# Dell Force10 Operating System (FTOS)

## Z-Series, E-Series, C-Series, and S-Series, System Software

Best-in-class stability and reliability; NetBSD Modular OS; one FTOS Code Train for all platforms

### Optimized for portability, resiliency and scalability

Dell FTOS, the Force10 Operating System, is a powerful and robust operating system that runs on the Dell Force10 switch/router product lines. It is architected for high performance, resiliency, and portability. The Hardware Abstraction Layer (HAL) makes FTOS applications portable across product lines. Its modular design dramatically increases code reuse and accelerates the delivery of applications. FTOS is based on NetBSD, with application code developed and maintained by Force10.

### Key features

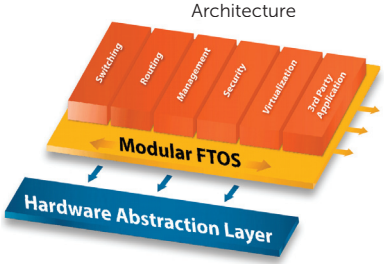
- Out-of-the-box stability, resiliency, performance, and security advantages
- Increased software portability and modularity to bring high performance application features to all switch/router product lines
- Based on NetBSD, an industry's leading, freely available open source operating system. NetBSD is highly reliable, portable and efficient

### FTOS: The power of one

**Rich functional coverage**

The primary FTOS attributes, modularity and extensibility, allows an accelerated evolution in different domains, including Layer 2 and Layer 3 services, as well as management functions, security services and other FTOS features.

FTOS Software Architecture




FTOS leverages a distributed, multiprocessor architecture that delivers highly scalable protocols and reliability in each product line. Z-Series and E-Series Route Processor Modules (RPMs) are designed with separate control plane CPUs for Layer 2, Layer 3 and management functions, with distributed processing on line card CPUs. The C-Series RPMs and S-Series switch/routers use one control plane CPU, with distributed processing on C-Series line cards and S-Series stack members.

The NetBSD kernel provides a stable operating system and unparallel resource management thanks to its renowned Hardware Abstraction Layer (HAL) architecture. Highly optimized it provides superior levels of concurrency, memory allocation, and process scheduling. All other applications run as independent and modular processes in their own protected memory space.

**Consistency**

Dell Force10's switch/route platforms derive from a single code base which follows a linear, sequential release path. It allows the Z-Series, E-Series, C-Series, and S-Series to deliver uniform solution sets. Dell Force10 ensures that customers benefit from stable code, consistent configuration environment, and simpler software management.

FTOS reliability and scalability characteristics provide the foundation for always-on networks and deliver substantial reliability and scalability advantages.

**Flexibility and faster time-to-market**

The trend towards increased service innovation requires decreased time-to-market. FTOS modular architecture allows for further expansion of enhanced applications to meet current and future key propositions, and thus, achieving further operational efficiencies.

**Stable code**

- The drive and benefits of a single code base and a single release train enables Dell Force10 to perform more robust and comprehensive rigorous functionality and scalability testing
- Customers benefit from more stable, reliable software and consistent CLI
- All platforms can benefit from a single maintenance release, which greatly simplifies software maintenance

FTOS leverages a distributed, multiprocessor architecture delivering highly scalable protocols and reliability in each product line

### Scalable protocols

- FTOS control plane inherits a high degree of maturity and stabilityfrom its roots in NetBSD's high performance IPv4 and IPv6 stacks
- Advanced inter-process communication (IPC) mechanisms enable a scalable and distributed control plane
- Switching and routing protocols have been extensively tested and hardened through deployment in large global networks
- FTOS can accommodate the most demanding environments, reliably scaling to support very large, high performance networks

### Streamlined Management

- Common management functionality and common user interface across Dell Force10 product lines make operating the network easier
- Simpler product training and learning curve because system configuration, diagnostics, troubleshooting and software maintenance are identical across platforms
- Support for the same CLI, SNMP, and XML management models throughout the network greatly simplifies life-cycle management of the infrastructure

Consistent functionality, a stable code base and a common management interface and tool set all help reduce operational expenses (OPEX), thus lowering total cost of ownership (TCO). By supporting FTOS across all its switch/router products, Force10 extends the reliability and scalability benefits to all tiers of the network for optimal uptime.

