NETRONOME SOLUTION OVERVIEW

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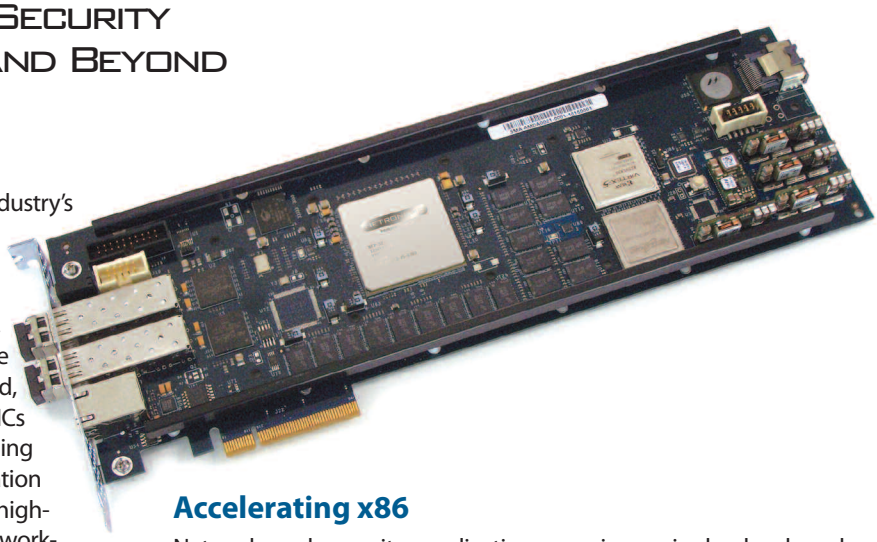
Netronome Network Flow Engine NFE-3240

Accelerate Network and Security Applications to 40 Gbps and Beyond



Netronome's Network Flow Engine (NFE-3240) is the industry's highest-performance PCIe acceleration card specifically designed to improve the network performance of Intel®-based appliances and servers. Available in 2-port 10 Gigabit Ethernet and 6-port Gigabit Ethernet options, the NFE-3240 provides up to 20 Gbps of line-rate programmable packet and flow processing per card, providing a 10x performance increase over standard NICs in real-world network and security applications running on IA/x86 systems. The NFE-3240 enables the acceleration of network and security applications by utilizing high-performance packet processing delivered from 40 networking-optimized microengine processor cores. The NFE-3240 utilizes several techniques to dramatically improve network I/O workloads, including packet classification, stateful flow analysis and action processing, deep packet inspection and dynamic load-balancing of flows across a high-performance virtualized PCIe datapath to multiple x86 CPU cores to parallelize application processing.

Powered by Netronome's Network Flow Processor, the NFE-3240 is ideal for high-speed, packet capture or inline applications requiring zero packet loss and low latency. Standard Linux®-based applications can quickly take advantage of these capabilities coupling the high-throughput capabilities of the NFE with the high-compute power of multicore x86 architectures for application and control plane processing.

The NFE significantly increases host application performance through:

- The ability to perform over 1,800 instructions/packet at 30 million pps delivered from 40 microengine RISC cores operating at up to 1.2 GHz;
- Line-rate flow processing, packet inspection and packet capture across all packet sizes;
- Integrated security processing including 20 Gbps of line-rate cryptography and PKI operations;
- Enhanced I/O virtualization (IOV) support offering bandwidth guarantees and isolation with extremely low latency to over 2,000 x86 destinations;
- Exemplary development tools, including a GUI-based software development kit, C-based APIs, extensive software libraries and sample applications;
- Full programming flexibility to support network or protocol changes; and
- Green computing through the industry's highest BIPs (billion instructions per second) per watt.

Accelerating x86

Network and security applications are increasingly developed and deployed in x86-based appliances. The x86 architecture alone, however, struggles to provide the required network intelligence at high throughputs. Netronome's acceleration architecture builds on the price, performance and innovation of the of x86 and augments it in functional areas in which it is not optimized, like I/O, packet and flow processing, as well as security processing. This tight combination of x86 with the NFE-3240 gives developers an open platform for application development reaching 40 Gbps and beyond through:

- **Rapid TTM:** Simple and easy integration with existing Linux-based network and security applications;
- **Reduced R&D:** Fully standards-based, using PCIe as an interface to standard COTS servers, to provide a high-performance networking appliance;
- **Lowest cost:** Industry-redefining price-per-megabit when compared to x86 alone or custom hardware developments; and
- **Green computing:** The industry's highest BIPS per watt.

