nGENIUS 6000 SERIES PACKET FLOW SWITCH ARCHITECTURE
HIGH-DENSITY PACKET FLOW SWITCHING
Overview & Specifications

NETSCOUT nGenius® 6000 series packet flow switch (PFS) is the most advanced system for high-density port aggregation and packet forwarding for monitoring and security tools. Featuring a robust packet handling architecture, as well as hardware acceleration components, it enables network packets to be properly optimized for each tool—regardless of whether they are encapsulated or fragmented, and no matter where or when they occurred, making it especially useful in Carrier networks, as well as in large Enterprise networks.

nGenius PFS 6010 can be seamlessly inserted into the NETSCOUT unified visibility plain, which enables a network monitoring fabric that supports thousands of access ports across multiple sites, globally.

nGenius PFS 6010 system consists of a 15RU chassis that supports speeds of 1Gbps to 100Gbps on up to ten blades (referred to as line cards), with each line card supporting up to 600Gbps throughput—for a chassis total of 6Tbps of throughput and up to 600 ports.

All power supplies, fans, air filters, and line cards are hot swappable. The redundant power supply entry units allow seamless transitions between power systems to ensure uptime. The management module and fabric modules also have redundancy.

nGenius PFS 6010 features a patented cooling system that ensures continuous heat dissipation, regardless of air-intake constraints in crowded data centers.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>nGenius PFS 6010</th>
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<tbody>
<tr>
<td>Chassis Height (RU)</td>
<td>15 RU</td>
</tr>
<tr>
<td>Line Card Slots</td>
<td>10</td>
</tr>
<tr>
<td>Management Module Slots</td>
<td>2</td>
</tr>
<tr>
<td>Maximum System Density - 1GigE ports</td>
<td>360 x 1G/10G</td>
</tr>
<tr>
<td>Maximum System Density - 40GigE ports</td>
<td>600 x 10G</td>
</tr>
<tr>
<td>Maximum System Density - 100GigE ports</td>
<td>150 x 40G</td>
</tr>
<tr>
<td>System Fabric Capacity</td>
<td>6Tbps unidirectional (12Tbps bidirectional)</td>
</tr>
<tr>
<td>Maximum Throughput per Line Card</td>
<td>60 x 100G</td>
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</tbody>
</table>

Table 1: nGenius PFS 6010 Specification Table.

Line Card

nGenius PFS 6010 line cards use onboard packet processors to provide distributed data-plane forwarding. Forwarding between ports on the same packet processor uses local resources and no fabric bandwidth is used. Forwarding across different packet processors uses all available crossbar fabrics (3 + 1 (optional)) in a fully active/ active mode.

All stages associated with packet forwarding are performed in integrated system-on-chip packet processors. A packet processor provides both the ingress and egress packet-forwarding pipeline for packets that arrive or are destined to ports serviced by that packet processor. Each packet processor can perform local forwarding for traffic between ports on the same packet processor.

Each standard blade features three packet processors. Advanced line cards feature two packet processors on each line card along with other programmable hardware elements.

ARCHITECTURE

nGenius PFS 6010 uses both standard silicon (such can be found in high-end switches), and specialized hardware, which supports advanced feature sets. The hardware system employs an orthogonal design, with three horizontally placed CLOS fabric modules supporting up to 10 line cards with onboard packet processors. This orthogonal design eliminates the need for a mid-plane, further increasing the high performance of the system.

Modules

- **36S6Qstd Line Card**
  36 x 1Gb/10Gb SFP+ Ports & 6 x 40Gb QSFP+ Ports

- **15Qstd Line Card**
  15 x 40Gb QSFP+ Ports

- **6Cstd Line Card**
  6 x 100Gb CFP2 Ports

- **40Sadv Line Card**
  40 x 1Gb/10Gb SFP+ Advanced Ports and Advanced feature packages

Figure 1: nGenius PFS 6010 Blade and Chassis System.
All stages associated with packet forwarding are performed in integrated system-on-chip packet processors. A packet processor provides both the ingress and egress packet-forwarding pipeline for packets that arrive or are destined to ports serviced by that packet processor. Each packet processor can perform local forwarding for traffic between ports on the same packet processor.

Each standard blade features three packet processors. Advanced line cards feature two packet processors on each line card along with other programmable hardware elements.

