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Nortel Multiservice Switch 7400/15000/20000

ATM Technology Fundamentals

NN10600-700

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Contents

What's new

There were no new features added to this document.

Attention: To ensure that you are using the most current version of an NTP, check the current NTP list in NN10600-000 *Nortel Multiservice Switch 7400/15000/20000 What's New*.

Introduction to ATM on Multiservice Switch networks

Asynchronous transfer mode (ATM) is a high bandwidth, low-delay, connection-oriented switching and multiplexing technique. ATM technology is based on the switching of small fixed-length packets of data called cells. In ATM, all data is transferred in 53-byte cells. Each cell has a 5-byte header that identifies the cell's route through the network and 48 bytes that contain user data (called the payload).

Navigation

Overview of ATM network architecture

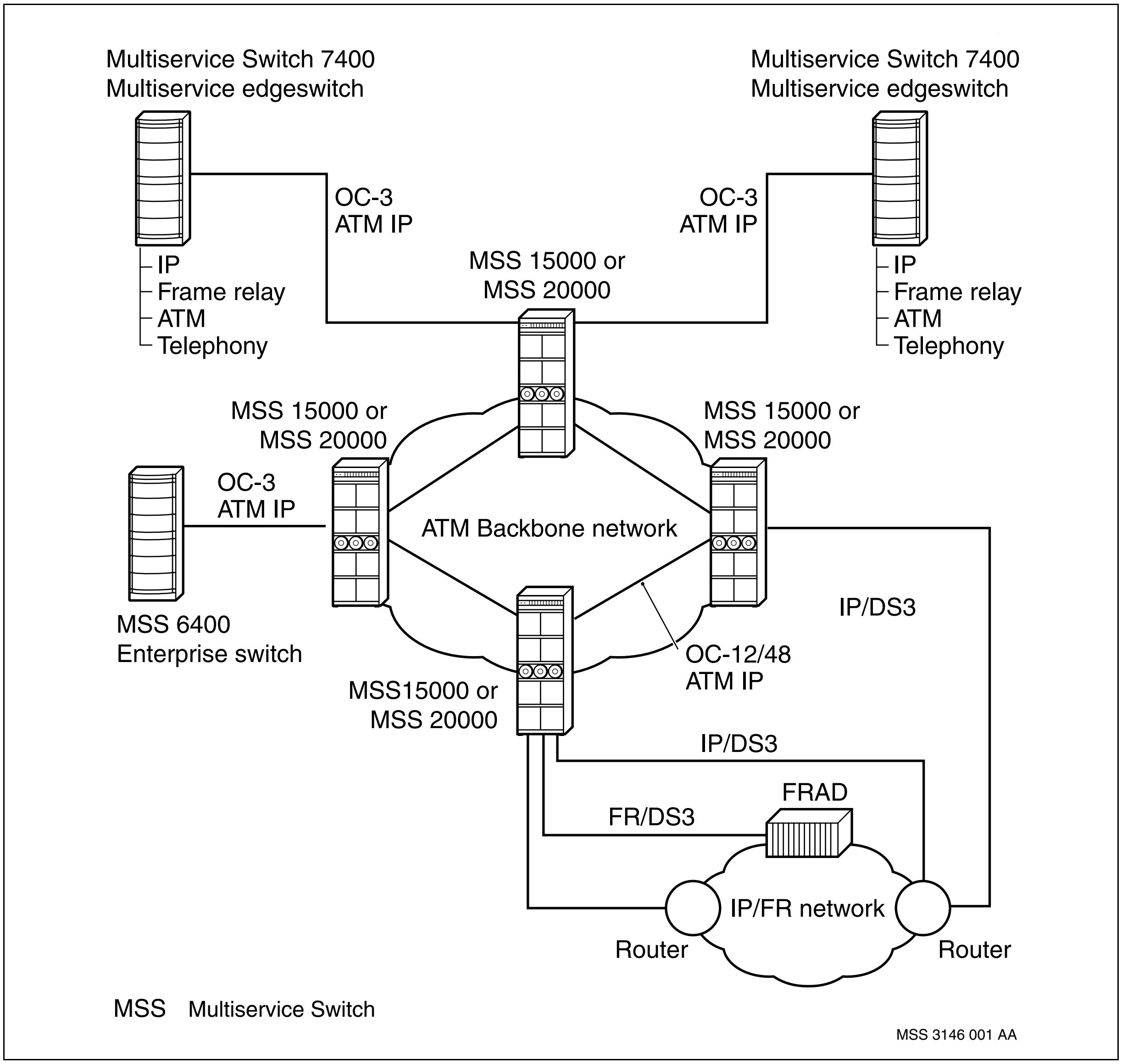
The figure ATM network architecture (page 7) illustrates a typical ATM network.