### Dell FTOS Command Line Interface (CLI)

The CLI is a primary method of administering, configuring, and monitoring FTOS applications and Dell Force10 switches/routers. The CLI is a significant asset in protecting training investments: It is fully compliant with the predominant, de-facto industry standard CLI. Certified engineers will be immediately familiar with the Dell Force10 CLI and productive from day one.

The CLI has many powerful features which make it very convenient for usage on a daily basis. It includes on-line help, auto-completion, plain text or XML front-ends, Unix-like tools, such as grep, and non-interactive mode for scripting, to mention some.

## Specifications: FTOS

### IEEE Compliance

| | |
|---|---|
| 802.1AB | LLDP |
| 802.1ad | Q-in-Q |
| 802.1ag | Connectivity Fault Management |
| 802.1D | Bridging, STP |
| 802.1p | L2 Prioritization |
| 802.1Q | VLAN Tagging, Double VLAN Tagging, GVRP |
| 802.1s | MSTP |
| 802.1w | RSTP |
| 802.1X | Network Access Control |
| 802.3ab | Gigabit Ethernet (1000BASE-T) |
| 802.3ac | Frame Extensions for VLAN Tagging |
| 802.3ad | Link Aggregation with LACP |
| 802.3ae | 10 Gigabit Ethernet (10GBASE-X) |
| 802.3af | Power over Ethernet |
| 802.3ak | 10 Gigabit Ethernet (10GBASE-CX4) |
| 802.3ba | 40 Gigabit Ethernet (40GBase-X) on optical ports |
| 802.3ba | 100 Gigabit Ethernet on optical ports 100 GBase-LR4/-SR4 |
| 802.3i | Ethernet (10BASE-T) |
| 802.3u | Fast Ethernet (100BASE-TX) |
| 802.3x | Flow Control |
| 802.3z | Gigabit Ethernet (1000BASE-X) |
| ANSI/TIA-1057 | LLDP-MED |
| Force10 | FRRP (Force10 Redundant Ring Protocol) |
| Force10 | PVST+ |

### RFC and I-D Compliance

#### General Internet Protocols

| | |
|---|---|
| 768 | UDP |
| 793 | TCP |
| 854 | Telnet |
| 959 | FTP |
| 1321 | MD5 |
| 1350 | TFTP |
| 1661 | PPP |
| 1989 | PPP Link Quality Monitoring |
| 1990 | PPP Multilink Protocol |
| 1994 | PPP CHAP |
| 2474 | Differentiated Services |
| 2615 | PPP over SONET/SDH |
| 2698 | Two Rate Three Color Marker |
| 3164 | Syslog |
| 4254 | SSHv2 |
| draft-ietf-bfd-base-03 | BFD |

#### General IPv4 Protocols

| | |
|---|---|
| 791 | IPv4 |
| 792 | ICMP |
| 826 | ARP |
| 1027 | Proxy ARP |
| 1035 | DNS (client) |
| 1042 | Ethernet Transmission |
| 1191 | Path MTU Discovery |
| 1305 | NTPv3 |
| 1519 | CIDR |
| 1542 | BOOTP (relay) |
| 1812 | Routers |
| 1858 | IP Fragment Filtering |
| 2131 | DHCP (server and relay) |
| 2338 | VRRP |
| 3021 | 31-bit Prefixes |
| 3046 | DHCP Option 82 |
| 3069 | Private VLAN |
| 3128 | Tiny Fragment Attack Protection |

#### General IPv6 Protocols

| | |
|---|---|
| 1981 | Path MTU Discovery (partial) |
| 2460 | IPv6 |
| 2461 | Neighbor Discovery (partial) |
| 2462 | Stateless Address Autoconfiguration (partial) |
| 2463 | ICMPv6 |
| 2464 | Ethernet Transmission |
| 2675 | Jumbograms |
| 3587 | Global Unicast Address Format |
| 4291 | Addressing |
| 4443 | ICMPv6 |
| 5798 | VRRPv3 for IPv6 |

