EXHIBIT C

User Manual

Contents

1
Introduction

Summary of Key Features

The XpressFlow Switch provides the following key features.

Switching Features

- Common high-speed switching bus (1 Gbps @ 33 MHz and 1.6 Gbps @ 50 MHz) for both Ethernet and Fast Ethernet switches.
- Adaptive switching modes support Turbo Cut-Through, Safe Cut-Through, and Store-and-Forward switching modes, with dynamic run-time adaptation:
  - Turbo Cut-Through mode provides the least amount of forwarding latency and jitter.
  - Safe Cut-Through mode provides minimized runt packets with limited forwarding latency.
  - Store and Forward mode eliminates runt packets, but imposes longer forwarding latency.
- 802.1D Spanning Tree Algorithm.

- Flow control support, programmable on a per-port basis:
  - 802.3X support for full-duplex mode
  - Back Pressure support for half-duplex mode
- Distributed flow caching, which caches the most recent forwarding information at each port to significantly improve switch performance.
- Ability to forward all frames in a single bus transfer, with granules.
- Multimedia-ready.
  - Supports four priority queues based on 802.1Q priority assignments for frame transmission.
  - Packets transfer as granules on the XpressFlow bus to preserve Quality of Service (QoS) for audio and video streams.
- Micro-code can be upgraded to meet evolving standards. Micro-code and system software in the SC201 switch engine can be upgraded via Ethernet or modem using the remote software upgrade feature via the TFTP protocol.
- Supports either CAM or SRAM in the switching database.
- Packet filtering based on the *<Source MAC, VLAN>* or *<Destination MAC, VLAN>*.
- Supports 8 KB MAC addresses.
- Supports up to 64 VLANs per switch.

Management Features

- Port- and MAC address-based RMON statistics support.
- SNMP support with Management Information Base (MIB)-2, four RMON groups (Statistics, History, Alarm, and Event), and bridge MIB.
- Local Management Console and Remote Management Console support.
- Level-1 and Level-2 VLAN support.
- Port-based and MAC address-based VLAN configuration, VLAN membership learning, VLAN classification, VLAN header stripping/tagging, and frame forwarding and flooding.

Physical Ports

The XpressFlow switch supports 10Base-T and 10Base-T/100Base-TX ports.

10Base-T Ports

10Base-T ports use RJ-45 connectors to attach to single endstations, 10Base-T hubs, or any 10Base-T-compatible device that uses standard 10Base-T adapters and wiring.

The 10Base-T ports can operate in half-duplex, full-duplex, or auto-sensing mode.

- Half-duplex mode uses Back Pressure flow control to prevent the receiving buffer from being overrun by data from a source node.
- Full-duplex mode uses the 802.3X flow control standard to prevent fast data traffic from over-running slow data traffic.
- Auto-sensing mode automatically determines whether full-duplex or half-duplex mode is used after auto-negotiating with the other end of the link.

The 10Base-T ports are configured as MDIX and provide a full 10 Mbps bandwidth to attached devices. Maximum segment length is 100 meters (328 feet) over Category 3, 4 or 5 twisted-pair cable.

10Base-T/100Base-TX Ports

The 10Base-T/100Base-TX ports use RJ-45 connectors and can operate in the following modes:

- 10Base-T full-duplex mode
- 10Base-T half-duplex mode
- 100 Base-TX full-duplex mode
- 100Base-TX half-duplex mode
- Auto-sensing mode

Half-duplex mode uses Back Pressure flow control to prevent the receiving buffer from being overrun by data from a source node. Full-duplex mode uses the 802.3X flow control standard to prevent fast data traffic from over-running slow data traffic. Auto-sensing mode automatically determines whether full-duplex or half-duplex mode is used after auto-negotiating with the other end of the link.

- When configured for 10Base-T operation, the ports are ideal for connection to single endstations, 10Base-T hubs, or any 10Base-T-compatible device that uses standard 10Base-T adapters and wiring. 10Base-T ports are configured as MDIX and provide a full 10 Mbps bandwidth to attached devices. Maximum segment length is 100 meters (328 feet) over grade 3, 4 or 5 twisted-pair cable.
- When configured for 100Base-TX operation, the ports are ideal for connection to server or network backbones. 100Base-TX ports are configured as MDIX and provide 100 Mbps bandwidth to attached devices. Maximum segment length is 100 meters (328 feet) over grade 5 twisted-pair cable.

Connection Links

The XpressFlow switch supports trunk port and access port connection links. Any physical port can be defined as either a trunk port or an access port.

Trunk Ports

Trunk ports typically interconnect two switches. Packets sent from a trunk port are always VLAN tagged, unless overridden by a setting for a specific VLAN. A trunk port cannot be used to connect the XpressFlow switch to another switch that does not support 802.1Q tagging.