The adaptation layer is the outer layer of the ATM network. This layer includes enterprise switches and service access multiplexers. These devices support the service interfaces and adapt legacy protocols, such as frame relay, to ATM. The Passport 6400 switch is an ATM access device and can exist either on the customer premises or in the service provider's central office.

The access layer is the middle layer of the ATM network. Nortel Multiservice Switch 7400 devices are access concentration nodes or edge nodes. These nodes receive cells from the nodes in the adaptation layer and concentrate these cells into the ATM backbone layer.

The ATM backbone is the central layer in the ATM network. A Nortel Multiservice Switch 15000 is responsible for routing traffic through the network at high speeds.

ATM network architecture



ATM on Multiservice Switch networks

ATM on Nortel Multiservice Switch networks is based on standards developed by the ATM Forum and the International Telecommunication Union (ITU). Because ATM uses small cells to transfer data and isochronal timing, Multiservice Switch devices can support a wide range of audio, video, image, and data communications requirements.

ATM uses a type of time division multiplexing that transmits different applications (voice, data, or video) over the same connection. With ATM technology, Multiservice Switch nodes can allocate bandwidth on demand based on each application's bandwidth and quality of service (QOS) requirements.

Unlike shared-medium local area network (LAN) technologies where users contend for bandwidth (ethernet and token ring), Multiservice Switch nodes provide dedicated, deterministic, high-speed connectivity.

Multiservice Switch nodes support the following ATM services to allow service providers to use other forms of traffic in their networks:

- Inverse multiplexing for ATM (page 12)
- AAL1 circuit emulation service (page 13)
- Multiservice Switch trunks over ATM (page 13)
- Frame relay over ATM (page 13)
- ATM multiprotocol encapsulation service (page 14)

Multiservice Switch nodes provide industry-standard network interfaces and virtual connections to support internetwork connectivity and multi-vendor interoperability. See ATM connections and signaling protocols (page 16) for more information.

Multiservice Switch nodes support the following advanced traffic management capabilities to allow service providers to optimize network performance:

- connection admission control
- bandwidth pool management
- resource management
- queue management
- congestion control
- traffic shaping and policing

See Traffic management for ATM (page 26) for more information on Multiservice Switch network traffic management capabilities.

The Multiservice Switch service management strategies optimize network performance and increase service provider revenues. Its flexible accounting features include usage-based billing, time-of-day billing, and carrier-class accounting. Multiservice Switch nodes monitor and collect statistics for each service category then spools them for off-line analysis.

ATM service reliability on Multiservice Switch 1500 and 2000

With Nortel Multiservice Switch 1500 and 20000, the applications and features that provide services fall into three categories: hot standby, warm standby, and cold standby. The following ATM services offer a hitless service:

- PVCs (VCCs, VPCs and VPT VCC (basic and standard) connections)
- point-to-point SVCs
- point-to-point source and destination PVCs
- point-to-point SVPs
- source and destination SPVPs

The ATM hitless services can be offered on UNI, IISP, AINI, and PNNI interfaces in non-associated signalling configurations.

Hot standby applications and features can run uninterrupted, even when the hardware providing that service changes. This means they can offer hitless services during an FP or CP switchover. This is done by operating with a standby instance of the software that is fully synchronized with the active instance of the software. Hot standby applications and features use equipment sparing of optical and electrical FPs to incur a minimal interruption of cell forwarding and maintain any connections that are established.

This ability reduces service down time and increases service reliability.

Warm standby applications and features also provide increased service reliability, although to a lesser extent than hot standby applications and services. During an equipment switchover, warm standby applications and features incur a longer outage of service than hot standby applications, but not as long as cold standby applications. As well, all connections must be re-established.

See NN10600-550 *Nortel Multiservice Switch 7400/15000/20000 Common Configuration Procedures* for a description of hitless services and hot, warm and cold standby applications and features.

ATM function processors

Nortel Networks defines ATM function processors (FPs) by the type of application specific integrated circuit (ASIC) and by the type of field programmable gate array (FPGA) on the card:

- APC-based FPs—Nortel Networks' name for a type of Nortel Multiservice Switch ATM FP that provides high performance ATM adaptations for IP, frame relay, and existing networking applications.

  APC-based FPs use the ATM Port Controller (APC) ASIC, the Multiservice Switch queue controller (PQC) ASIC, and the Queue Relay Device (QRD) FPGA to provide enhanced functionality.

