Solution Brief

Network Load Balancing
Intel® Xeon® 6 Processors with P-cores

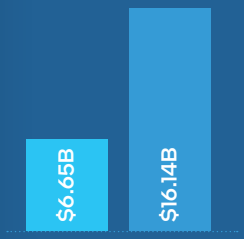
Optimized Network Load Balancers Improve Performance, Scalability, Cost and Security

Ecosystem enablement across network load balancer solutions helps take advantage of the features and capabilities of the Intel® Xeon® 6 processor with Performance-cores (P-cores). The platform supports large numbers of HTTPS connections in data centers, at the edge and in the cloud for increasingly distributed workloads that are often based on microservices.

Enterprises must innovate to deliver excellent user experiences in the face of growing data volumes and computing requirements across increasingly distributed environments. Network and application workloads must drive performance and scale as they become more sophisticated and resource-intensive. To meet the business needs associated with those technical requirements, IT organizations are under pressure to drive up operational cost efficiencies.

Network load balancers help enterprises make better use of resources by intelligently distributing work among server endpoints. They are becoming increasingly important in IT environments, as reflected by the market segment's 15.9% CAGR globally, across load balancer hardware, software and services.[1] Assigning workloads intelligently with network load balancing helps increase server utilization and avoids overloading any particular resource, even during periods of peak demand. Load balancing application traffic enhances service availability and helps application capacity scale up and down smoothly, which helps avoid lost revenue and reputational damage due to poor customer experiences.

Global Network Load Balancer Market Size[1]



15.9%
CAGR,
2024-2030

Largest Market:
North America

Fastest Growing Market:
Asia Pacific

As more network traffic and applications move to the edge and cloud, network load balancers play an increasing role in accelerating networking and security functions, including providing a layer of protection for backend servers and performing Transport Level Security (TLS) encryption and decryption. Layer 7 load balancers in particular direct traffic streams based on application-layer protocol data such as HTTP headers and SSL session IDs.

Terminating TLS connections at the network load balancer offloads encryption and decryption from application servers, helping optimize responsiveness over HTTPS streams. For threat response, network load balancers can direct traffic away from compromised systems or help mitigate distributed denial of service attacks. They can also integrate with firewalls, to support traffic inspection capabilities based on rule matching or deep learning inference.

Intel works with key ecosystem providers to enable leading offerings to take advantage of the performance and security capabilities of Intel platforms. With the introduction of Intel® Xeon® 6 processors, network load balancers deliver new enterprise value to drive future-focused performance, scale, cost efficiency and security.

Network load balancing advantages with Intel Xeon 6 processors

Intel Xeon 6 processors with P-cores build on the capabilities of predecessors to improve performance and performance per watt, helping drive higher compute throughput and lower energy costs. They are engineered and tested to handle compute-intensive network workloads at scale, including network load balancing and security services. Robust resources including hardware-based and built-in workload acceleration drive up throughput in network load balancers, avoiding bottlenecks even when traffic levels are high. Intel Xeon 6 processors provide improvements across execution, memory and I/O for load balancing and other critical network functions:

- **Up to 86 P-cores per socket** based on the latest Intel 3 process technology for high-throughput workload processing with enhanced instructions and built-in hardware accelerators.
- **Memory subsystem enhancements** including up to eight channels of DDR5-6400 MT/s or 8000 MT/s MCR DIMM memory and a larger L2 cache than predecessors.
- **Increased I/O resources**, with up to 88 lanes of PCIe 5.0, four UPI 2.0 links at up to 24 GT/s and up to 64 lanes of CXL Type 3 per socket.

Intel Xeon 6 processors deliver throughput and power-efficiency advantages as the foundation for load balancer appliances, the system to run load balancer software or the platform to run load balancer as a cloud-native or virtual network function (VNF). Processor offloads for critical functions such as encryption reduce the associated performance impacts to maintain responsiveness and a high-quality user experience, even when network demands are at their highest.

Intel Xeon 6 processors provide a range of built-in hardware accelerators that are each purpose-built to increase performance on a specific type of workload, including tasks for data movement, analytics, AI and security. Accelerators that are central to the network load balancing function are discussed in the remainder of this section.

