FORCE10™

Force10's FTOS Delivers End-to-End Reliability While Lowering Network TCO

Introduction

For years, IT designed the enterprise network architecure to emphasize different characteristics at each layer – high performance and high availability in the data center, scalability in the LAN core and low cost and basic functionality in the wiring closet. Those design principles make sense when applications are centralized and data is the sole traffic on the network. However, today's network environment is much richer and more dynamic, supporting a fluid mix of new applications and traffic types.

For example, peer-to-peer collaboration applications are becoming widespread, as well as adoption of the software as a service (SaaS) model. These applications don't depend on the availability of the data center. In the case of peer-to-peer applications, traffic patterns are between workgroups or among individuals within a workgroup. Loss of a wiring closet switch would completely disrupt such applications. With SaaS, users must have a stable connection across the enterprise network and the wide area network to be productive.

In addition to new applications, today's converged networks support everything from voice, video and wireless access to traffic from security cameras, card readers, building automation systems and other devices. These new applications and traffic types are driving the need for high reliability at every layer in the network, from the data center down to the wiring closet. With voice over IP (VoIP), loss of a wiring closet switch now means phones as well as data devices are down.

Unplanned down time can cost a business thousands to tens of thousands of dollars per minute. Even companies whose networks have been designed with best-in-class availability suffer an average of five hours of unplanned down time annually. Reducing that down time by even 20 percent per year – just one hour – can yield significant savings, both in dollars and corporate reputation. Force10 Networks designed its FTOS modular operating system to meet the stringent reliability, scalability and serviceability requirements of the data center. Over the past five years, FTOS has been hardened in some of the largest and most demanding data centers in the world. Now Force10 is delivering the always-on capabilities of FTOS to every tier of the network by supporting FTOS across its switch/router line, including the E-Series, C-Series and S-Series platforms.

With FTOS, Force10 is enabling enterprises to cost effectively build end-to-end reliable, scalable networks while also reducing operations and management overhead. The robust design of FTOS provides the following benefits, each of which helps reduce the total cost of network ownership:

- *Consistency*
- *Reliability*
- *Scalability*
- *Serviceability*

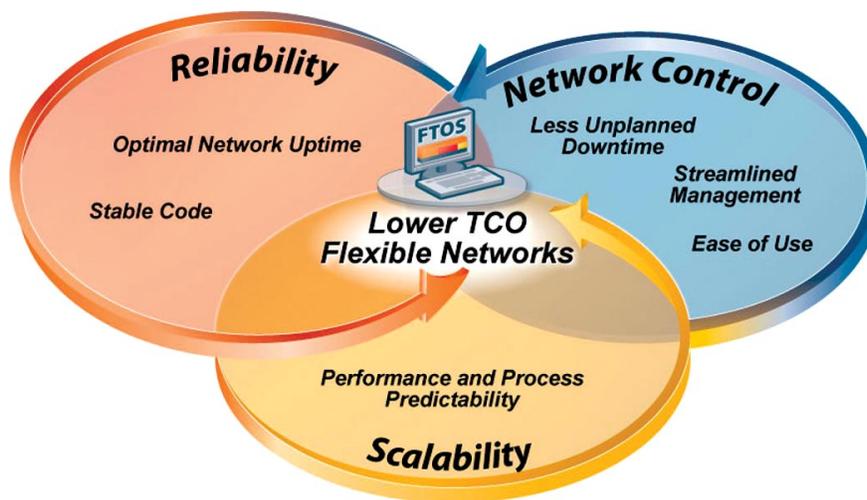*Let's examine each in turn.*

Figure 1. The Force10 modular FTOS operating system is designed to lower TCO through advanced reliability, network control and scalabilty features

The Power of One: Consistency

Rather than requiring customers to run a different OS at each tier of the network or delivering variants of code for each different platform, Force10 delivers a single version of FTOS that follows a linear, sequential release path. Because of this design philosophy, FTOS greatly simplifies IT's job and gives enterprises much needed flexibility in rolling out new services and applications. By delivering a common OS across all of its hardware platforms, Force10 ensures that customers benefit from:

Stable code: Having a single code base and single release train enables Force10 to perform more rigorous pre-release testing. Customers benefit from more stable, reliable operations with fewer software errors and system restarts. In addition, FTOS greatly simplifies software maintenance because only one patch process and one bug-fix process are required across all Force10 platforms.