#### IPv6 Routing Protocols

| | |
|---|---|
| 2080 | RIPng |
| 2545 | BGP-4 extensions for IPv6 |
| 5308 | IS-IS for IPv6 |
| 5340 | OSPFv3 |
| 4601 | PIM-SM for IPv4/IPv6 |

#### RIP

| | |
|---|---|
| 1058 | RIPv1 |
| 2453 | RIPv2 |

#### OSPF

| | |
|---|---|
| 1587 | NSSA |
| 1745 | OSPF/BGP interaction |
| 1765 | OSPF Database overflow |
| 2154 | MD5 |
| 2328 | OSPFv2 |
| 2370 | Opaque LSA |
| 2740 | OSPFv3 |
| 3101 | OSPF NSSA |
| 3623 | Graceful Restart |
| 4222 | Prioritization and Congestion Avoidance |
| | OSPF Link-State Advertisement (LSA) Throttling |

#### IS-IS

| | |
|---|---|
| 1142 | IS-IS |
| 1195 | IPv4 Routing |
| 2763 | Dynamic Hostname |
| 2966 | Domain-wide Prefixes |
| 3373 | Three-way Handshake |
| 3567 | MD5 |
| 3784 | Wide Metrics |
| 5120 | Multi-topology |
| 5301 | Dynamic Hostname Exchange. |
| 5302 | Dynamic Wide Prefixes |
| 5303 | Three-way Handshake |
| 5304 | MD5 |
| 5305 | TE Extensions to ISIS |
| 5306 | Restart Signaling for IS-IS |
| draft-ietf-isis-igp-p2p-over-lan-06 | Point-to-Point Operation |
| draft-ietf-isis-ipv6-06 | IPv6 Routing |
| draft-kaplan-isis-ext-eth-02 | Extended Frame Size |

#### BGP

| | |
|---|---|
| 1997 | Communities |
| 2385 | MD5 |
| 2439 | Route Flap Damping |
| 2545 | Multiprotocol Extensions for IPv6 |
| 2796 | Route Reflection |
| 2842 | Capabilities |
| 2858 | Multiprotocol Extensions |
| 2918 | Route Refresh |
| 3065 | Confederations |
| 4271 | BGP-4 |
| 4360 | Extended Communities |
| 4893 | 4-byte ASN |
| 4724 | BGP Graceful Restart |
| 4760 | Multiprotocol Extensions |
| 5396 | 4-byte ASN Representation |
| 5492 | Capabilities Advertisement |
| draft-ietf-idr-bgp4-20 | BGPv4 |
| draft-ietf-idr-restart-06 | Graceful Restart |
| draft-michaelson-4byte-as-representation-05 | 4-byte ASN Representation (partial) |

### Multicast

| | |
|---|---|
| 1112 | IGMPv1 |
| 2236 | IGMPv2 |
| 2710 | MLDv1 |
| 3376 | IGMPv3 |
| 3569 | SSM for IPv4/IPv6 |
| 3618 | MSDP |
| 3810 | MLDv2 |
| 3973 | PIM-DM |
| 4541 | IGMPv1/v2/v3, MLDv1 Snooping, MLDv2 Snooping |
| draft-ietf-pim-sm-v2-new-05 | PIM-SM for IPv4/IPv6 |

### MPLS

| | |
|---|---|
| 2702 | Requirements for TE Over MPLS |
| 3031 | MPLS Architecture |
| 3032 | MPLS Label Stack Encoding |
| 3209 | RSVP-TE: Extensions to RSVP for LSP Tunnels |
| 3630 | TE Extensions to OSPF Version 2 |
| 3784 | IS-IS Extensions for TE |
| 3812 | MPLS-TE MIB |
| 3813 | MPLS LSR MIB |
| 4090 | Fast Reroute Extensions to RSVP-TE for LSP Tunnels |
| 4379 | Detecting MPLS Data Plane Failures (TE/LDP) Ping & Traceroute |
| 5036 | LDP Specification |
| 5063 | Extensions to GMPLS RSVP Graceful Restart |

