/2 40000M Yes
NP#0-1                0-3  np6_0_8  40000M  Yes
NP#0-1                0-3  np6_0_9  40000M  Yes
NP#0-1                0-3  np6_0_10 40000M  Yes
NP#0-1                0-3  np6_0_17 40000M  Yes
NP#0-1                0-3  np6_0_18 40000M  Yes
NP#0-1                0-3  np6_0_19 40000M  Yes
NP#0-1                0-3  np6_0_20 40000M  Yes
NP#0-1                0-3  np6_0_21 40000M  Yes
NP#0-1                0-3  np6_0_22 40000M  Yes
NP#0-1                0-3  np6_0_23 40000M  Yes
NP#0-1                0-3  np6_0_24 40000M  Yes
NP#0-1                0-3  fctrl1/trunk01 40000M Yes
NP#0-1                0-3  fctrl2/trunk01 40000M Yes
NP#0-1                0-3  np6_0_27 40000M  Yes
NP#0-1                0-3  np6_0_28 40000M  Yes
NP#0-1                0-3  np6_0_29 40000M  Yes
NP#0-1                0-3  np6_0_30 40000M  Yes
NP#0-1                0-3  np6_0_31 40000M  Yes
NP#0-1                0-3  np6_0_32 40000M  Yes
NP#0-1                0-3  fctrl1/f1-1 10000M Yes
NP#0-1                0-3  fctrl2/f1-1 10000M Yes
NP#0-1                0-3  fctrl1/f1-2 10000M Yes
NP#0-1                0-3  fctrl2/f1-2 10000M Yes
NP#0-1                0-3  fctrl1/f1-3 10000M Yes
NP#0-1                0-3  fctrl2/f1-3 10000M Yes
NP#0-1                0-3  fctrl1/f1-4 10000M Yes
NP#0-1                0-3  fctrl2/f1-4 10000M Yes
NP#0-1                0-3  fctrl1/f1-5 10000M Yes
NP#0-1                0-3  fctrl2/f1-5 10000M Yes
NP#0-1                0-3  fctrl1/f1-6 10000M Yes
NP#0-1                0-3  fctrl2/f1-6 10000M Yes
NP#0-1                0-3  fctrl1/f1-7 10000M Yes
NP#0-1                0-3  fctrl2/f1-7 10000M Yes
NP#0-1                0-3  fctrl1/f1-8 10000M Yes
NP#0-1                0-3  fctrl2/f1-8 10000M Yes
NP#0-1                0-3  fctrl1/f1-9 10000M Yes
NP#0-1                0-3  fctrl2/f1-9 10000M Yes
NP#0-1                0-3  fctrl1/f1-10 10000M Yes
NP#0-1                0-3  fctrl2/f1-10 10000M Yes
NP#0-1                0-3  fctrl1/f2-1 10000M Yes
NP#0-1                0-3  fctrl2/f2-1 10000M Yes
NP#0-1                0-3  fctrl1/f2-2 10000M Yes
NP#0-1                0-3  fctrl2/f2-2 10000M Yes
NP#0-1                0-3  fctrl1/f2-3 10000M Yes
```

```
NP#0-1                0-3  fctrl2/f2-3 10000M Yes
NP#0-1                0-3  fctrl1/f2-4 10000M Yes
NP#0-1                0-3  fctrl2/f2-4 10000M Yes
NP#0-1                0-3  fctrl1/f2-5 10000M Yes
NP#0-1                0-3  fctrl2/f2-5 10000M Yes
NP#0-1                0-3  fctrl1/f2-6 10000M Yes
NP#0-1                0-3  fctrl2/f2-6 10000M Yes
NP#0-1                0-3  fctrl1/f2-7 10000M Yes
NP#0-1                0-3  fctrl2/f2-7 10000M Yes
NP#0-1                0-3  fctrl1/f2-8 10000M Yes
NP#0-1                0-3  fctrl2/f2-8 10000M Yes
NP#0-1                0-3  fctrl1/f2-9 10000M Yes
NP#0-1                0-3  fctrl2/f2-9 10000M Yes
NP#0-1                0-3  fctrl1/f2-10 10000M Yes
NP#0-1                0-3  fctrl2/f2-10 10000M Yes
--------------------  ---- ------ ------- ----------
```

Splitting front panel interfaces

You can use the following CLI command to split the port1 and port2 front panel interfaces into four interfaces.