These other hardware elements include:

- **Gearboxes** – All ports are driven directly from the packet processors, with the exception of the 100GigE ports, which feature a gearbox (PHY) to convert from one number of media lanes to another.
- **FPGAs** – Packet processors are supplemented by FPGAs and RLDRAM for supporting specialized functions such as accurate time stamping, protocol stripping/de-encapsulation, conditional packet slicing, encapsulated packet filtering/balancing, packet de-duplication, and other applications.

**Packet Processors**

The packet processors on each line card perform all packet ingress and egress functions. The network interface is responsible for receiving and transmitting bit streams from the physical interfaces (networks, tools, or interconnects). The ingress packet processor is responsible for dividing packets into 256 Byte cells for transmission across the crossbar fabric. In turn, the egress packet processor is responsible for reassembling cells received from the crossbar fabric back into packets. For packet forwarding to a port on the same packet processor, the ingress packet processor will handoff traffic to the egress packet processor, with no consumption of fabric resources.
The fabric modules provide CLOS cell-based forwarding between packet processors on each line card. Packets are transmitted across the crossbar fabric in cell sizes of 256 bytes each and all available crossbar data paths are used active/active.

![Fabric Module Architecture](image)

**Fabric**

PFS 6010 uses three active/active fabric modules (a fourth fabric module is available for redundancy), where every packet processor across all blades is directly connected to each fabric. Each crossbar fabric provides up to 2.8Tbps raw fabric bandwidth full duplex. Useable bandwidth is 2Tbps, with total useable bandwidth across all fabrics equal to 6Tbps. With the fourth fabric module, an additional 2Tbps bandwidth is available for a total (overprovisioned) fabric bandwidth of 8Tbps; however the maximum system bandwidth is 6Tbps.

![Packet Processor Architecture](image)
Management Modules
Management modules on nGenius PFS 6010 are used for control-plane and management-plane functions only; all data-plane forwarding logic occurs on line cards and forwarding between line cards is always via the crossbar fabric.

nGenius PFS 6010 supports up to two management modules for 1:1 redundancy. Each management module features a COM Express Multicore Celeron processor with 8GB DRAM, and Enterprise-grade 8GB NAND (SLC) SSD. Four time-syncing methods are supported: NTP, GPS receiver, 1PPS signal, and PTP server. The PTP server port can also act as a PTP Master if GPS or 1PPS are being received for synchronization.

The management modules have control pathways to each fabric module, line card, and alternate secondary management module. When two management modules are present, the secondary module will behave in passive redundant mode, only becoming active if the primary management module fails or is removed.
Optimized Hardware

Hardware acceleration

nGenius PFS 6010, unlike standard switching systems, contains optional sub-components that perform highly specialized functions designed to optimize packets for monitoring tools.

These hardware sub-components (FPGAs, etc.) are placed in front of or after the packet processor, enabling de-duplication, conditional slicing, handling of encapsulated traffic (filtering, load balancing, stripping/de-encapsulation), and other features. Performing these functions in hardware, rather than employing a general-purpose processor, improves reliability and accuracy, and accelerates performance.

Service on every port

Bandwidth and processing power is fully provisioned for each port. All ports can be simultaneously used at full throughput with all features enabled without any performance or system compromise. For high-availability of the data plane, an additional fabric card (active standby) exists to over-provision the line cards and ensure 100% throughput even if a fabric card is removed or unavailable.

Patent-pending cooling method

Network communication systems, such as switches and packet brokers, contain hardware components that generate heat. Excessive heat can degrade system performance, damage components, and eventually cause failure. To avoid elevated temperatures, heat is typically removed through a method such as forced convection airflow.

![Figure 7: Cooling system, side view.](image)

NOTE: Some matrix switches are prone to overheating in highly dense environments, as they may rely on oversized racks to provide side air ventilation, or else have front panel intake openings that can become obstructed by connectors and cabling. Insufficient airflow can affect the performance and lifespan of the switch, as well as have an adverse effect on the cooling system of the data center.
Conventionally, network chassis systems contain sub-components, such as line cards and fabric cards. To accommodate the interconnections between these components, chassis systems typically leverage an orthogonal design that makes use of one of two cooling methods:

- The first method uses side airflow to cool horizontal cards, while vertical cards are cooled with separate blowers. Unfortunately, side airflow can be inhibited in dense environments, where oversized racks may not be in use. It also messes with some datacenter cooling regimes.
- The second method uses front to rear cooling where air is introduced through the air intake holes on the front of the chassis. Unfortunately, these intake holes may become partially or fully blocked by a large number of connectors and cables.