- AQM-based FPs—Nortel Networks' name for a type of Multiservice Switch ATM FP that provides high performance ATM adaptations for IP, frame relay, and existing networking applications. This type of FP also improves and expands the network's ATM traffic management capabilities.

  AQM-based FPs use the Multiservice Switch queue controller (PQC) and ATM queue manager (AQM) ASICs to provide enhanced functionality. However, the 1-port OC-12 FPs use the PQC and the ATM queue scheduler (AQS) FPGA to provide OC-12 capacity.

- AQS-based FPs—Nortel Networks' name for the Multiservice Switch ATM FP that provides high performance ATM adaptations for IP, frame relay, and existing networking applications.

  AQS-based FPs use the PQC ASIC and the ATM queue scheduler (AQS) FPGA to provide OC-12 capacity.

- CQC-based FP—a type of Multiservice Switch ATM FP that uses a cell queue controller (CQC) ASIC. This type of FP is the original ATM FP on Multiservice Switch devices.

- GQM-based FP—a type of Multiservice Switch ATM FP that uses the generic queue manager (GQM) ASIC. This type of FP is a descendent of earlier traffic management ASICs such as the AQM and QRD. The GQM FP also uses the ASICs Atlas 3200 for policing and the RSP2 for IP applications.

- Multiservice Access FPs—Nortel Networks' name for a type of Multiservice Switch FP which provides significantly higher DS1 or E1 port density than any existing node FP and supports multiple types of services which would otherwise be performed on a number of separate existing node FPs. The Multiservice Access FPs are designed to interwork with existing Multiservice Switch node CP2 (or later) control processors. They are targeted for application at the service provider network edge. The Multiservice Access FPs inter-operate seamlessly with existing FP technology and are consistent with the Multiservice Switch management and control paradigm.

The Multiservice Access FPs use the Multiservice Switch node queue controller (PQC) and ATM queue manager (AQM) ASICs to provide enhanced functionality.

The table Function processor ASICs (page 11) maps the FP to the type of ASIC and Multiservice Switch series.

See NN10600-170 *Nortel Multiservice Switch 7400 Hardware Description* and NN10600-120 *Nortel Multiservice Switch 15000/20000 Hardware Description* for more information about ATM FPs.

Function processor ASICs

Product	Function processor	ASIC
Multiservice Switch 7400 series	2-port JT2 ATM	CQC
Multiservice Switch 7400 series	2-port OC-3 ATM IP	AQM, PQC
Multiservice Switch 7400 series	2-port STM-1 electrical ATM IP	AQM, PQC
Multiservice Switch 7400 series	3-port DS1 ATM	CQC
Multiservice Switch 7400 series	3-port DS3 ATM	CQC
Multiservice Switch 7400 series	3-port E1 ATM	CQC
Multiservice Switch 7400 series	3-port E3 ATM	CQC
Multiservice Switch 7400 series	3-port OC-3 ATM	CQC
Multiservice Switch 7400 series	3-port DS3 ATM IP	AQM, PQC
Multiservice Switch 7400 series	3-port E3 ATM IP	AQM, PQC
Multiservice Switch 7400 series	8-port DS1 ATM	CQC
Multiservice Switch 7400 series	8-port E1 ATM	CQC
Multiservice Switch 7400 series	32-port DS1 MSA FP	AQM, PQC
Multiservice Switch 7400 series	32-port E1 MSA FP	AQM, PQC
Multiservice Switch15000 or 20000 series	1-port OC-12/STM-4	AQS, PQC
Multiservice Switch 15000 or 20000 series	1-port OC-48/STM-16	QRD, PQC
Multiservice Switch 15000 or 20000 series	1-port OC-48/STM-16 channelized with APS	QRD, PQC
Multiservice Switch 15000 or 20000 series	4-port DS3Ch ATM	AQM, PQC
(1 of 2)		

Function processor ASICs (continued)

Product	Function processor	ASIC
Multiservice Switch 15000 or 20000 series	4-port OC-3/STM1	AQM, PQC
Multiservice Switch 15000 or 20000 series	4-port OC-12/STM-4 ATM	APC QRD, PQC
Multiservice Switch 15000 or 20000 series	12-port DS3	AQM, PQC
Multiservice Switch 15000 or 20000 series	12-port E3	AQM, PQC
Multiservice Switch 15000 or 20000 series	16-port OC-3/STM1 ATM	APC, QRD, PQC
Multiservice Switch 15000 or 20000 series	16-port OC-3/STM1 POS and ATM	Atlas 3200, GQM, RSP2
(2 of 2)		

Inverse multiplexing for ATM

Inverse multiplexing for ATM (IMA) is a feature that supports the transparent transmission of ATM cells over a combination of multiple DS1/E1 links (an IMA link group). The link group uses the inverse multiplexing process to transmit a single stream of ATM layer traffic across multiple links. IMA then combines the traffic back into the original cell sequence at the remote end.