Rapid feature roll out: Force10 has a single roadmap for the development of new features. As a result, customers can roll out new features simultaneously on all platforms across the network. Planning, staging and deploying OS upgrades to take advantage of new features are greatly simplified. Enterprises benefit from the ability to dynamically adapt to changing needs with fewer discontinuities in functions across network tiers. Likewise, interoperability issues disappear. For example, with FTOS, a single Layer 2/Layer 3 protocol stack is supported, so protocols are guaranteed to be interoperable across Force10 platforms. In contrast, interoperability isn't assured when platforms run different OSes or OS versions.

Streamlined management: Having common management functionality and a common user interface across the Force10 product line yields significant efficiencies for IT. Product training is streamlined and system downtime due to operator error is reduced because system configuration, diagnostics, troubleshooting and software maintenance are identical across all platforms. Force10's support for the same CLI and XML management model from the wiring closet to the data center greatly simplifies lifecycle management of the network infrastructure.

Consistent functionality, a stable code base and common management interface and tool set all help reduce operational expenses, thus lowering total cost of ownership (TCO).

Fundamentals: Reliability and Scalability

Whether conducting business globally or locally, many organizations operate 24x7. These always-on enterprises demand an always-on network that can adapt as their needs change and the business grows. Force10 engineered FTOS to deliver reliable, scalable performance in the most demanding data center environments where unplanned downtime can have drastic financial consequences and ruin a business' reputation. By supporting FTOS across all its switch/router products, Force10 extends these reliability and scalability benefits to all tiers of the network for optimal uptime.

FTOS is based on NetBSD, a highly portable, open source, modular operating system. The NetBSD kernel handles memory allocation and scheduling while all other functions run as independent, modular processes in their own protected memory space. For example, Force10 has created separate processes for each Layer 2 and Layer 3 protocol, as well as management functions and security services and protocols. FTOS also supports a distributed, multiprocessor architecture with separate control CPUs or Layer 2 switching, Layer 3 routing and management control on the E-Series platform. The modular design and process isolation deliver the following reliability and scalability benefits:

Scalable protocols: The FTOS control plane inherits a high degree of maturity and stability from NetBSD's high performance IP stacks. In addition, its switching and routing protocols have been extensively tested and hardened through deployment in large global data center environments. As a result, FTOS can accommodate the most demanding environments, reliably scaling to support very large, high performance networks with rapid convergence in the event of a Layer 3 fault or disruption.

Distributed processes: The modular architecture of FTOS provides dedicated resources to support each network feature that's turned on. This ensures that the system as a whole, as well as individual processes, can scale and operate predictably under load. In addition, FTOS allows the system to offload processes, such as sFlow or BFD, to line cards on the E-Series and C-Series platforms. As a result, these Force10 platforms can easily run multiple processes at the same time without performance degradation or bottlenecks. By distributing processing capacity and control plane functions, FTOS enables Force10 platforms to scale dramatically without compromising reliability or performance.

Fault isolation: FTOS eliminates many potential catastrophic system failures by restricting faults to specific processes. Because each process is modular and runs in its own protected memory space, a fault in one module cannot affect any other modules. As a result, software problems are isolated to specific processes and the rest of the system continues to operate.

Optimal application uptime: To ensure that mission critical and other high availability applications continue to work in the event of a network fault, FTOS supports hitless forwarding in addition to rapid convergence. Should any redundant component fail – whether a line card, switch fabric, route processor module (RPM) or power supply – FTOS ensures all packets are forwarded. By enabling each line card in a Force10 switch/router to continue forwarding using its own copy of the forwarding information base, FTOS prevents application disruption.

The reliability and scalability characteristics of FTOS provide the foundation for always-on networks. With FTOS, IT can turn on features as needed and know a Force10 switch/router will reliably deliver the same high level of performance regardless of traffic load or the number of features enabled.

Day-to-Day Efficiency: Serviceability

Human error is a leading cause of network down time, accounting for as much as 40 percent of outages, according to Gartner Group. In addition to lost user productivity, such errors take an economic toll by driving up ongoing operations and management tasks, increasing TCO. Force10 has built a variety of serviceability features into FTOS that are designed to reduce human errors and streamline day-to-day operations for a lower TCO and higher uptime. In addition, Force10 is tracking industry efforts to automate common configuration and management tasks with an eye to bringing customers even greater operational efficiencies.

Force10 designed FTOS with system serviceability in mind. FTOS includes many features for managing, debugging and troubleshooting the system, which provide the following serviceability benefits:

Inline monitoring and diagnostics: Using inline tools, IT can easily monitor and diagnose problems without shutting down the switch/router or disrupting application traffic. The FTOS kernel monitors all processes to ensure operations are within normal limits of resource utilization. FTOS also provides system-wide monitoring for out-of-

range environmental conditions and other fault conditions, such as unsynchronized configurations of line cards.

