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Optimize Throughput and Power Efficiency for Next-Generation Firewalls

With up to 144 cores per socket and higher base frequency than the previous generation, Intel® Xeon® 6 processors with Efficient-cores (E-cores) are an outstanding fit for next-generation firewalls (NGFWs). The platform enables higher deterministic throughput and better performance per watt compared to predecessors, helping reduce total cost of ownership for on-premises NGFW offerings.

intel XEON

The cyberthreat environment faced by enterprises across industries continues to become more destructive and sophisticated. Globally, cybercrime costs are now growing at the rate of 15% per year,[1] and each internet-connected computer is probed by hackers once every 39 seconds on average.[2] The average cost of a data breach in 2023 was about $4.5M.[3] Businesses face advanced persistent threats that are becoming more destructive and harder to detect, while ransomware continues to evolve, with potentially devastating results. Meanwhile, attacks are becoming easier to perpetrate, including with greater automation and "as-a-service" models that streamline cybercriminal workflows.

One response to this treacherous security landscape has been the evolution of NGFWs to offer more advanced services and sustain high performance as network traffic levels grow. In particular, NGFWs delivered as hardware appliances or for dedicated server deployments on-premises must deliver high throughput per CPU and per watt for processing-intensive functions such as deep packet inspection. These properties help deliver cost-effective results by handling higher packet rates per device and a smaller data center footprint, as well as lower energy consumption to help reduce operating costs.

Intel Xeon 6 processors break new ground in performance, density and power savings with up to 144 E-cores per socket. Together with the software concurrency enabled by high core counts, high per-core performance helps drive up NGFW throughput. The power efficiency advantages of the E-core architecture compound that value, helping reduce total cost of ownership. These characteristics of Intel Xeon 6 processors make them an outstanding foundation to help increase competitiveness of enterprise NGFW hardware appliances and software solutions for dedicated servers.

NGFW on Intel® Xeon® 6 processors

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Intel® Xeon® 6 processor

UP TO **5.8x** higher NGFW performance[4]

UP TO **3.5x** higher performance/watt (socket power)[4]

with Intel® Xeon® 6780E processor vs 2nd Gen Intel® Xeon® Gold 6252N processor on Next Gen Firewall solutions

Supporting key NGFW design considerations

In a typical deployment at the boundary between networks or subnetworks with different trust levels, the NGFW must perform all its functions at line rate to avoid becoming a bottleneck. The requirement is becoming more demanding as the scope of security functions it handles continues to grow, including at layer 7 (L7) of the OSI protocol stack, such as deep packet inspection (DPI). Fundamental NGFW attributes and capabilities — to which many may be added for specific solutions — include the following:

- **Traditional stateful firewall capabilities** such as port and protocol inspection and blocking.

- **Integrated intrusion protection system (IPS)** to monitor the network for signs of attacks and policy violations.

- **Application awareness** to inspect traffic and identify applications, to allow or block traffic according to policy.

The amount of processing that the NGFW must perform on a given packet varies dramatically at different layers of the stack and with varying traffic profiles. This attribute makes it desirable to have granular control over the power/performance of processing resources.

Content inspection is among the most resource-intensive components of NGFW services, because it requires inspection of the full packet payload. The pervasive encryption and decryption required for VPN and TLS also takes significant compute, including for TLS handshake negotiation.

Global ecosystem engagement through Intel® Network Builders

Intel® Network Builders, part of the Intel Partner Alliance, provides community and enablement for diverse industry providers including for NGFWs and other security elements. To help improve the quality and interoperability of components and solutions, it includes a broad and deep framework of collaboration that encompasses the following:

- 350+ global member companies

- 100+ proofs of concept, trials and deployments

- 13,000+ developers trained worldwide

CPU innovation drives NGFW evolution

Intel Xeon 6 processors with E-cores provide breakthrough core density per socket for high throughput with outstanding energy efficiency on NGFW workloads. As the underlying CPU platform for hardware appliances or dedicated NGFW servers, Intel Xeon 6 processors are tuned and optimized for networking and security, which helps drive up NGFW product performance and quality. Intel Xeon 6 processors deliver advanced resources across a balanced platform:

- **Up to 144 Efficient-cores (E-cores) per socket,** in one- or two-socket configurations, are augmented with built-in accelerators[5] that enhance targeted workloads for high throughput at scale.

- **Eight DDR5 memory channels per CPU,** operating at up to 6400 MT/s, provide up to 15% higher bandwidth versus the previous generation to keep the massive execution resources supplied with data.

- **Up to 88 lanes of PCIe 5.0 per socket and Compute Express Link (CXL) 2.0** provide robust I/O to support workload acceleration and data growth for high throughput.

FORTINET

Fortinet has been helping drive the evolution of cybersecurity since its founding more than 20 years ago. The company's history of deep optimizations for Intel® platforms delivers breakthrough performance and power efficiency on Intel® Xeon® 6 processors.