Access Ports

Access ports typically connect the XpressFlow switch to network nodes other than switches. Access ports can also connect the XpressFlow switch to other switches that do not support 802.1Q tagging. Packets sent from an access port are always VLAN untagged, unless overridden by the specific setting for a specific VLAN.

Switch Operations

With built-in VLAN switching support in hardware, the XpressFlow Switch can download different micro-code to meet various user requirements. Two versions of micro-code are supplied with the XpressFlow Switch: one for VLAN-Unaware Switches (described below) and one for VLAN-Aware Switches (described on page 9).

VLAN-Unaware Switches

The XpressFlow Switch is designed to switch frames from a receiving port to one or more transmitting ports. The XpressFlow Switch performs a number of steps during the switching process, including:

- Learning
- Filtering
- Forwarding
- Aging

Unicast Switching

The following sections describe the Learning, Filtering, Forwarding, and Aging processes performed during unicast switching.

Learning

When the XpressFlow Switch receives a Unicast frame, the Switch checks the source MAC address in the switching database to see whether the address is unknown.

- If the source MAC address is unknown, the Switch Manager CPU performs source MAC address learning.
- Otherwise, the XpressFlow Switch checks whether the source MAC address has a mismatched port ID. If the port ID associated with the source MAC address in the switching database is different than the receiving port, the XpressFlow Switch modifies the port ID in the switching database and notifies the Switch Manager CPU about the new port change.

Filtering

After performing the Learning process, the XpressFlow Switch checks whether the:

- Source port or destination port is not in the forwarding state.
- Source MAC address or destination MAC address is to be filtered.
- Source port ID is the same as destination port ID.

If any one of these conditions is met, the XpressFlow Switch drops the receiving frame. Otherwise, the XpressFlow Switch continues with the forwarding process (described below).

Forwarding

During the forwarding process, the XpressFlow Switch checks whether the destination MAC address is unknown.

- If it is unknown, the receiving frame floods to all ports, except the source port.
- Otherwise, the receiving frame is forwarded to the port associated with the destination MAC address.

Multicast Switching

The following sections describe the Multicast Switching process for VLAN-unaware switches.

BPDU Checking

During multicast switching, the XpressFlow Switch checks whether the received frame is a BPDU.

- If a BPDU is received, the frame is forwarded to the Switch Manager CPU for further processing by the Spanning Tree Protocol.
- Otherwise, the XpressFlow Switch performs the following processes.

Learning

If the source MAC address of a received frame is unknown, the Switch Manager CPU learns the source MAC address; otherwise, the XpressFlow Switch checks whether the source MAC address has a mismatched port ID.

If the port ID associated with the source MAC address in the switching database is different than the receiving port, the XpressFlow Switch modifies the port ID in the switching database and notifies the Switch Manager CPU about the new port change.

Filtering

If the source port is not in the forwarding state or the source MAC address is to be filtered, the XpressFlow Switch discards the received multicast frame.

Forwarding

Otherwise, the received multicast frame floods to all ports, except the source port.

Aging

The XpressFlow Switch performs the aging process for the MAC addresses in the switching database. Once a MAC address is aged out, the switching database is modified and the Switch Manger CPU performs house cleaning.

VLAN-Aware Switches

The XpressFlow Switch is designed to switch both VLAN-tagged and VLAN-untagged frames from a receiving port to one or more transmitting ports. The XpressFlow Switch performs a number of steps during the switching process, including:

- VLAN Classification
- Learning
- Filtering
- Forwarding
- Aging

VLAN-Aware Switches run a superset of micro-code used in the VLAN-Unaware Switches. When the XpressFlow Switch performs frame-switching activities in a VLAN-aware environment, the Switch uses the *<MAC Address, VLAN>* pair instead of using only the MAC Address.

Unicast Switching

The following sections describe the VLAN Classification, Learning, Filtering, Forwarding, and Aging processes performed during unicast switching.

VLAN Classification

A receiving frame from an ingress port is classified to an associated VLAN, according to its source MAC address or ingress port number. The classification is performed in the order of Level-2 VLAN (MAC address-based VLAN), then Level-1 VLAN (port-based VLAN). If the frame is not associated with any Level-2 or Level-1 VLAN, it is classified into the default VLAN.

Learning

After VLAN classification, the XpressFlow Switch checks the *<source MAC address, VLAN>* pair in the switching database to see whether the *<source MAC address, VLAN>* pair is unknown.