Both of these cooling methods are problematic in highly dense environments, and are likely to lead to performance issues or reduced MTBF (mean time between failures).

To overcome the limitations of these two cooling methods, NETSCOUT designed and patented a cooling system for the PFS 6010 that enables it to be used in high-capacity, space-constrained environments, without compromise to performance.

**Modern Os**

nGenius PFS 6010 control plane is based on an object-oriented modular software architecture that features a YANG data model. The object-oriented architecture supports feature and application velocity and reliability, and is OpenFlow ready.

nGenius PFS 6010 Hardware abstraction layer and YANG data model facilitate portability to other platforms, making adding new traffic handling capabilities faster and less error prone.

The orchestration layer of PFS 6010 is supported by vMC, the vBroker central management system. The orchestration layer is also extensible to accommodate SDN and virtualization.

![Figure 8: PFS 6010 VXOS Software Architecture.](image-url)

- nGenius PFS 6010 uses large, front facing air intakes and dual top-loaded fan and blower trays that create an updraft through the vertical line cards, and a partial siphoning of air through the rear horizontal fabric cards. Each of the two ventilation trays features two fans and one blower. Each of the rear loaded fabric and management modules feature three fans each, totaling eighteen (18) fans when all six (6) module-slots are loaded.
- nGenius PFS 6010 is designed to hold up to ten (10) vertically inserted line cards, each of which helps to facilitate consistent airflow through the entire system. In the event that fewer than ten line cards are inserted, dummy cards are used to ensure proper airflow.
- nGenius PFS 6010 cooling system does not rely on oversized racks for side air intake. The large front air intakes on the chassis are located below the ports of the line cards, and strategically placed fans and blowers ensure continuous, uninterrupted airflow through all components of the chassis, line cards and modules.
## Optimized SW Architecture

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Object-oriented modular architecture</strong></td>
<td>Supports faster development and addition of new features and applications</td>
</tr>
<tr>
<td><strong>Linux Core upgradability</strong></td>
<td>More rapid response to newly identified vulnerabilities to be applied to deployed systems</td>
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<tr>
<td><strong>Hardware Abstraction Layer</strong></td>
<td>Facilitates portability to other platforms, Makes adding new traffic handling capabilities faster and less error prone</td>
</tr>
<tr>
<td><strong>YANG data model</strong></td>
<td>Facilitates portability to other platforms</td>
</tr>
<tr>
<td><strong>OpenFlow Ready</strong></td>
<td>OpenFlow Agent can be added very quickly</td>
</tr>
<tr>
<td><strong>Hardened SW Architecture</strong></td>
<td></td>
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<tr>
<td><strong>Zero MQ</strong></td>
<td>Faster, more efficient execution of software.</td>
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<tr>
<td><strong>Google Protocol Buffers</strong></td>
<td>Improved performance due to more efficient messaging syntax.</td>
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<tr>
<td><strong>Flexible, simplified management</strong></td>
<td></td>
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<tr>
<td><strong>RBAC (rule based access control)</strong></td>
<td>Facilitates more structured user roles and privileges. Allows for private and public ownership of forwarding rules as well as resources</td>
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<tr>
<td><strong>Multiple image files</strong></td>
<td>Streamlines software upgrade preparation and execution, Allows different software versions to be used as default and as running</td>
</tr>
<tr>
<td><strong>Multiple configuration files</strong></td>
<td>Improves configuration management, Allows different configurations to be used at boot-up and as active</td>
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<tr>
<td><strong>Exportable and importable ASCII Configuration files</strong></td>
<td>Facilitates easier management and debug of configurations as well as definition of common configurations</td>
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<tr>
<td><strong>Partial Configuration files</strong></td>
<td>Facilitates bulk application of common configuration elements across multiple products, or base parameter configuration recovery</td>
</tr>
<tr>
<td><strong>Multiple file transfer protocols</strong></td>
<td>FTP, SFTP, SCP – secure file transfer, file transfer can be used that meets corporate guidelines</td>
</tr>
</tbody>
</table>

Table 2: PFS 6010 Features Integration.

## Scaling a Monitoring Fabric with PFS 6010

PFS 6010 is modular and can scale to up to 600 ports in a single chassis. With the VSS patented interconnection system, vMeshTM, multiple PFS 6010s (and other NETSCOUT PFSs) can be formed into a single monitoring fabric that can scale to thousands of ports across disparate sites worldwide. PFS 6010 blade and chassis network packet broker is the only NPB available that can seamlessly grow into a web and cloud scale monitoring fabric.

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