```
config system global
   set split-port {port1 port2}
end
```

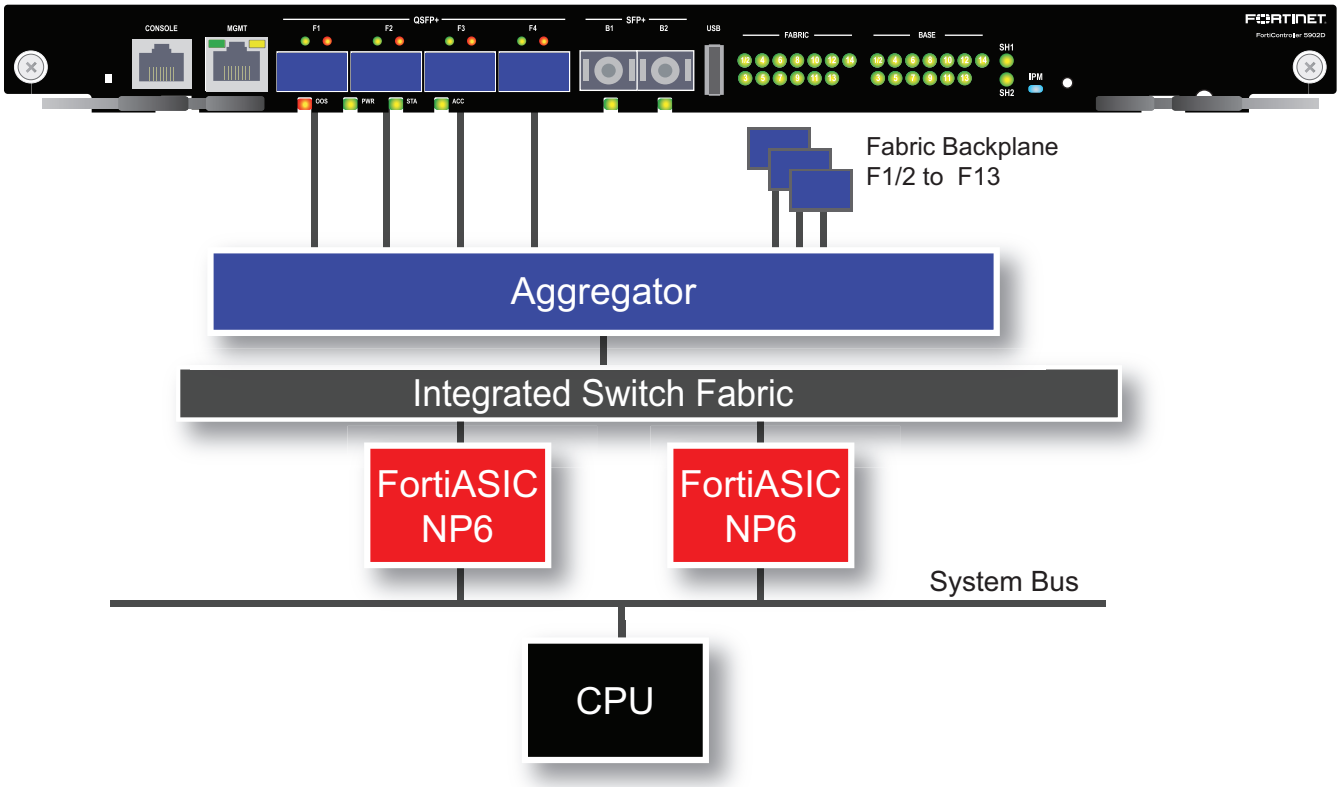
FortiController-5902D fast path architecture

The FortiController-5902D NP6 network processors and integrated switch fabric (ISF) provide hardware acceleration by offloading load balancing from the primary FortiController-5902D CPU. Network processors are especially useful for accelerating load balancing of TCP and UDP sessions.

The first packet of every new session is received by the primary FortiController-5902D and the primary FortiController-5902D uses its load balancing schedule to select the worker that will process the new session. This information is passed back to an NP6 network processor and all subsequent packets of the same sessions are offloaded to an NP6 network processor which sends the packet directly to a subordinate unit. Load balancing is effectively offloaded from the primary unit to the NP6 network processors resulting in a faster and more stable active-active cluster.

Traffic accepted by the FortiController-5902D F1 to F4 interfaces is that is processed by the primary FortiController-5902D is also be offloaded to the NP6 processors.

Individual FortiController-5902D interfaces are not mapped to NP6 processors. Instead an Aggregator connects the all fabric interfaces to the ISF and no special mapping is required for fastpath offloading.



NP6 content clustering mode interface mapping

FortiController-5902Ds run in content clustering mode and load balance sessions to FortiGate 5001D workers. Use the following command to enable content clustering:

```
config system elbc
   set mode content-cluster
   set inter-chassis-support enable
end
```

You can use the following get command to display the content clustering FortiController-5902D NP6 configuration. The output shows that all ports are mapped to all NP6 processors. You can also use the `diagnose npu np6 port-list` command to display this information.

```
get hardware npu np6 port-list

Chip   XAUI Ports          Max      Cross-chip
                           Speed    offloading
------ ---- ----------     ------   ----------
all    0-3  f1             40000M   Yes
all    0-3  f2             40000M   Yes
all    0-3  f3             40000M   Yes
all    0-3  f4             40000M   Yes
all    0-3  np6_0_4        10000M   Yes
all    0-3  np6_0_5        10000M   Yes
all    0-3  elbc-ctrl/1-2  40000M   Yes
all    0-3  elbc-ctrl/3    40000M   Yes
all    0-3  elbc-ctrl/4    40000M   Yes
```

```
all    0-3  elbc-ctrl/5    40000M  Yes
all    0-3  elbc-ctrl/6    40000M  Yes
all    0-3  elbc-ctrl/7    40000M  Yes
all    0-3  elbc-ctrl/8    40000M  Yes
all    0-3  elbc-ctrl/9    40000M  Yes
all    0-3  elbc-ctrl/10   40000M  Yes
all    0-3  elbc-ctrl/11   40000M  Yes
all    0-3  elbc-ctrl/12   40000M  Yes
all    0-3  elbc-ctrl/13   40000M  Yes
all    0-3  elbc-ctrl/14   40000M  Yes
------ ---- ----------     ------  ----------
```

NP6 default interface mapping

You can use the following command to display the default FortiController-5902D NP6 configuration.