Enhanced I/O Virtualization

The explosion of task-specific network and security appliances within networks has created a significant cost, power and operational challenge. Many network operators are taking advantage of highly virtualized solutions to meet these challenges. Cloud computing, next-generation data center servers and appliances, and new network infrastructure products are all taking advantage of highly virtualized multicore processors to reduce the required number of network devices. The missing link to unify these virtualized network and x86 environments is I/O virtualization (IOV) in servers and network appliances. Without IOV, many of the benefits provided by operating system (OS) virtualization are lost. IOV provides guaranteed bandwidth, latency and isolation of traffic across multiple cores and VMs.

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Through the NFE-3240's enhanced IOV support, the NFE and x86 workload-optimized processor domains are linked via an enhanced version of PCI Express 2.0's IOV standard. This creates a high-performance, virtualization-aware communications path offering bandwidth guarantees and isolation with extremely low latency. Zero-copy drivers allow for fast and efficient big-block transfers of data from the NFE-3240 to the x86 cores, virtual machines or over 2,000 virtual end points. This high-performance, network I/O-aware communications path provides the final link between virtualized network infrastructure, multicore network-optimized flow processors and general-purpose multicore application processors.

Power Efficiency

As data centers explode to meet our insatiable appetite for bandwidth and storage, the amount of electricity required to power them has continued to double every five years. The real measure of power efficiency is not only the total power consumption of a particular device, but rather the power used per gigabit of workload processing. Combining standard x86 platforms with the network- and security-optimized multicore processors on the NFE-3240 provides solutions with the highest performance-to-power consumption ratio available in the industry and can reduce power consumption by up to 70%.

Competitive Approaches

There are three distinctly different interface card types to consider and compare to the NFE. First, commodity 10GigE NICs from vendors provide no network acceleration and simply are a conduit to get packets from the interfaces into the operating system OS kernel. They rely completely on the x86 general-purpose cores for networking and security, as well as application and control plane processing and, thus, suffer from extreme performance degradation at high network throughputs.

Other specialized packet capture cards are optimized for efficiently getting packets into x86 cores bypassing the OS kernel, but again provide no CPU offload mechanisms. These cards also are incapable of supporting inline applications and, rather, only support passive packet capture applications.

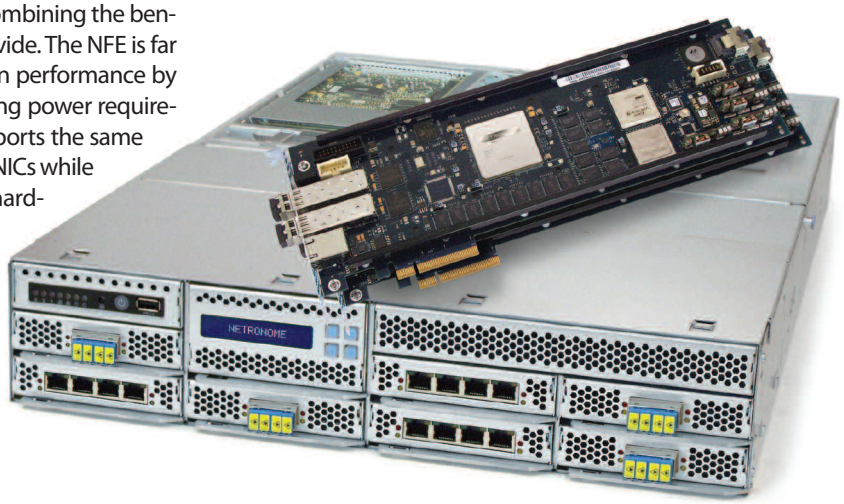
Finally, a third alternative is interface cards with supporting general-purpose processing cores. These solutions require extensive software development and recommend offloading entire applications to the card processor cores, as opposed to a cooperative processing environment with x86, which is workload-specific.

The NFE-3240, on the other hand, outrivals these three alternatives on price, flexibility and performance while combining the benefits that all three alternatives can individually provide. The NFE is far superior to commodity NICs on overall application performance by significantly increasing performance while lowering power requirements from a BIPs/watt perspective. The NFE supports the same packet capture performance as passive capturing NICs while adding support for inline applications through hardware-based packet classification, flow state maintenance, security processing and virtualization. The NFE also is superior to the general-purpose processing core alternatives through the heterogeneous processing architecture and speeds development with a set of open APIs relieving developers from having to port their software to a different architecture.