Accelerate AES cryptography

Intel® Advanced Encryption Standard New Instructions (Intel® AES-NI) accelerate certain processing-intensive parts of the AES block cipher in hardware to further increase crypto performance on the platform. The architecture consists of six instructions that offer full in-processor hardware support for AES. Four instructions (AESENC, AESENCLAST, AESDEC and AESDECLAST) facilitate high-performance AES encryption and decryption, and two other instructions (AESKEYGENASSIST and AESIMC) support AES key generation. Vector AES-NI extends Intel AES-NI using Intel® Advanced Vector Instructions 2 (Intel® AVX2) or Intel® Advanced Vector Extensions 512 (Intel® AVX-512), enabling the cryptographic workloads to operate in parallel on up to four separate data elements simultaneously. That data is stored in registers up to 512 bits wide, providing up to a 4x increase in throughput. Vector AES-NI is incorporated into the OpenSSL library and is fully supported on Intel Xeon 6 processors.

Note: AES-256 is broadly considered to be quantum-safe. The Intel Xeon 6 processor provides acceleration for AES-256.

Balance system processing load among cores

Intel® Dynamic Load Balancer (Intel® DLB) is a hardware accelerator built into Intel Xeon 6 processors that improves system performance related to data handling by efficiently distributing work among CPU cores/threads, dynamically adapting to varying system loads. The technology also assists in restoring the order of networking packets after they have been processed across separate processor cores. Intel DLB complements network load balancing for handling the large continuous TCP traffic flows sometimes referred to as "elephant flows."

Accelerating load balancing on Intel Xeon 6 platforms with Intel® Ethernet E830 and Intel Ethernet E610 Controllers and Network Adapters

Intel® Ethernet E830 and E610 Network Adapters enhance network load balancing by delivering high throughput and low latency, crucial for real-time applications. The E830 products support high port density with bandwidth of up to 200 GbE and incorporate features including Dynamic Device Personalization (DDP) and hardware assists to offload CPU tasks. The E610 offers flexibility with 2.5G and 10GBASE-T options. Both employ the Data Plane Development Kit (DPDK) for optimized packet processing, enabling improved performance and scalability for demanding network environments.

Ecosystem Support Through Intel® Industry Solution Builders

The Intel Industry Solution Builders program helps partners innovate and adapt to evolving business, technology and end-user needs, effectively and cost-efficiently. The program provides members with a variety of technical enablement options such as hands-on support from subject matter experts, access to virtual testing and optimization labs, training, tools and other resources.

Real-world implementation example with NGINX

NGINX is an open source web server that provides many supporting services, including load balancing functionality as well as other capabilities to optimize application delivery, such as reverse proxy and HTTP caching. F5 provides an enterprise version of the software on a paid basis as NGINX One. Used by a large proportion of the world's websites, NGINX helps scale and secure enterprise operations, including enhancing administrative control over the data plane to enhance agility and speed.

"With the advancement of AI technologies, including Generative AI and Large Language Models, more workloads and data are being generated and processed at the edge. F5 is excited about the Intel® Xeon® 6 processor, which enables us to collaborate and deliver enhanced network and security workload performance. This collaboration is crucial for supporting critical network infrastructure that requires handling large data traffic with mission-critical value."

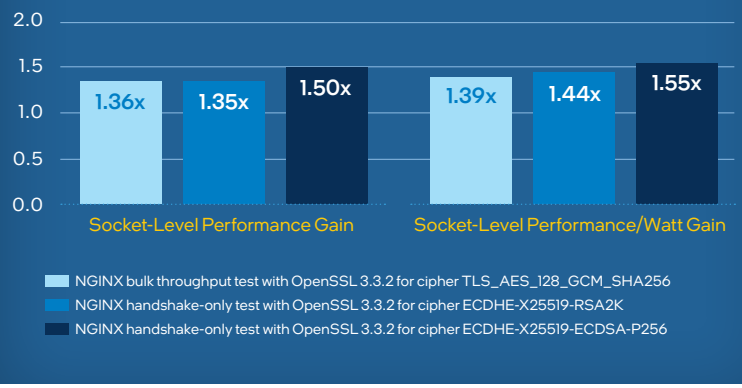
– Shawn Wormke, General Manager of NGINX at F5