The modular design of FTOS makes it easy to trace software errors to specific processes and facilitates any required remedial action. Through enhanced serviceability commands, Force10 provides a complete hardware and software diagnostic suite that enables IT to quickly gather debugging information. With a few commands, a network administrator can collect the information needed to analyze and solve a problem, rather than simply reacting to its symptoms.

Figure 2. **FTOS provides a common interface across Force10's product portfolio of chassis and fixed configuration switch/routers**

Ease of use: Force10 has provided FTOS with an industry standard CLI configuration syntax, which minimizes the learning curve by leveraging IT's existing knowledge base. Force10 delivers the same look and feel on all its platforms and has enhanced its CLI with ease of use features, such as pre- and bulk-configuration and search commands, which make configuration and troubleshooting simpler and more efficient.

Third-party support: FTOS includes an XML interface that makes it easy for Force10 to integrate with third-party systems, from management platforms to network access control (NAC) and other security products. A full suite of standards-based SNMP MIBs, as well as MIBs designed to manage each switch/router hardware platform, enable easy integration into HP OpenView or other management software.

Fail-safe configuration: FTOS supports advanced version control and configuration roll back mechanisms to protect the network from operator configuration errors. The change control system of FTOS allows network administrators to save multiple device configurations as a backup. This makes it easy for an admin to view changes from one configuration version to another and to prevent fatal

configuration errors. For example, a configuration mistake that breaks routing can render a device unreachable, making it impossible to reconfigure the device without going on-site. With automatic rollback, the router itself can revert to the last known working configuration and restore device reachability.

Automated fault correction: Beyond monitoring, FTOS provides timely fault reporting and automated fault correction, which help minimize system interruption and maximize uptime. For example, with the data plane loopback test, each RPM and each line card CPU periodically sends out test frames that loopback through the switch fabric module. These test results reflect the overall health status of the data plane and can be used to identify a faulty switch fabric.

Customers can select the action the system will take in the event of a failed test, ensuring that system behavior is consistent with uptime and availability targets and hardware sparing policies. One option is to allow the system to take the failed switch fabric offline automatically if a back-up switch module is in place and to send an alarm.

Similarly, Force10 RPMs and line cards support multiple parity checking points to ensure data integrity throughout the internal forwarding, lookup and buffering path. FTOS uses an automated memory scanning diagnostic to proactively determine whether a parity error is a transient error or a persistent (hard) error and if a reset or other action is required. In the case of a persistent error, the FTOS diagnostics would call for the reset or replacement of the line card in question.

Force10 is closely tracking industry developments with regard to automating management and other functions. For example, storage and server companies are investigating ways to automatically power down idle servers and storage arrays during low usage times and load balance traffic among the remaining systems. Similar developments in the networking arena are expected to lead to the automation of network tasks using secure policy servers.

For example, based on business requirements, IT could put in place security and quality of service policies that are activated on a scheduled or timed basis, triggering the appropriate configuration of network devices. Such automation would streamline device configuration, reducing human errors and lowering operations overhead. The robust FTOS architecture and XML interface lay the foundation for such automation.

FTOS helps increase the mean time between failure (MTBF) by preventing the occurrence of certain types of hard errors and reduces the mean time to repair (MTTR) by speeding fault isolation and resolution time. With its rich serviceability features, FTOS improves system uptime and availability while reducing the operations and management burden on IT.

Building the Always-on Network

Today's rich, dynamic applications environment is driving the need for high reliability, scalability and serviceability at every layer in the network, from the data center down to the wiring closet. At the same time, IT is looking for ever greater efficiencies in order to lower TCO and deliver more value to the enterprise. Achieving an always-on network can't come at the price of complexity and higher overhead.

With its experience in some of the world's largest data centers and most demanding network environments, Force10 Networks understands what it takes to build always-on networks. One of the keys is a robust network operating system. FTOS provides always-on capabilities at every tier of the network, boosting uptime while reducing operations and management overhead.

By supporting FTOS across its entire switch/router line, Force10 greatly simplifies IT's job and gives enterprises flexibility in rolling out new services and applications. Force10 designed FTOS to reduce human errors and streamline day-to-day operations for lower TCO and maximum uptime. Force10's FTOS provides the reliability, scalability and rich serviceability foundation that enterprises need to build an end-to-end, always-on network.