```
diagnose npu np6 port-list
```

```
Chip   XAUI Ports       Max     Cross-chip
                        Speed   offloading
------ ---- ----------  ------  ----------
all    0-3  f1          40000M  Yes
all    0-3  f2          40000M  Yes
all    0-3  f3          40000M  Yes
all    0-3  f4          40000M  Yes
all    0-3  np6_0_4     10000M  Yes
all    0-3  np6_0_5     10000M  Yes
all    0-3  fabric1/2   40000M  Yes
all    0-3  fabric3     40000M  Yes
all    0-3  fabric4     40000M  Yes
all    0-3  fabric5     40000M  Yes
all    0-3  fabric6     40000M  Yes
all    0-3  fabric7     40000M  Yes
all    0-3  fabric8     40000M  Yes
all    0-3  fabric9     40000M  Yes
all    0-3  fabric10    40000M  Yes
all    0-3  fabric11    40000M  Yes
all    0-3  fabric12    40000M  Yes
all    0-3  fabric13    40000M  Yes
all    0-3  fabric14    40000M  Yes
```

FortiGate NP6XLite architectures

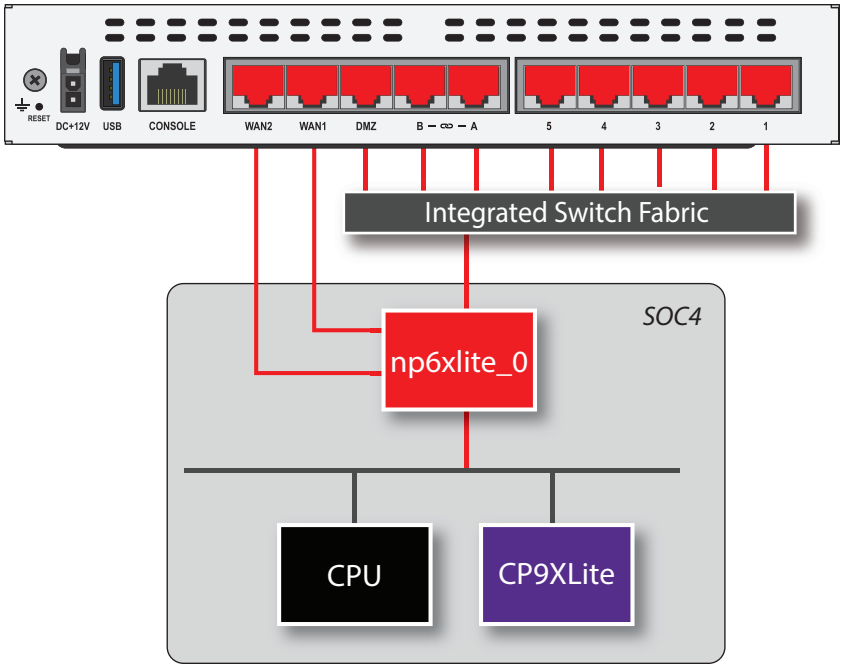
This chapter shows the NP6XLite architecture for FortiGate models that include NP6XLite processors.

FortiGate 60F and 61F fast path architecture

The FortiGate 60F and 61F includes the SOC4 and uses the SOC4 CPU, NP6XLite processor, and CP9XLite processor. All of the data interfaces (1-5, A, B, DMZ, WAN1, and WAN2) connect to the NP6XLite processor. The FortiGate 60F and 61F also includes an integrated switch fabric that connects some of the data interfaces (1-5, A, B, and DMZ) to the NP6XLite processor. The WAN1 and WAN2 interfaces connect directly to the NP6XLite processor. The A and B interfaces can also be used as FortiLink interfaces.

The FortiGate 60F and 61F models feature the following front panel interfaces:

- Eight 10/100/1000BASE-T Copper (1-5, A, B, DMZ) connected to the NP6XLite processor through the integrated switch fabric
- Two 10/100/1000BASE-T Copper (WAN1 and WAN2) directly connected to the NP6XLite processor



You can use the command `diagnose npu np6xlite port-list` to display the FortiGate 60F or 61F NP6XLite configuration.

```
diagnose npu np6xlite port-list
Chip    XAUI Ports            Max    Cross-chip
                              Speed offloading
------ ---- -------           ----- ----------
np6xlite_0
       11    wan1              1000M          NO
```