Additional capabilities include acting as an API gateway to harden protection for APIs and backend servers against network cyberthreats with authentication, authorization and policy management. API performance is protected with health monitoring and reporting, as well as real-time analytics for insights that help improve deployment, operation and management. NGINX App Protect, a web application firewall, is designed to help defend against attacks and protect digital assets and systems.

Intel enablement for NGINX on Intel Xeon 6 processors demonstrates substantial increases in HTTPS performance. Compared to 5th Gen Intel Xeon Scalable processors, the Intel Xeon 6 processor increases socket-level NGINX throughput by up to 1.36x and NGINX handshake performance by up to 1.50x.[4] The Intel Xeon 6 processor increases socket-level NGINX throughput per watt by up to 1.39x and NGINX handshake performance per watt by up to 1.55x.[4] These performance increases reflect the CPU's balanced platform improvements across execution, memory and I/O.

NGINX Performance and Performance per Watt Gains:

Intel® Xeon® 6 Processor with P-Cores vs 5th Gen Intel® Xeon® Processor[4]
(Higher is Better)



Like other load balancers, NGINX can be deployed alongside Layer 7 web application firewalls such as NGINX App Protect to optimize traffic inspection and prevent common attacks based on SQL injection and cross-site scripting (XSS), as well as more unusual ones such as remote code execution. They can also block traffic from known malicious IP addresses and identify known threats as well as suspicious behaviors that suggest unknown ones.

High Density Software Load Balancer (HDSLB)

HDSLB is a high-performance Layer-4 network load balancer. This software is specially optimized on Intel processors for scenarios requiring superior performance. It leverages advanced techniques, such as lock-free architecture, the separation of fast and slow paths and vectorized packet processing. HDSLB can achieve high performance on Intel® Xeon® 6 processors.

Traffic inspection based on rule-based matching against known threats can be accelerated on NGINX using Hyperscan. This high-performance regular expression (regex) library developed by Intel is optimized for performance on Intel Xeon 6 processors using Intel AVX-512 technology for vectorized operation and higher throughput.

In addition, AI-based matching extends detection capabilities to unknown threats, using models and frameworks that are highly optimized for the hardware features of Intel Xeon 6 processors. One such optimization is the use of AVX-512 vector neural network instructions (VNNI), which fuse together instructions to reduce the number of steps needed for repeated multiplication and accumulation of values. In addition, Intel® Advanced Matrix Extensions (Intel® AMX), a purpose-built accelerator built into the platform, accelerates the matrix multiplication operations at the heart of deep learning algorithms.

Together, these optimizations accelerate network security operations associated with network load balancing solutions including NGINX, with future-focused optimizations to support ongoing innovation.

Conclusion

Intel Xeon 6 processors and optimizations for network load balancers help deliver application throughput, reliability, cost efficiency and security. The hardware platform's advances across execution, memory and I/O resources, together with built-in hardware accelerators, increase socket-level performance by up to 1.50x and socket-level performance per watt by up to 1.55x.[4] As load balancers play a growing role in security, the processor provides additional acceleration for both rule-based pattern-matching and AI-driven traffic inspection that helps harden applications against threats, adding further to the value proposition for improved network operation and TCO.

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Learn More
www.intel.com/xeon
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[1] Grand View Research, July 2024. "Load Balancer Market Size, Share & Trends Analysis Report, 2024 - 2030." https://www.grandviewresearch.com/industry-analysis/load-balancer-market-report.

[2] See [7G20] at intel.com/processorclaims: Intel® Xeon® 6. Results may vary.

[3] See [7G21] at intel.com/processorclaims: Intel Xeon 6. Results may vary.

[4] See [7N25] at intel.com/processorclaims: Intel Xeon 6. Results may vary.

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