### Network Management

| | |
|---|---|
| 1155 | SMIv1 |
| 1156 | Internet MIB |
| 1157 | SNMPv1 |
| 1212 | Concise MIB Definitions |
| 1215 | SNMP Traps |
| 1493 | Bridges MIB |
| 1657 | BGP-4 |
| 1724 | RIPv2 MIB |
| 1850 | OSPFv2 MIB |
| 1901 | Community-based SNMPv2 |
| 1905 | SNMPv2 |
| 1907 | SNMP MIB |
| 2011 | IP MIB |
| 2012 | TCP MIB |
| 2013 | UDP MIB |
| 2024 | DLSw MIB |
| 2096 | IP Forwarding Table MIB |
| 2233 | Interfaces MIB |
| 2558 | SONET/SDH MIB |
| 2570 | SNMPv3 |
| 2571 | Management Frameworks |
| 2572 | Message Processing and Dispatching |
| 2574 | SNMPv3 USM |
| 2575 | SNMPv3 VACM |
| 2576 | Coexistence Between SNMPv1/v2/v3 |
| 2578 | SMIv2 |
| 2579 | Textual Conventions for SMIv2 |
| 2580 | Conformance Statements for SMIv2 |
| 2618 | RADIUS Authentication MIB |
| 2665 | Ethernet-like Interfaces MIB |
| 2674 | Extended Bridge MIB |
| 2787 | VRRP MIB |
| 2819 | RMON MIB (groups 1, 2, 3, 9) |
| 2863 | Interfaces MIB |
| 2865 | RADIUS |
| 2933 | IGMP MIB |
| 3273 | RMON High Capacity MIB |
| 3416 | SNMPv2 |
| 3418 | SNMP MIB |
| 3434 | RMON High Capacity Alarm MIB |
| 3580 | 802.1X with RADIUS |
| 3815 | LDP MIB |
| 4292 | IPv6 Forwarding Table MIB |
| 4293 | IPv6 MIB |
| 5060 | PIM MIB |
| ANSI/TIA-1057 | LLDP-MED MIB |
| draft-grant-tacacs-02 | TACACS+ |
| draft-ietf-idr-bgp4-mib-06 | BGP MIBv1 |
| draft-ietf-isis-wg-mib-16 | IS-IS MIB |
| IEEE 802.1AB | LLDP MIB |
| IEEE 802.1AB | LLDP DOT1 MIB |
| IEEE 802.1AB | LLDP DOT3 MIB |
| IPv4 | Multicast MIB |
| ISIS | MIB |
| ruzin-mstp-mib-02 | MSTP MIB (traps) |
| sFlow.org | sFlowv5 |
| sFlow.org | sFlowv5 MIB (version 1.3) |

### MIBs

FORCE10-BGP4-V2-MIB
FORCE10-CHASSIS-MIB
FORCE10-COPY-CONFIG-MIB
FORCE10-CS-CHASSIS-MIB
FORCE10-FIB-MIB
FORCE10-FORWARDINGPLANE-STATS-MIB
FORCE10-IF-EXTENSION-MIB
FORCE10-LINKAGG-MIB
FORCE10-MON-MIB
FORCE10-PRODUCTS-MIB
FORCE10-SMI
FORCE10-SS-CHASSIS-MIB
FORCE10-SYSTEM-COMPONENT-MIB
FORCE10-TC-MIB
FORCE10-TRAP-ALARM-MIB

## Management and Security

HP OpenView support
Industry-standard CLI
Interface access control
Layer 2 and 3 ACLs
NTPv3
Port mirroring
Port monitoring
RADIUS/TACACS+ authentication
RMON (groups 1, 2, 3, 9)
Secure copy (scp)
sFlow traffic accounting
SNMPv1/v2/v3
XML configuration and command output

### Automation

Hyperlink
JumpStart
SmartScripts
SwitchLink

### Quality of Service and Rate Policing

Weighted Fair Queuing (WFQ)

## Virtualization

VRF-Lite

## Other

ACL-based accounting
Destination-based MAC accounting
DNS Client
Ping & Traceroute

Feature capabilities vary between the Z-Series, E-Series, C-Series, and S-Series due to hardware differences. Consult the data sheets and product manuals for specific details on supported software features for each platform.



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