```
15    wan2              1000M          NO
7     dmz               1000M          NO
6     internal1         1000M          NO
5     internal2         1000M          NO
4     internal3         1000M          NO
3     internal4         1000M          NO
10    internal5         1000M          NO
9     a                 1000M          NO
8     b                 1000M          NO
```

FortiGate 80F, 81F, and 80F Bypass fast path architecture

The FortiGate 80F and 81F includes the SOC4 and uses the SOC4 CPU, NP6XLite processor, and CP9XLite processor. The SFP1, SFP2, WAN1, and WAN2 data interfaces connect directly to the NP6XLite processor. The 1-6, A, and B data interfaces connect to the NP6XLite processor through an integrated switch fabric.

Interfaces SFP1 and WAN1 and SFP2 and WAN2 are shared SFP or Ethernet interfaces. Only one of each of these interface pairs can be connected to a network. This allows you to, for example, connect SFP1 to an SFP switch and WAN2 to 10/100/1000BASE-T Copper switch.

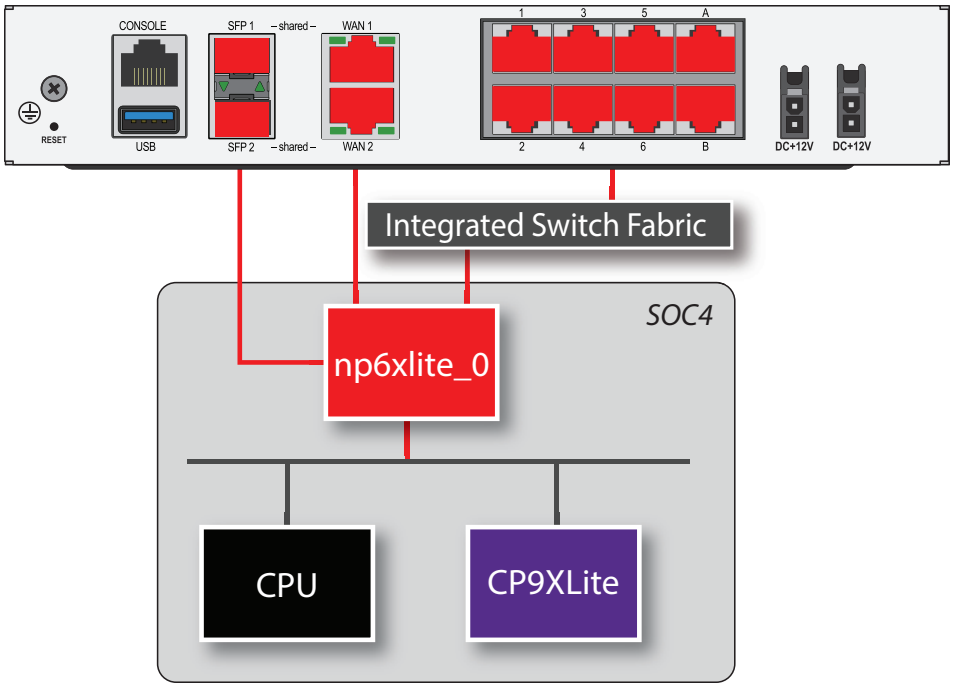
On the FortiGate 80F Bypass model, the WAN1 and 1 interfaces form a copper bypass pair. The SFP1 interface is not part of the bypass pair. On the GUI and CLI the 1 interface is named internal1.

The FortiGate 80F and 81F features the following front panel interfaces:

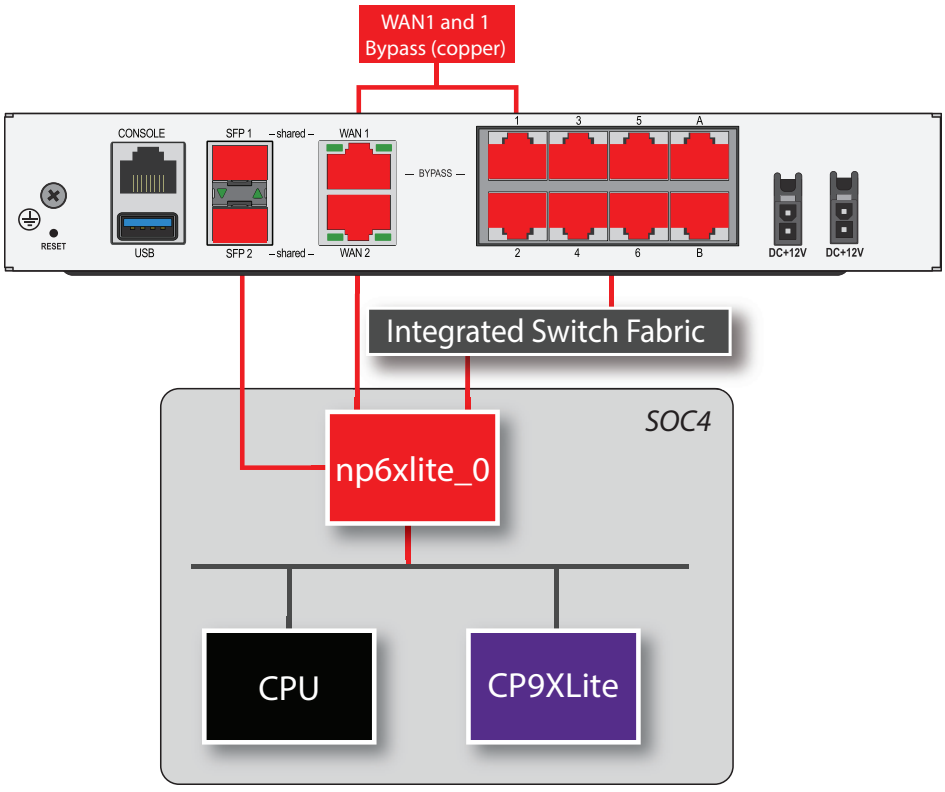
- Two 1GigE SFP interfaces (SPF1 and SPF2) connected directly to the NP6XLite processor.
- Two 10/100/1000BASE-T Copper interfaces (WAN1, WAN2) connected to the NP6XLite processor through the integrated switch fabric.
- Eight 10/100/1000BASE-T Copper (1-6, A, and B) connected to the NP6XLite processor through the integrated switch fabric. A and B are FortiLink interfaces.
- The FortiGate-80F Bypass includes two shared interfaces that can be either:
  - 1GigE SFP (SPF1 and SFP2)
  - 10/100/1000BASE-T Copper (WAN1 and WAN2)

On the FortiGate 80F Bypass model, the WAN1 and 1 interfaces form a bypass pair. Interface 1 (internal1) is part of a hardware switch named internal. To enable bypass mode, you must remove internal1 from the hardware switch.

FortiGate 80F and 81F back panel



FortiGate 80F Bypass back panel



You can use the command `diagnose npu np6xlite port-list` to display the FortiGate 80F or 81F NP6XLite configuration.