"Enables continuous and critical innovation for the industry"

– Neil Prasad, VP of Global Technology Alliances, Fortinet

The E-cores that Intel Xeon 6 processors are based on are engineered for high performance, low per-core energy consumption and small physical size. High core base frequency helps drive line-speed throughput for the expanding full-stack range of NGFW functions. The unparalleled Intel software ecosystem, including both open source commitment and partnership with industry leaders, provides rich enablement for NGFW vendors. Optimized and validated software building blocks help streamline product development for faster time to market and reduced cost and risk.

NGFW makers can help accelerate their time to market with software compatibility between E-cores and other Intel architectures past and present, including processors based on Performance-cores (P-cores). This unified coding environment enables reuse of software components across products. For NGFWs, this includes hardware appliances, on-premises server software and cloud security functions, including those delivered as managed services. Intel Xeon 6 processors with E-cores also help maximize the value of development investments with long-life availability.[6]

The high performance and performance per watt of the processor cores is assisted by offloading specific tasks to built-in hardware accelerators. These purpose-built engines accelerate workloads in hardware, with higher throughput and energy efficiency than performing them in software on the processor cores, as well as freeing those resources for other work. They also offer significant power and latency advantages compared with dedicated accelerators on add-in-cards that require communication across the PCIe bus. Intel provides software libraries and other enablement to simplify implementation. Accelerators and related technologies in Intel Xeon 6 processors that particularly benefit NGFW designs are described in the remainder of this section.

Intel® QuickAssist Technology (Intel® QAT)

Intel QAT is a hardware accelerator for data encryption/decryption and public key cryptography for key exchange, and it also accelerates compression/decompression. Intel QAT acceleration is incorporated into the open source Vector Packet Processing (VPP) framework to improve symmetric encryption performance, including for the IPsec cryptographic protocol. Integration with OpenSSL accelerates asymmetric encryption including improved TLS handshake performance.

Intel® Advanced Vector Extensions 2 (Intel® AVX2)

Intel AVX2 provides single instruction multiple data (SIMD) instructions to accelerate content inspection use cases such as policy or pattern matching as well as cryptographic operations. Intel's Hyperscan library takes advantage of SIMD instructions to boost NGFW performance significantly.

Intel® Speed Select Technology (Intel® SST)

Intel SST provides multiple frequency and power configurations that can be assigned on a per-core basis, according to profiles established for specific tasks and use cases. This ability benefits the range of resource requirements among various NGFW functions discussed earlier in this brief. For example, demanding L7 use cases such as DPI and IPS can be dynamically switched from the default Networking profile to Compute mode to increase core frequency and throughput, within overall system Thermal Design Power (TDP).

Validating performance and performance per watt gains

Using an internally developed benchmarking tool, an Intel performance engineering team tested Intel Xeon 6 processors against predecessors to quantify gains in NGFW performance and performance per watt. Cleartext content inspection was chosen for testing, as a particularly compute-intensive workload that combines L2-L4 stateful firewall functions, implemented using VPP, with L7 IPS, using Snort. The test architecture is shown in Figure 1 and Table 1. See the NGFW optimizations solution brief for more architecture details.
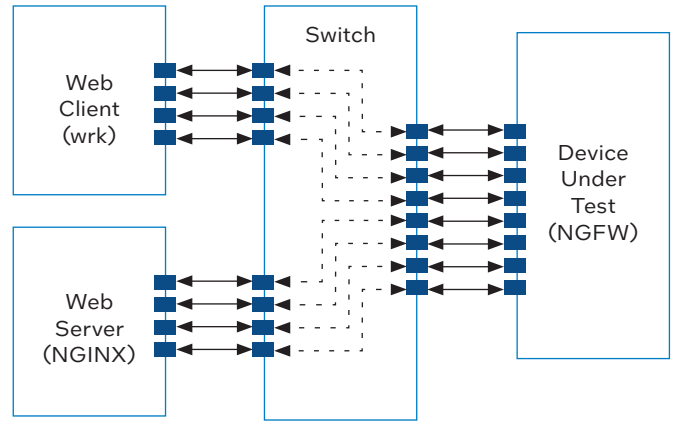

Figure 1. NGFW test architecture

Table 1. NGFW test configuration.

Metric	Value
Use Case	Cleartext inspection (firewall and IPS)
Traffic Profile	HTTP 64 KB
VPP ACLs	Yes (two stateful ACLs)
Snort Rules	lightSPD (~49K rules total)
Snort Policy	Security (~19K rules enabled)
GET Requests per Connection	1

The team found Snort to be by far the most compute-intensive element of the test architecture. While in some cases, not all packets need to be processed by Snort, this differential typically makes it appropriate to assign more cores to Snort than to VPP.