IMA on Nortel Multiservice Switch nodes supports the use of synchronized and non-synchronized links within an IMA link group. Use an IMA link group within a Multiservice Switch network to access an external ATM network. IMA is available to both private and public user-to-network (UNI) or network-to-network (NNI) interfaces. The Multiservice Switch network's traffic management capabilities also apply to ATM connections served by IMA link groups.

IMA provides reliability and robustness of cell traffic. When you remove a link, if there is sufficient bandwidth on the remaining links, no traffic loss will occur.You can remove or add links without tearing down the link group or the ATM interface served by the IMA link group. If a link fails, Multiservice Switch nodes maintain ATM connections served by the link group at a reduced capacity.

Multiservice Switch node software follows the ATM Forum *Inverse Multiplexing for ATM (IMA) Specification.* For more information about IMA, see NN10600-730 *Nortel Multiservice Switch 7400/15000/20000 Operations: Inverse Multiplexing for ATM*.

AAL1 circuit emulation service

The ATM adaptation layer 1 (AAL1) circuit emulation service (CES) transports DS1 and E1 constant bit rate (CBR) data over an ATM network. The service transmits the data at the high-performance level of a dedicated circuit. CES converts the DS1 or E1 circuit data to ATM cells, transferring the cells across an ATM network, and then reconverts the data to its original DS1 or E1 circuit form.

Use AAL1 CES in a backbone switch deployed in enterprise networks for network and device consolidation. AAL1 CES allows multi-vendor interoperability for DS1 or E1 circuits over ATM networks. You can also use the AAL1 CES to transport video codecs or any protocol over ATM. AAL1 CES can also transport voice over ATM in limited scenarios.

For more information about AAL1 CES, see NN10600-720 *Nortel Multiservice Switch 7400/15000/20000 Operations: AAL1 Circuit Emulation*.

Multiservice Switch trunks over ATM

Nortel Multiservice Switch node-to-Multiservice Switch node links are called Multiservice Switch trunks (trunks). A trunk is a point-to-point or logical connection between two Multiservice Switch nodes over which Multiservice Switch proprietary routing protocols run. Multiservice Switch trunks over ATM implement an unacknowledged protocol and support ATM connections for node-to-node connectivity.

Trunks over ATM allow all non-ATM Multiservice Switch services and DPN-100 traffic to travel transparently over ATM while allowing the transport of all existing services. This transport mechanism also enables new service offerings to be carried prior to standardization of future adaptation protocols.

Trunks over ATM can connect nodes directly together, through a series of nodes or through an external ATM network

For more information about Multiservice Switch trunks over ATM, see NN10600-420 *Nortel Multiservice Switch 7400/15000/20000 Operations: Trunking*.

Frame relay over ATM

The frame relay to ATM (FR-ATM) interworking service for Nortel Multiservice Switch nodes allows the carriage of frame relay traffic over an ATM networking and transport infrastructure. It maps frame relay permanent virtual connections (PVC) to and from ATM PVCs to provide connectivity between frame relay customer premises equipment (CPE) and ATM CPE.

The FR-ATM service is both a core frame relay UNI or NNI service and an interworking function. The core frame relay UNI/NNI service provides the access side of a frame relay UNI or NNI. The interworking function provides an interface for connection to an ATM subnet

The FR-ATM interworking function supports the application of either the FRF.8 standard to support service interworking (SIWF), or the FRF.5 standard to support network interworking (NIWF).

The SIWF maps frame relay connections to an ATM connections. It maintains standard interworking between frame relay and ATM equipment that is transparent to the end users.

The NIWF encapsulates frame relay over ATM and normally multiplexes many frame relay connections to one ATM connection. The FR-ATM NIWF enables frame relay CPE connectivity over frame relay networks interconnected over a backbone ATM network. The NIWF maintains standard interworking between frame relay networks or nodes around an ATM core. Frame relay users on interconnected frame relay networks or nodes are unaware of the use of ATM in the core.

For more information about FR-ATM on the Multiservice Switch nodes, see NN10600-920 *Nortel Multiservice Switch 7400/15000/20000 Operations: Frame Relay to ATM Interworking*.