```
diagnose npu np6xlite port-list
Chip   XAUI Ports            Max   Cross-chip
                            Speed offloading
------ ---- -------          ----- ----------
np6xlite_0
       14   wan1             1000M          NO
       13   wan2             1000M          NO
       7    internal1        1000M          NO
       8    internal2        1000M          NO
       9    internal3        1000M          NO
       10   internal4        1000M          NO
       3    internal5        1000M          NO
       4    internal6        1000M          NO
       5    a                1000M          NO
       6    b                1000M          NO
```

Bypass interfaces (WAN1 and 1)

The FortiGate 80F Bypass model includes a bypass interface pair, WAN1 and 1, that provides fail open support. When a FortiGate 80F Bypass model experiences a hardware failure or loses power, or when bypass mode is enabled, the bypass interface pair operates in bypass mode. In bypass mode, WAN1 and 1 are directly connected. Traffic can pass between WAN1 and 1 bypassing the FortiOS firewall and the NP6XLite processor, but continuing to provide network connectivity.

In bypass mode, the bypass pair acts like a patch cable, failing open and allowing all traffic to pass through. Traffic on the bypass interface that is using VLANs or other network extensions can only continue flowing if the connected network equipment is configured for these features.

The FortiGate 80F Bypass model will continue to operate in bypass mode until the failed FortiGate 80F Bypass model is replaced, power is restored, or bypass mode is disabled. If power is restored or bypass mode is disabled, the FortiGate 80F Bypass model resumes operating as a FortiGate device without interrupting traffic flow. Replacing a failed FortiGate 80F Bypass model disrupts traffic as a technician physically replaces the failed FortiGate 80F Bypass model with a new one.

Manually enabling bypass mode

You can manually enable bypass mode if the FortiGate 80F Bypass model is operating in transparent mode. You can also manually enable bypass mode for a VDOM if WAN1 and 1 are both connected to the same VDOM operating in transparent mode.

By default, interface 1 (internal1) is part of a hardware switch named internal. Before you enable bypass mode, you must enter the following command s to edit the hardware switch and remove internal1 from the switch:

```
config system virtual-switch
   edit internal
      delete internal1
   end
```

Then you can use the following command to enable bypass mode:

```
execute bypass-mode enable
```

This command changes the configuration, so bypass mode will still be enabled if the FortiGate 80F Bypass model restarts.

You can use the following command to disable bypass mode:

```
execute bypass-mode disable
```

Configuring bypass settings

You can use the following command to configure how bypass operates. To configure these settings, you must first remove the internal1 interface from the internal hardware switch.