- If the pair is unknown, the Switch Manager CPU learns the *<source MAC address, VLAN>* pair.
- Otherwise, the XpressFlow Switch checks whether the pair has a mismatched port ID. If the port ID associated with the *<source MAC address, VLAN>* pair in the switching database is different than the receiving port, the XpressFlow Switch modifies the port ID in the switching database and notifies the Switch Manager CPU about the new port change.

Filtering

After performing the Learning process, the XpressFlow Switch checks whether the:

- Source port or destination port is not in the forwarding state.
- The *<source MAC address, VLAN>* pair or *<destination MAC address, VLAN>* pair is to be filtered.
- Source port ID is the same as destination port ID.

If any of these conditions is met, the XpressFlow Switch drops the receiving frame. Otherwise, the XpressFlow Switch continues with the forwarding process (described below).

Forwarding

During the forwarding process, the XpressFlow Switch checks whether the <*destination MAC address, VLAN*> pair is unknown.

- If the pair is unknown, the receiving frame floods to all ports, except the source port.
- Otherwise, the receiving frame is forwarded to the port associated with the <*destination MAC address, VLAN*> pair.

Multicast Switching

The following sections describe the Multicast Switching process for VLAN-aware switches.

BPDU Checking

During multicast switching, XpressFlow Switch checks whether the received frame is a BPDU.

- If a BPDU is received, the frame is forwarded to the Switch Manager CPU for further processing by the Spanning Tree Protocol.
- Otherwise, the following processes are followed.

VLAN Classification

A frame received from an ingress port is classified to an associated VLAN, according to its source MAC address or ingress port number. The classification is performed in the order of Level-2 VLAN (MAC address-based VLAN), then Level-1 VLAN (port-based VLAN). If the frame is not associated with any Level-2 or Level-1 VLAN, it is classified into the default VLAN.

Learning

If the <*source MAC address, VLAN*> pair of a received frame is unknown, the Switch Manager CPU learns the <*source MAC address, VLAN*> pair; otherwise, the XpressFlow Switch checks whether the <*source MAC address, VLAN*> pair has a mismatched port ID. If the port ID associated with the <*source MAC address, VLAN*> pair in the

switching database is different than the receiving port, the XpressFlow Switch modifies the port ID in the switching database and notifies the Switch Manager CPU about the new port change.

Filtering

If either the source port is not in the forwarding state or the <*source MAC address, VLAN*> pair is to be filtered, the XpressFlow Switch discards the received multicast frame.

Forwarding

Otherwise, the received multicast frame floods to all ports in the VLAN, except the source port.

Aging

The XpressFlow Switch also performs the aging process for the <*MAC address, VLAN*> pair in the switching database. Once a <*MAC address, VLAN*> pair is aged out, the switching database is modified and the Switch Manger CPU performs house cleaning.

VLAN

Virtual LANs (VLANs) are logical, independent workgroups within a network. These workgroups communicate as if they had a physical connection to the network. However, VLANs are not limited by the hardware constraints that physically connect traditional LAN segments to a network. As a result, VLANs can define a network into various logical configurations.

For example, VLANs can define a network by application. For instance, a company might create one VLAN for multimedia users and another for e-mail users. VLANs can also define a network by department. For example, a company might have one VLAN for its Engineering Department, another for its Marketing Department, and another for its Accounts Payable Department.

VLANs can also be set up according to the organization structure within a company. For example, the company president might have his own VLAN, his executive staff might have a different VLAN, and the remaining employees might have yet a different VLAN.

As these examples show, VLANs offer unparalleled flexibility. The following sections describe how deploying VLANs can benefit organizations and reduce administration costs.

Broadcast Containment

VLANs offer a more cost-effective broadcast containment than routers.

In traditional networks, traffic broadcasts to all network devices, whether they are the intended recipients or not. However, VLANs can be set up to contain only those devices that need to communicate with each other. As a result, VLANs significantly reduce network congestion In addition, VLANs prevent broadcast storms from causing a network meltdown due to volumes of traffic.

Reduced Cost of Network Administration

In traditional networks, administrators spend a great deal of time adding, moving, and deleting network users. For example, if users move to a different IP subnet location on the network, the administrator must manually revise the IP addresses of each endstation. If users are deleted from the network, their IP address must also be deleted.

VLANs simplify these administrative activities. For example, if an endstation in a VLAN moves to a different port in the network, an administrator can specify the new port assignment quickly and easily using the XpressFlow Switch console. This simplicity gives network administrators time to handle more important matters..

Enhanced Flexibility for Portable Network Users

LAN routers make it very difficult to support mobile users on a network. This is because a router's addressing scheme always expects to find a given address on a given segment. If that address moves to another segment, the router's tables need to be manually changed. This is a very time-consuming process, so user mobility is discouraged in a router-based network.