ATM multiprotocol encapsulation service

The ATM multiprotocol encapsulation service (MPE) service allows separate LANs to communicate over an ATM network. The ATM MPE service on the Nortel Multiservice Switch node follows the specifications detailed in RFC 1483. This service has two encapsulation methods for transmitting network interconnect traffic over ATM AAL5. The first method allows multiplexing of multiple protocols over a single ATM virtual circuit. The second method requires the transmission of each protocol over a separate ATM virtual circuit.

Multiservice Switch ATM MPE service allows different IP networks to connect. This connectivity allows IP traffic to be transmitted across the ATM network.

This service allows multiple users to share ATM services and removes the need for a dedicated ATM interface. The service allocates the shared line's bandwidth to any user who is transmitting at any time.

For more information about Multiservice Switch ATM MPE service, see NN10600-800 *Nortel Multiservice Switch 7400/15000/20000 IP Technology Fundamentals*.

ATM MPE also supports multiprotocol label switching (MPLS). MPLS is a label-swapping, networking technology that forwards IP traffic over multiple, underlying layer-2 media. For more information about MPLS, see NN10600-445 *Nortel Multiservice Switch 7400/15000/20000 Operations: Multiprotocol Label Switching*.

ATM connections and signaling protocols

Nortel Multiservice Switch supports ATM permanent, soft permanent, and switched connections. Multiservice Switch uses the user-to-network interface (UNI), the interim inter-switch protocol (IISP) and the ATM inter-network interface (AINI) signaling protocols to support soft permanent connections. Multiservice Switch uses the private network-to-network interface (PNNI) signaling protocol to support switched connections.

Navigation

Connections

Nortel Multiservice Switch ATM connection provides end-to-end information transfer capability to access points.

A virtual channel connection (VCC) is an ATM connection where switching is performed on the virtual path identifier (VPI) and virtual channel identifier (VCI) fields of each cell. A VPI is a field in the ATM cell header that indicates the virtual path for routing the cell. A VCI is a unique numerical tag, as defined by a 16-bit field in the ATM cell header that identifies the virtual channel over which the cell is to travel. A virtual path connection is an ATM connection where routing is performed only on the VPI field of each cell.

Multiservice Switch nodes support four ATM connection types:

- Permanent virtual channels and paths (page 17)
- Soft permanent virtual channels and paths (page 17)
- Switched connections (page 18)
- Virtual path terminators (page 19)

For more information on ATM connections, see NN10600-702 *Nortel Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*.

Permanent virtual channels and paths

A permanent virtual connection can be either a virtual path (PVP) or virtual channel (PVC). A permanent connection has a predefined static route that provides a permanently configured connection between the customer premise equipment and the ATM networks. Permanent connections are set up using predetermined user requirements for bandwidth and the duration of the connection. Once configured, permanent connections remain set up even when they are not in use.

Soft permanent virtual channels and paths

Soft permanent connections (SPVPs and SPVCs) support the same functionality as permanent connections and eliminate the need to manually configure each node along the connection. The end point is configured but the connection route is automatically selected. Soft permanent connections also support automatic route selection, and connection establishment and re-establishment.

Soft permanent connections use special information elements (IEs) that are added to the call setup protocol data unit (PDU). These IEs specify the end point VPI and VCI connection map address space for the SPVC/SPVP.

Point-to-multipoint SPVCs allow the user to originate PMP connections which can terminate within, at the edge, and outside a Multiservice Switch network. Upon PMP SPVC connection failure (entire or partial tree) each leaf will automatically attempt to re-establish immediately and retry every SPVC/P retry interval thereafter until successful.

The SPVP and SPVC lock and unlock feature introduces the lock and unlock commands to the SPVP and point-to-point SPVC configured components. The lock and unlock commands can be invoked operationally at the source node to release or reestablish the connection. The operational lock command releases the connection and the allocated bandwidth from the source to the destination. To reestablish a connection that has been operationally locked, the unlock command must be invoked.

The SPVP and SPVC lock and unlock feature enables you to:

- isolate a connection on a given interface by locking the other ones in order to trace or test it, which facilitates network troubleshooting.
- reset these soft connections in order to re-initialize them without affecting other services under the ATM interface.

- configure these connections in a locked state when these connections cannot establish due to network conditions. For example, the end-user is not ready to accept calls. In this case, you can avoid unnecessary call attempts during that time.
- release SPVC connections for a certain period of time, without having to reconfigure the connection later on.
- make temporary use of a connection, in particular for an administrative backup. In this case, the SPVC is permanently locked and only re-establishes when the data transfer is needed.
- reserve the configuration data.