```
config system bypass
   set bypass-watchdog {disable | enable}
   set poweroff-bypass {disable | enable}
end
```

`bypass-watchdog` enable to turn on bypass mode. When bypass mode is turned on, if the bypass watchdog detects a software or hardware failure, bypass mode will be activated.

`poweroff-bypass` if enabled, traffic will be able to pass between the wan1 and internal1 interfaces if the FortiGate 80F Bypass is powered off.

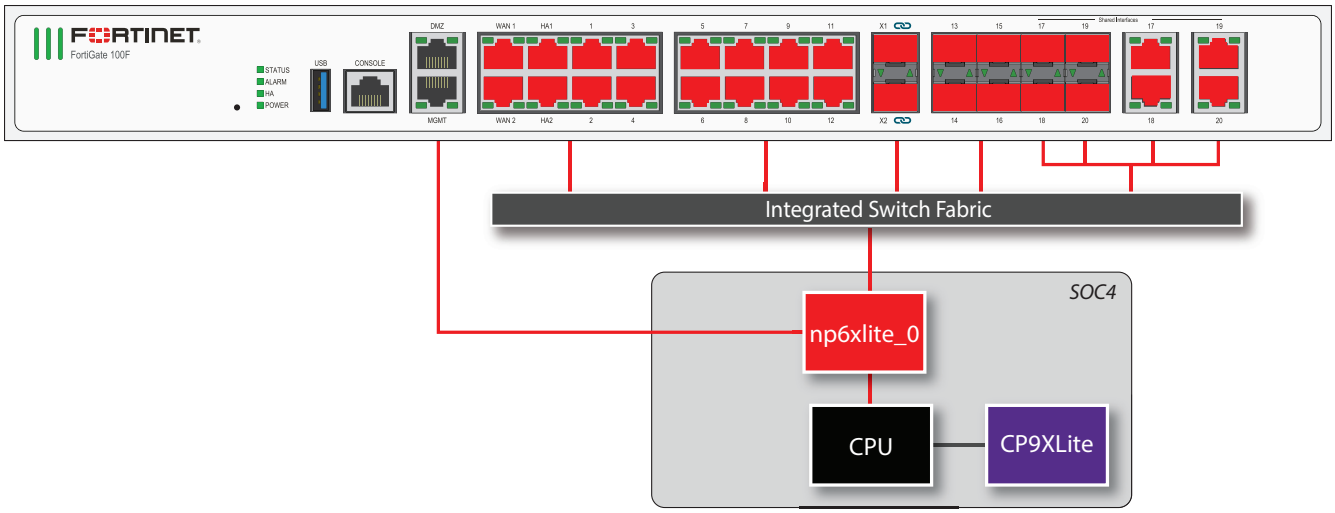
FortiGate 100F and 101F fast path architecture

The FortiGate 100F and 101F both include a SOC4 and use the SOC4 CPU, NP6XLite processor, and CP9XLite processor. All of the data interfaces (1-20), the HA interfaces, and the Fortilink interfaces (X1 and X2) connect to the NP6XLite processor through the integrated switch fabric. The DMZ and MGMT interfaces connect directly to the NP6XLite processor.

Interfaces 17 to 20 are shared SFP or Ethernet interfaces. That means there are two sets of physical interfaces numbered 17 to 20 but only one of each can be connected to a network. This allows you to, for example, connect interfaces 17 and 18 to an SFP switch and interfaces 19 and 20 to a 10/100/1000BASE-T Copper switch.

The FortiGate 100F and 101F models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (DMZ, MGMT) that connect directly to the NP6XLite.
- Sixteen 10/100/1000BASE-T Copper (WAN1, WAN2, HA1, HA2, 1 to 12) that connect to the internal switch fabric.
- Two 10 GigE SFP+ (X1 and X2) FortiLink interfaces.
- Four 1GigE SFP (13 to 16).
- Four shared interfaces (17 to 20) that can be either:
  - 10/100/1000BASE-T Copper
  - 1GE SFP



You can use the command `diagnose npu np6xlite port-list` to display the FortiGate 100F or 101F NP6XLite configuration.

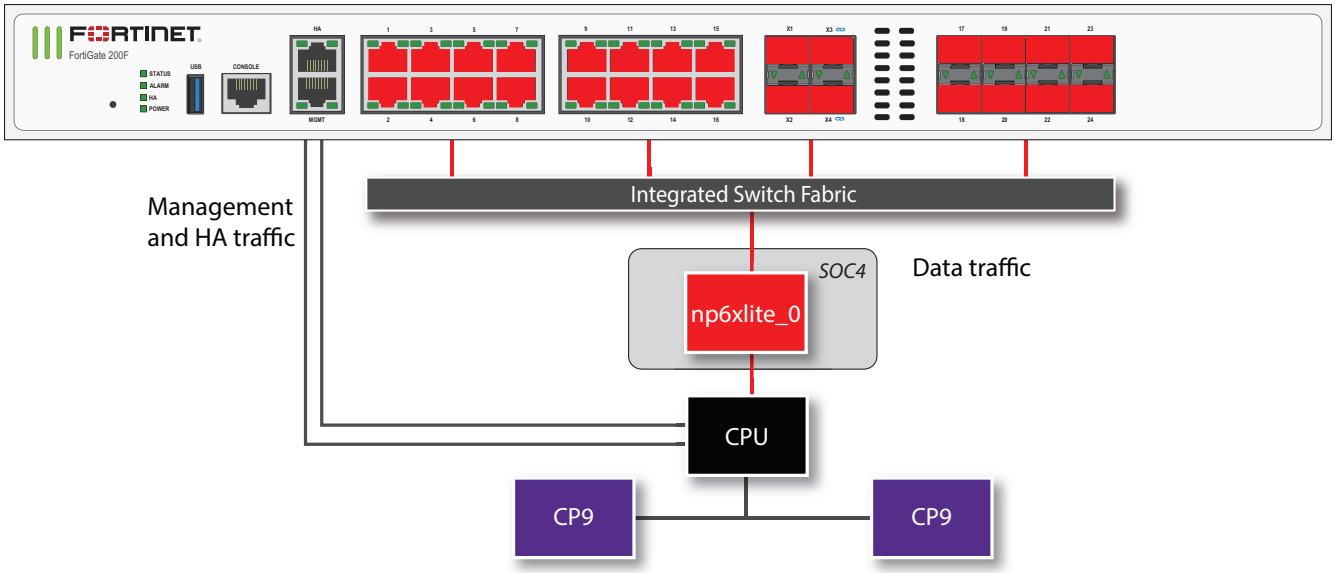
```
diagose npu np6xlite port-list
Chip    XAUI Ports            Max    Cross-chip
                              Speed offloading
------ ---- -------           ----- ----------
np6xlite_0
        11   dmz               1000M          NO
        15   mgmt              1000M          NO
        19   wan1              1000M          NO
        19   wan2              1000M          NO
        19   ha1               1000M          NO
        19   ha2               1000M          NO
        19   port1             1000M          NO
        19   port2             1000M          NO
        19   port3             1000M          NO
        19   port4             1000M          NO
        19   port5             1000M          NO
        19   port6             1000M          NO
        19   port7             1000M          NO
        19   port8             1000M          NO
        19   port9             1000M          NO
        19   port10            1000M          NO
        19   port11            1000M          NO
        19   port12            1000M          NO
        19   x1                10000M         NO
        19   x2                10000M         NO
        19   port13            1000M          NO
        19   port14            1000M          NO
        19   port15            1000M          NO
        19   port16            1000M          NO
        19   port17            1000M          NO
        19   port18            1000M          NO
        19   port19            1000M          NO
        19   port20            1000M          NO
```

FortiGate 200F and 201F fast path architecture

The FortiGate 200F and 201F both include a SOC4 NP6XLite processor. The SOC4 CPU and CP9XLite are not used. Instead, the FortiGate 200F and 201F architecture includes separate CPU resources and two standard CP9 processors. All of the data interfaces (1 to 24 and X1 to X4) connect to the NP6XLite processor through the integrated switch fabric. The X3 and X4 interfaces are FortiLink interfaces. The HA and MGMT interfaces, are not connected to the NP6XLite processor.

The FortiGate 200F and 201F models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (HA, MGMT) that are not connected to the NP6XLite.
- Sixteen 10/100/1000BASE-T Copper (1 to 16).
- Four 10 GigE SFP+ (X1 to X4). X3 and X3 are FortiLink interfaces.
- Eight 1GigE SFP (17 to 24).



All front panel data interfaces and the NP6XLite processor connect to the integrated switch fabric (ISF). All data traffic passes from the data interfaces through the ISF to the NP6XLite processor. All supported traffic passing between any two data interfaces can be offloaded by the NP6XLite processor. Data traffic to be processed by the CPU takes a dedicated data path through the ISF and the NP6XLite processor to the CPU.

The MGMT interface is not connected to the NP6XLite processor. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. The HA interface is also not connected to the NP6XLite processor. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing. The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the command `diagnose npu np6xlite port-list` to display the FortiGate 200F or 201F NP6XLite configuration.