VLANs, on the other hand, use either MAC addresses (Level-2 VLANs) or network addresses (Level-3 VLANs) to decide who connects to whom and can therefore build up virtual teams of users based on MAC addresses. Regardless of location, the XpressFlow Switch in a VLAN configuration allows users of predefined workgroups to communicate.

In this way, VLANs eliminate the limitation in a traditional router environment that requires all end stations sharing the same broadcast domain to reside in the same physical segment. As a result, virtual workgroups can be dynamically reassigned according to changing needs over time, without having to move hardware or manually reconfigure the network.

Multicast-Based Multimedia Applications

Multimedia applications, such as interactive training, video conferencing, and news-video transmissions, require large amounts of bandwidth. These applications are also extremely sensitive to variable delays, which are unavoidable on a shared Ethernet network. By defining a VLAN based on the IP multicast address for all subscribing members on the VLAN, sufficient bandwidth will be available for these applications, providing true multimedia on Ethernet.

Enhanced Security

Because VLANs are self-contained, only the devices within the same VLAN can communicate with each other. If a device in one VLAN wants to communicate with a device in another VLAN, the traffic must go through a router.

VLAN Membership

Vertex's VLAN implementation allows:

- Up to 64 VLANs in one switch.
- VLANs across multiple switches by using explicit or implicit tagging.
- An end station's network interface card to belong to multiple VLANs.
- A switch port to be associated with multiple VLANs.

Definitions of VLAN Membership

Vertex's VLAN implementation allows VLAN membership to be defined based on ports or MAC addresses.

- MAC address-based VLANs are based on the MAC address of the end station. This means that users with portable computers can connect to any point in the network. The XpressFlow Switch will ensure that the user is connected to the correct workgroup.

- Port-based VLANs are organized by physical port number. For example, switch ports 1, 2, 4, and 6 can be one VLAN, while ports 3, 5, 7, and 8 can be another VLAN. Broadcasts from serves within each group would only go to the members of its own VLAN. This ensures that broadcast storms cannot cause a network meltdown due to volumes of traffic.

Future VLAN implementations will support VLANs based on protocol encapsulation and network layer address.

VLAN Membership Learning

Level-1 VLAN is defined using a static binding between a VLAN and its associated ports. The XpressFlow Switch's forwarding decision is based on the destination MAC address and its associated port ID. Therefore, to make valid forwarding and flooding decisions, the XpressFlow Switch learns the relationship of the MAC address to its related port — and thus to the VLAN — at run-time.

Level-2 VLAN is defined using a static binding between a VLAN and its associated MAC addresses. The XpressFlow Switch learns the relationship of a MAC address to its related ports as the switch performs the learning process. As a result, the XpressFlow Switch can also learn the relationship of a VLAN and its associated ports at run-time.

Remote VLAN Learning

To reduce the chance of uplink flooding, the XpressFlow Switch supports remote VLAN learning within a Vertex Switching Domain. The learning of remote VLANs is accomplished by piggybacking the VLAN ID in BPDUs used by the Spanning Tree Protocol.

When the XpressFlow Switch receives an explicitly tagged BPDU, it learns the remote VLAN membership of a source link, while the STP ignores the VLAN Tag and processes as usual. All XpressFlow Switches can then learn remote VLANs quickly and efficiently, and the VLAN membership binding will be known promptly to minimize unnecessary flooding.

VLAN Membership Distribution and Management

The IEEE 802.1Q committee is working on the Group Address Registration Protocol (GARP) mechanism, defined by the 802.1P subworking group, as a centralized way to dynamically register and deregister VLAN membership.

In addition, the 802.1Q committee is creating VLAN-related MIBs, which can be utilized as a way to globally distribute the VLAN definitions and membership across switches from different vendors.

Vertex has been closely monitoring and actively participating in the 802.1Q committee, and plans to implement the standards for VLAN membership distribution and management as soon as they stabilize.

VLAN Configuration

Vertex currently provides a Local/Remote Management Console Interface for VLAN configuration and management. An SNMP MIB-based solution will be provided when the 802.1Q committee stabilizes its VLAN MIB standard proposal.

Until then, Vertex is reviewing Web browser-based network management as a future VLAN configuration tool.

Intra-VLAN Communication

The XpressFlow Switch supports intra-VLAN communication using ASIC with Turbo-Cut-Through Switching, Safe-Cut-Through Switching, or Store-and-Forward Switching. The forwarding decision of a packet will be affected by the filter-setting, and by the Spanning Tree state of the source and destination ports.

Inter-VLAN Communication

The current generation of the XpressFlow Switch supports inter-VLAN communications using software-based routing with RIP protocol.