For more information on configuring the SPVP and SPVC lock and unlock feature, see NN10600-710 *Nortel Multiservice Switch 7400/15000/20000 ATM Configuration Management*.

The following network features support soft permanent and switched connections:

- PNNI signaling protocol
- UNI signaling protocol
- IISP
- AINI signaling protocol

For network nodes that support UNI, IISP, or AINI signaling protocols, the nodes must be configured for static routing. For network nodes that support the PNNI signaling protocol, no additional configuration is required.

Switched connections

A switched connection supports the same functionality as permanent connections and provides dynamic establishment at each node along the connection route. The connection route is automatically selected. Switched connections do not require configuration, but network nodes must be configured for ATM routing.

Nortel Multiservice Switch supports point-to-point and point-to-multipoint connections. These connections are dynamically set up and taken down on a call-by-call basis.

Point-to-point connections provide the capability for bi-directional unicast data communication. Data traffic moves simultaneously in both directions, and allows for the possibility of the two streams of traffic requiring different bandwidths.

Point-to-multipoint connections provide the capability for unidirectional multicast data communications using VCC-based switched connections. A point-to-multipoint connection is a collection of associated ATM virtual channels with associated end point nodes. Data traffic moves in one direction only, from the single source to the multiple destinations.

Nortel Multiservice Switch point-to-multipoint connections can be used to provide point-to-multipoint capability for IP multicast applications.

Virtual path terminators

A virtual path terminator (VPT) is an ATM network entity that unbundles the virtual channels of a virtual path for independent processing of each virtual channel. There are two types of VPTs, basic and standard, that serve as connection end points of a virtual path connection.

In an environment where ATM public switched connection services are not available the VPT feature, combined with traffic class routing, provides the capability to route connections on a particular PVP of the same or different service category.

Nortel Multiservice Switch nodes support static and dynamic routing over the appropriate tunnel, using the virtual path attributes and metrics as optimization criteria. In case of network failures in the service provider network, they can interpret the alarm signals and update the topology database in order to reroute the traffic on an alternate virtual path.

VPTs on the node provide fault interworking capability, notification of connection level services to applications upon occurrence of a virtual path layer fault, termination capabilities, and shaping. VPTs also provide effective management of virtual path bandwidth that allows dynamic sharing of virtual channels within a single virtual path service category and maintenance of priorities among the services.

For information about VPT level traffic management, see the following documents:

- NN10600-705 *Nortel Multiservice Switch 7400/15000/20000 ATM Traffic Management Fundamentals*
- NN10600-707 *Nortel Multiservice Switch 7400/15000/20000 ATM Queuing and Scheduling Fundamentals*
- NN10600-708 *Nortel Multiservice Switch 7400/15000/20000 ATM CAC and Bandwidth Fundamentals*

Basic VPT

For basic VPTs, independent virtual connections configured within a basic VPT are equivalent from a datapath and traffic management perspective. Basic VPTs support the following capabilities:

- virtual path operations and maintenance functionality (end-to-end loopbacks and virtual path to virtual channel fault interworking)
- spooled VCC statistics and accounting records
- optional VPT connection admission control (CAC)

A basic VPT is suitable for applications in which the network needs one or more virtual interfaces for switched connections within the VPT. When you do not configure a VPT CAC, a basic VPT is suitable for a single link with multiple connections grouped into one VPT or a link with multiple VPTs where the network does not need VP traffic management.

Standard VPT

Standard VPTs provide traffic management capabilities at both the virtual path and virtual channel levels. Standard VPTs can dynamically share bandwidth among virtual paths and virtual channels within a given virtual path. In addition to the features supported by basic VPTs, standard VPTs also support the following capabilities:

- real-time statistics (operationally viewable as opposed to spooled) implemented at the VPT level
- virtual path shaping and weighted fair queuing (WFQ)
- multiplexing of multiple virtual channel service classes

Unlike a basic VPT (with no virtual path-related datapath for ATM cells at the VPT connection point), a standard VPT is directly involved in the datapath. This feature allows most of the traffic management capabilities of relay-point VPCs to be available at the VPT connection point.

ATM signaling protocols

Nortel Multiservice Switch ATM signaling interface is the connection between two network nodes or entities. Each entity is either customer premises equipment (CPE), another Multiservice Switch node, or an external ATM network. The ATM interface layer provides the direct association between the interface and the physical port and, by extension, the physical link hard-wired to the port. Each physical ATM link or inverse multiplexing for ATM (IMA) link group has one ATM interface at each end. The interface, and the networking and protocol associated with that interface, control connections on the ATM link.