```
diagnose npu np6xlite port-list
Chip    XAUI Ports            Max   Cross-chip
                              Speed offloading
------ ---- -------           ----- ----------
np6xlite_0
```

```
19   port1            1000M          NO
19   port2            1000M          NO
19   port3            1000M          NO
19   port4            1000M          NO
19   port5            1000M          NO
19   port6            1000M          NO
19   port7            1000M          NO
19   port8            1000M          NO
19   port9            1000M          NO
19   port10           1000M          NO
19   port11           1000M          NO
19   port12           1000M          NO
19   port13           1000M          NO
19   port14           1000M          NO
19   port15           1000M          NO
19   port16           1000M          NO
19   port17           1000M          NO
19   port18           1000M          NO
19   port19           1000M          NO
19   port20           1000M          NO
19   port21           1000M          NO
19   port22           1000M          NO
19   port23           1000M          NO
19   port24           1000M          NO
19   x1               10000M         NO
19   x2               10000M         NO
19   x3               10000M         NO
19   x4               10000M         NO
```

FortiGate NP6Lite architectures

This chapter shows the NP6Lite architecture for FortiGate models that include NP6Lite processors.

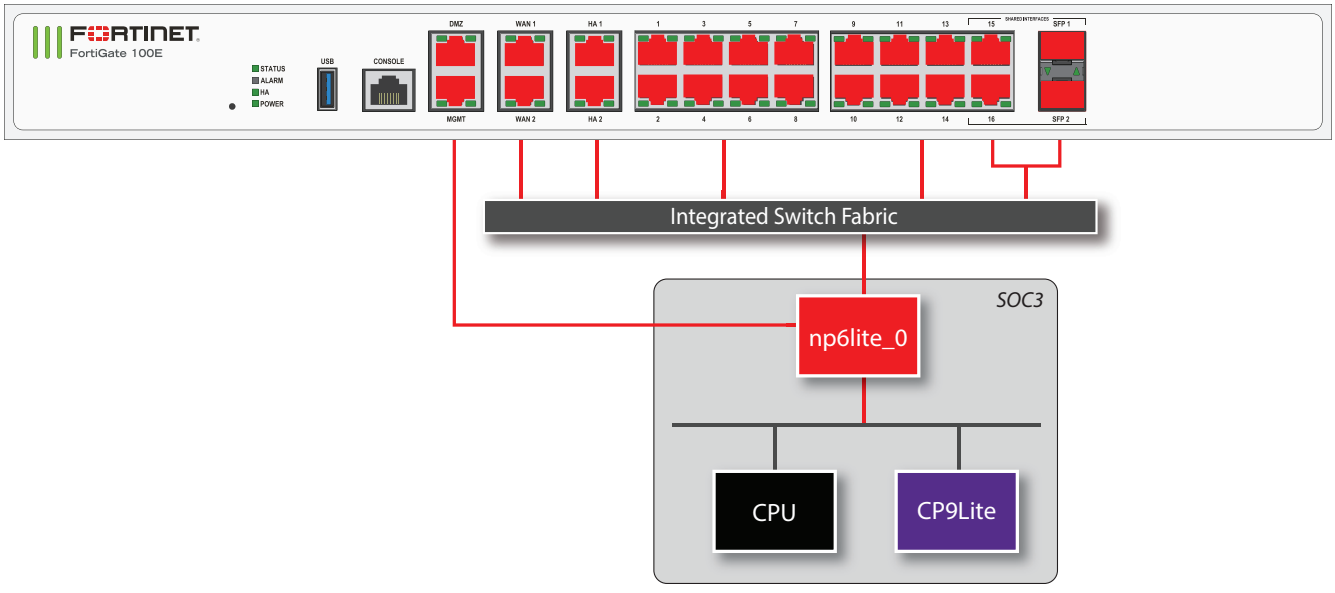
FortiGate 100E and 101E fast path architecture

The FortiGate 100E and 101E includes the SOC3 and uses the SOC3 CPU, NP6Lite processor, and CP9Lite processor. The WAN1, WAN2, HA1, HA2, 1 - 16, SFP1, and SFP2 interfaces connect to the NP6Lite processor through the integrated switch fabric. The DMZ and MGMT interfaces connect directly to the NP6Lite processor.

Interfaces 15 and SFP1 are paired and interfaces 16 and SPF2 are paired. Only one of each interface pair can be connected to a network at a time. This allows you to, for example, connect interface SFP1 to an SFP switch and interface 16 to a 10/100/1000BASE-T Copper switch.

The FortiGate 100F and 101F models feature the following front panel interfaces:

- Two 10/100/1000BASE-T Copper (DMZ, MGMT) that connect directly to the NP6Lite
- Eighteen 10/100/1000BASE-T Copper (WAN1, WAN2, HA1, HA2, 1 to 14) that connect to the NP6Lite processor through the internal switch fabric
- Two shared interfaces that connect to the NP6Lite processor through the internal switch fabric and can be either:
  - 10/100/1000BASE-T Copper (15 and 16), or
  - 1GE SFP (SFP1 and SFP2)



You can use the following get command to display the FortiGate 100E or 101E NP6Lite configuration. You can also use the `diagnose npu np6lite port-list` command to display this information.