Heterogeneous Multicore Processing Architecture

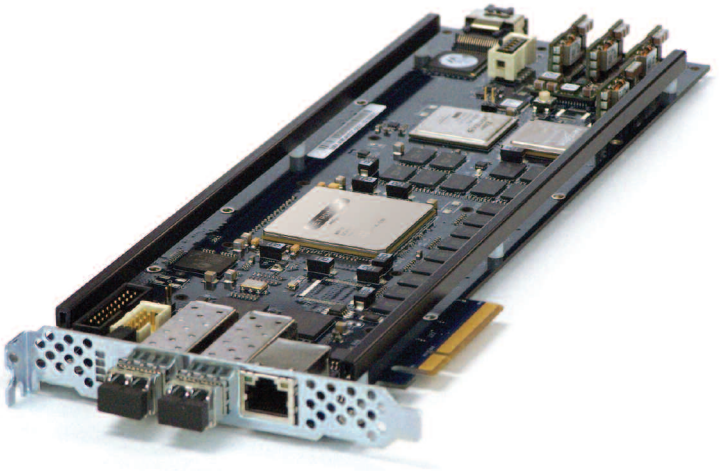
Network traffic in both enterprise and carrier networks continues to rise, driving bandwidth requirements to 10 Gbps today with expectations of quickly growing to 40 Gbps and beyond. With the need for application awareness, deep packet content inspection and security processing, the amount of processing power required within the network infrastructure grows exponentially at these increasing line rates.

To meet these performance challenges, Netronome has created a new and innovative processing paradigm for high-performance systems required by the intelligent network capable of analyzing traffic at L2-L7 at sustained throughputs of 10 Gbps and higher. Achievement of these goals requires specialized and varied processing elements, each custom-designed for a specific type of workload computation. Using the NFE-3240 in a heterogeneous multicore architecture sets a new performance benchmark for embedded application development though multiple levels of packet, flow and application processing, each with increasing levels of granularity. The architecture tightly couples network flow processor (NFP) cores with general-purpose multicore x86 systems over a high-speed, virtualized PCIe datapath. This architecture can provide developers with a common product architecture that scales from very low-end systems to appliances offering hundreds of Gigabits per second of application throughput, all with a common software architecture. This processing architecture provides line-rate application performance and extremely low latency while retaining the comfort, familiarity and standardization of x86. Designs based on this heterogeneous multicore architecture enable equipment providers to deliver high-performance, flexible and field-programmable systems that are up to ten times more efficient than traditional x86 systems with standard network interface cards (NICs).



Features

- High-performance network flow processing powered by the NFP-3240 (40 MEs @1.2 GHz)
- TCAM-based packet classification for up to 64,000 rules
- Stateful flow analysis and action processing for up to 8 million flows in hardware
- Flexible interface options including 2x10GigE and 6x1GigE and a netmod interface
- High-speed PCIe Gen2 interface with 8 lanes offering up to 40 Gbps of bandwidth between the NFE and the host x86 system
- Hardware-based cryptography and PKI operations
- Low latency with less than 150µs for inline applications and less than 40µs for full traffic offload onto NFE
- Packet timestamping with 11ns accuracy
- I/O virtualization through an enhanced version of the SR-IOV standard for communication to over 2,000 x86 and networking endpoints
- Dynamic load balancing to parallelize application performance
- Full programming flexibility to support network or protocol changes
- Fully supported C APIs
  - PCIe messaging datapath and tools for microengine (ME) programming
  - An abstraction layer that controls the packet processing occurring in the NFE MEs



Specifications

Model Number	NFE-3240
Network Ports	Two 10GigE, six 1GigE or netmod interface options
NPU Type	NFP-3240
NPU Clock	up to 1.2Ghz
TCAM	up to 36MB
QDR SRAM	up to 32MB @ 300Mhz
DDR3	up to 4GB @ 1066Mhz
Media Types	Twisted-pair copper or fiber
Port Speeds	10 Gbps or 1000 Mbps
Connectors	RJ-45 or SFP+
Bus Type	PCI Express Gen 2 x8
Power	75W (maximum)
Diagnostic LEDs	Link status, network activity, and status
Platforms	64-bit IA/x86-compliant

Environmental

Operating Temperature	0-50°C
Storage Temperature	–10-70°C
Operating Humidity	10-90% (non-condensing)

Dimensions

Dimensions (without extender bracket)	311.988mm (12.283") x 98.400mm (3.874") x 14.10mm (0.555")
Dimensions (with extender bracket)	337.988mm (13.307") x 98.400mm (3.874") x 14.10mm (0.555")
Weight (including two SFP+ Modules)	400g (14.11 oz.)

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Netronome has operations in:
USA (Pittsburgh [HQ], Santa Clara & Boston), UK (Cambridge), Malaysia (Penang), South Africa (Centurion) and China (Shenzhen, Hong Kong)

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