Multiservice Switch nodes support the following ATM signaling interface types:

- User-to-network interface (page 21)
- Interim interswitch signaling protocol interface (page 21)
- ATM inter-network interface (page 22)
- Private network-to-network interface (page 22)
- Virtual interfaces (page 24)

For more information about ATM signaling protocols, see NN10600-702 *Nortel Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*.

User-to-network interface

UNIs exist between CPE ATM devices and private or public ATM network equipment, the network nodes in the same ATM network, or different ATM networks. There are both private and public UNI protocols. Private UNIs define the communication exchange protocol between an ATM user and a private ATM device. Public UNIs define the communication exchange protocol between an ATM user and a public carrier service. UNIs use integrated local management interface (ILMI) control procedures for dynamic address registration across the interface.

Nortel Multiservice Switch UNIs provide dynamic address registration across the interface because of the use of ILMI control procedures. They support network service access point (NSAP)-international code designator (ICD), NSAP-data country code (DCC), NSAP-E.164, native E.164 format, and signaling routing protocols. Multiservice Switch UNIs also support group addressing for anycast point-to-point connections.

Multiservice Switch UNIs are compliant with the following ATM Forum standards:

- *User-to-Network Interface Specification Version 3.0*
- *User-to-Network Interface Specification Version 3.1*
- *User-to-Network Interface Specification Version 4.0*
- *Interim Local Management Interface Specification (ILMI) Version 3.1*
- *Integrated Local Management Interface Specification (ILMI) Version 4.0*

Interim interswitch signaling protocol interface

IISP interfaces on the Nortel Multiservice Switch node, exist between network nodes on ATM networks. The IISP signaling protocol on this type of interface supports switched connections between Multiservice Switch nodes, other Multiservice Switch devices, and devices from other vendors. Each IISP link is configurable as the user side or the network side of the signaling interface. These sides are manually configured, with the calling side usually being assigned to be the user and the called side the network. The network nodes do not exchange routing information, and a fixed routing algorithm with static routes must be implemented at each IISP node. IISP interfaces provide static routing and associated node-to-node signaling.

Multiservice Switch IISP interfaces allow an interoperability of vendor devices through a standard routing functionality. They also support manually configured SPVCs and switched virtual channel (SVC) connections established using the IISP signaling protocol.

Multiservice Switch ATM supports IISP interfaces that are based on UNI 3.0 and 3.1 signaling and are compliant with the ATM Forum standard *Interim Inter-switch Signaling Protocol (IISP) Specification Version 1.0*.

ATM inter-network interface

The ATM inter-network interfaces (AINIs) on the Nortel Multiservice Switch node, exist between network nodes on ATM networks. The AINI signaling protocol on this type of interface supports switched connections between Multiservice Switch nodes, other Multiservice Switch devices, and devices from other vendors. Each AINI link is configurable on the user side or the network side of the signaling interface. These sides are manually configured, with the calling side usually being assigned to be the user and the called side being assigned to the network. The network nodes do not exchange routing information, and a fixed routing algorithm with static routes must be implemented at each AINI node. AINI interfaces provide static routing and associated node-to-node signaling.

Multiservice Switch AINI interfaces allow an interoperability of vendor devices through a standard routing functionality. They also support manually configured SPVCs and switched virtual channel (SVC) connections established using the AINI signaling protocol.

Multiservice Switch ATM supports AINI interfaces that are based on PNNI 1.0 signaling and are compliant with the ATM Forum standard *ATM Inter-Network Interface Specification (af-cs-0125.000)*.

Private network-to-network interface

Nortel Multiservice Switch PNNI (private network-to-network interface) protocol is used between ATM devices, and between groups of private ATM devices. Multiservice Switch supports all mandatory functionality subsets described in Annex G of the ATM Forum’s PNNI Specification, Version 1.0, including hierarchical PNNI.

Multiservice Switch PNNIs provide a signaling protocol and a topological protocol. The signaling protocol is used to establish point-to-point and point-to-multipoint connections across the ATM network. The topological protocol uses a hierarchical mechanism that allows for the support of a large number of nodes in a WAN. Multiservice Switch PNNIs also support dynamic routing and quality of service.

Multiservice Switch PNNIs includes two categories of protocols:

- a protocol defined for distributing topology information between nodes and clusters of nodes. This information is used to compute paths through the network. Use of a hierarchy mechanism ensures that the topological protocol can support a large number of nodes in a wide area network (WAN). A key feature of the PNNI hierarchy mechanism is its ability to automatically configure itself in networks in which the address structure reflects the topology.
- a protocol defined for signaling and used to establish point-to-point and point-to-multipoint connections across the ATM network. The Multiservice Switch PNNI version of this protocol is based on the ATM Forum's UNI signaling specifications, with added mechanisms to support source routing, crankback, and alternate routing of call setup requests in case of connection setup failure.