Overall, test results show steady improvement in both throughput and throughput per watt on successive processor generations, as shown in Figure 2.[4] Performance gains are relatively linear, from 2nd Gen Intel Xeon Scalable processors introduced in 2019 through Intel Xeon 6 processors in 2024.
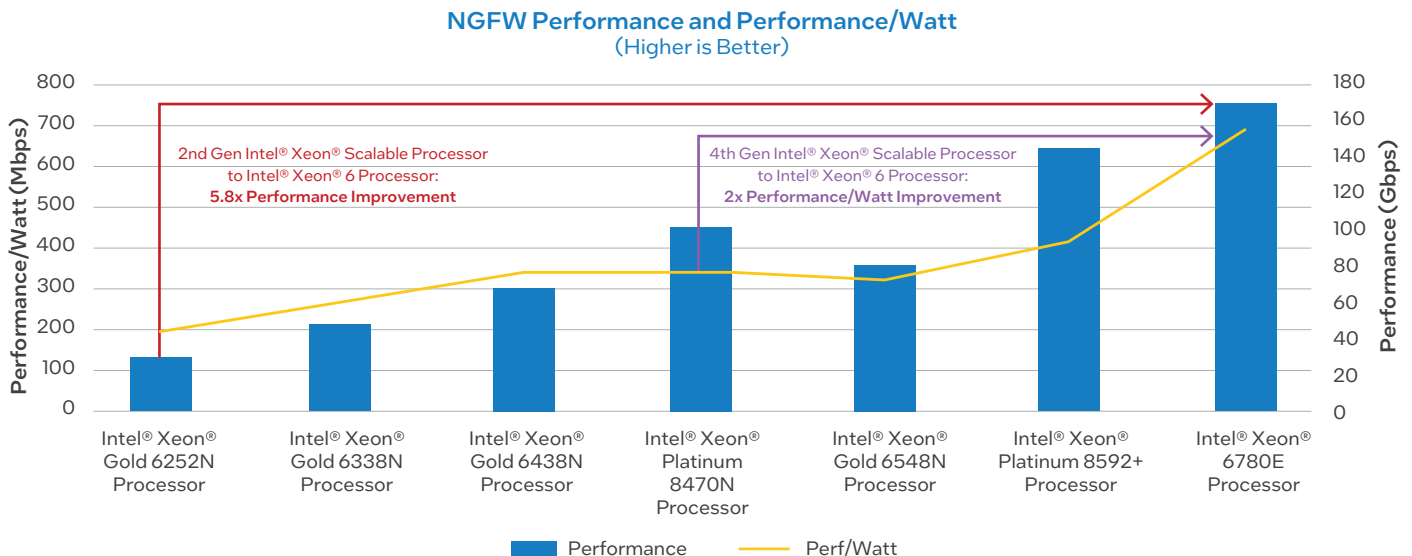
NGFW Performance and Performance/Watt
(Higher is Better)

2nd Gen Intel® Xeon® Scalable Processor to Intel® Xeon® 6 Processor:
5.8x Performance Improvement

4th Gen Intel® Xeon® Scalable Processor to Intel® Xeon® 6 Processor:
2x Performance/Watt Improvement

Figure 2. NGFW performance and performance per watt gains with Intel® Xeon® 6 processors.[4]

Performance per watt on the same range of CPUs shows increases at a higher than linear rate. While those increases are substantial from 2nd Gen to 4th Gen, Intel Xeon 6 processors with E-cores provide 2x performance per watt improvement over 4th Gen Intel Xeon Scalable processors in these results.[4] These power-efficiency improvements help NGFWs reduce total cost of ownership, enabling a potential competitive advantage.

Conclusion

Intel Xeon 6 processors with E-cores give NGFW vendors a compelling foundation for high-throughput, energy-efficient hardware appliances. They are software-compatible with other Intel processors, promoting code reuse across data center, edge and cloud solutions, for faster time to market and lower development cost. Up to 5.8x higher performance and 3.5x higher performance/watt (socket power) with Intel® Xeon® 6780 processor, versus 2nd Gen Intel Xeon 6252N processor enable superior results.[4] Looking forward, Intel Xeon 6 processors will support the future where NGFWs continue to have more sophisticated and comprehensive functionality added.

Learn More

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Solution provided by:

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[1] Cybercrime Magazine, May 24, 2023. "2023 Cybersecurity Almanac: 100 Facts, Figures, Predictions, And Statistics." https://cybersecurityventures.com/cybersecurity-almanac-2023/.

[2] Astra IT, September 13, 2023. "160 Cybersecurity Statistics 2023 [Updated]." https://www.getastra.com/blog/security-audit/cyber-security-statistics/.

[3] IBM. "Cost of a Data Breach Report 2023." https://www.ibm.com/reports/data-breach.

[4] See [7N2] at intel.com/processorclaims: Intel® Xeon® 6. Results may vary.

[5] Availability of accelerators varies depending on SKU. Visit the Intel® Product Specifications page for additional product details.

[6] Intel does not commit or guarantee product availability or software support by way of road map guidance. Intel reserves the right to change road maps or discontinue products, software and software support services through standard EOL/PDN processes. Contact your Intel account rep for additional information.

See [7N2] at intel.com/processorclaims: Intel® Xeon® 6. Results may vary.