```
get hardware npu np6lite port-list
Chip   XAUI Ports            Max   Cross-chip
```

```
                          Speed offloading
------ ---- -------       ----- ----------
np6lite_0
       2    dmz           1000M          NO
       1    mgmt          1000M          NO
       3    wan1          1000M          NO
       4    wan2          1000M          NO
       11   ha1           1000M          NO
       11   ha2           1000M          NO
       11   port1         1000M          NO
       11   port2         1000M          NO
       11   port3         1000M          NO
       11   port4         1000M          NO
       11   port5         1000M          NO
       11   port6         1000M          NO
       11   port7         1000M          NO
       11   port8         1000M          NO
       11   port9         1000M          NO
       11   port10        1000M          NO
       11   port11        1000M          NO
       11   port12        1000M          NO
       11   port13        1000M          NO
       11   port14        1000M          NO
       11   port15        1000M          NO
       11   port16        1000M          NO
```

FortiGate 200E and 201E fast path architecture

The FortiGate 200E and 201E features the following front panel interfaces:

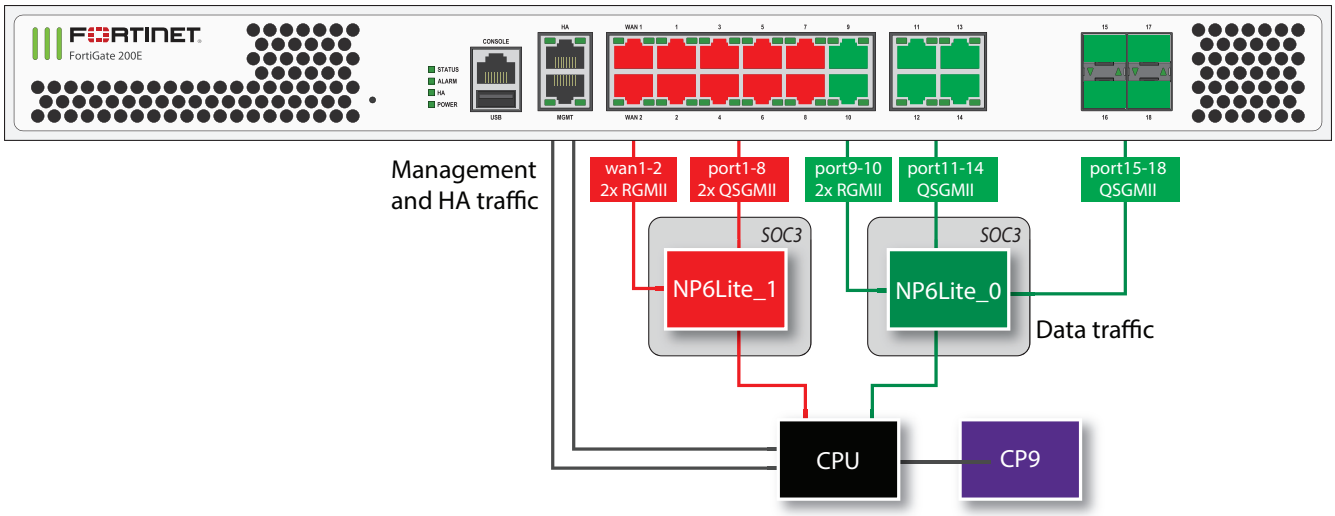
- Two 10/100/1000BASE-T Copper interfaces (MGMT and HA , not connected to the NP6Lite processors)
- Sixteen 10/100/1000BASE-T Copper interfaces (wan1, wan2, 1 to 14)
- Four 1GE SFP interfaces (15 to 18)

The FortiGate 200E and 201E include two SOC3 NP6Lite processors. The SOC3 CPUs and CP9Lite processors are not used. Instead, the FortiGate 200E and 201E architecture includes separate CPU resources and a standard CP9 processor. Because this model does not include a switch fabric, you cannot create Link Aggregation Groups (LAGs) or redundant interfaces between interfaces connected to different NP6Lites. As well, traffic will only be offloaded if it enters and exits the FortiGate on interfaces connected to the same NP6Lite.

The NP6Lites are connected to network interfaces as follows:

- NP6Lite_0 is connected to six 1GE RJ-45 interfaces (9 to 14) and four 1GE SFP interfaces (15 to 18).
- NP6Lite_1 is connected to ten 1GE RJ45 interfaces (wan1, wan2, 1 to 8).

The following diagram also shows the RGMII and QSGMII port connections between the NP6Lite processors and the front panel interfaces. Both RGMII and QSGMII interfaces operate at 1000Mbps. However, QSGMII interfaces can also negotiate to operate at lower speeds: 10, 100, and 1000Mbps. To connect the FortiGate 200E to networks with speeds lower than 1000Mbps use the QSGMII interfaces (port1-8 and port11-18).



All data traffic passes from the data interfaces through to the NP6Lite processors. Data traffic to be processed by the CPU takes a dedicated data path through the ISF and an NP6Lite processor to the CPU.

The MGMT interface is not connected to the NP6Lite processors. Management traffic passes to the CPU over a dedicated management path that is separate from the data path. The HA interface is also not connected to the NP6Lite processors. To help provide better HA stability and resiliency, HA traffic uses a dedicated physical control path that provides HA control traffic separation from data traffic processing. The separation of management and HA traffic from data traffic keeps management and HA traffic from affecting the stability and performance of data traffic processing.

You can use the following get command to display the FortiGate 200E or 201E NP6Lite configuration. You can also use the `diagnose npu np6lite port-list` command to display this information.

```
get hardware npu np6lite port-list
Chip    XAUI Ports            Max   Cross-chip
                              Speed offloading
------  ---- -------          ----- ----------
np6lite_0
        2    port9            1000M          NO
        1    port10           1000M          NO
        4    port11           1000M          NO
        3    port12           1000M          NO
        6    port13           1000M          NO
        5    port14           1000M          NO
        9    port15           1000M          NO
        10   port16           1000M          NO
        8    port17           1000M          NO
        7    port18           1000M          NO
np6lite_1
        2    wan1             1000M          NO
        1    wan2             1000M          NO
        4    port1            1000M          NO
        3    port2            1000M          NO
        6    port3            1000M          NO
        5    port4            1000M          NO
        8    port5            1000M          NO
        7    port6            1000M          NO
        10   port7            1000M          NO
        9    port8            1000M          NO
```