While ATM Forum standards for protocols exchanged between ATM nodes ensure multi-vendor interoperability, room for differentiation between vendor products remains. In addition to being fully standards compliant, Multiservice Switch PNNIs support additional features such as

- permanent connection functionality that allows ATM bearer connections and trunks over ATM to traverse PNNI interfaces
- point-to-point and point-to-multipoint switched connections
- UNI 3.0, UNI 3.1, UNI 4.0, PNNI, IISP, and AINI interface signaling interworking, including frame discard and cause codes
- mapping of UNI group addressing and connection scope to PNNI routing level
- alternate routing as a result of crankback and crankback extensions to non-PNNI links
- ICD, DCC, X.121e, E.164e, E1.164N addressing and address conversion
- SPVC and SPVP connections across UNI, PNNI, IISP, and AINI interfaces
- constant bit rate (CBR), real time variable bit rate (rtVBR) and non-real time variable bit rate (nrtVBR), traffic bandwidth overbooking, and link capacity partitioning
- unspecified bit rate (UBR) connection admission control and load balancing

- PNNI-IMA interworking
- configurable QOS and traffic parameters for PNNI routing control channel (RCC) and signaling channels
- enhanced generic connection admission control (GCAC) algorithm
- path selection and configurable optimization criteria
- connection trace and route finder tools
- per-virtual channel accounting and network call correlation identifier transport
- on switch PNNI topology information translation

Signaling of individual quality of service (QOS) parameters like the acceptable cell delay variation (CDV), maximum cell transfer delay, cell transfer delay (CTD), and cell loss ratio (CLR) fulfill customer's real-time requirements for guaranteed bandwidth and bounded delay. These signaling capabilities allow network operators to control and select routes that satisfy the customer's maximum cell transfer delay and delay variation requirements, thereby ensuring that the CDV and CTD thresholds are not exceeded. These capabilities also guarantee that connections with excessively long delay are refused.

With the edge-based re-routing capability, PNNI also allows established connections to recover automatically from network failures or move to better PNNI routes.

For more information on Multiservice Switch PNNI, see NN10600-702 *Nortel Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*.

Virtual interfaces

Virtual interfaces on Nortel Multiservice Switch provide multiple interfaces on one physical port. A virtual interface can use the UNI, PNNI, IISP, or AINI interface protocols. A number of virtual interfaces of each type can work on one physical port. Each virtual interface is associated with a PVP, and has its own signaling channel which can set up SVC connections within that PVP. The device's virtual interfaces provide SVC tunneling through a PVP network. Tunnelling allows the use of SVCs even where the ATM backbone service provider does not offer SVC service, or where the customer's core network only has permanent connection capabilities.

Virtual interfaces on the Multiservice Switch devices support

- multiple virtual UNIs, PNNIs, IISPs, and AINIs on each port
- one virtual path for each virtual UNI, PNNI, IISP, or AINI interface
- one signaling channel for each virtual UNI, PNNI, IISP, or AINI interface

- multiple static ATM addresses for each virtual UNI, PNNI, IISP, or AINI interface
- connection admission control (CAC) for each virtual UNI, PNNI, IISP, or AINI interface
- the same capabilities as physical ATM traffic management

Virtual interfaces also reduce the number of required physical connections to the PVP network to only one for each location.

Virtual interfaces on the Multiservice Switch node support UNI, PNNI, IISP, and AINI interfaces compliant with the following ATM Forum standards:

- *User-to-Network Interface Specification Version 3.0*
- *User-to-Network Interface Specification Version 3.1*
- *Interim Inter-switch Signaling Protocol (IISP) Specification Version 1.0*
- *Private Network-Network Interface Specification Version 1.0*
- *ATM Inter-Network Interface Specification (af-cs-0125.000)*

For more information about virtual interfaces, see NN10600-702 *Nortel Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*.

Traffic management for ATM

Nortel Multiservice Switch ATM networks can support many applications, such as voice, video, data, and interactive communication. Because each application has unique traffic and performance characteristics, the application defines the service requirements for each subscriber.

The communication needs of these applications translate into a set of traffic characteristics based on the required quality of service (QOS) classes and the traffic descriptor types. Multiservice Switch provides traffic management functions that ensure that the QOS objectives for each subscriber are met. Multiservice Switch traffic management strategies also optimize the service provider's use of network resources so that the service offering is cost effective.

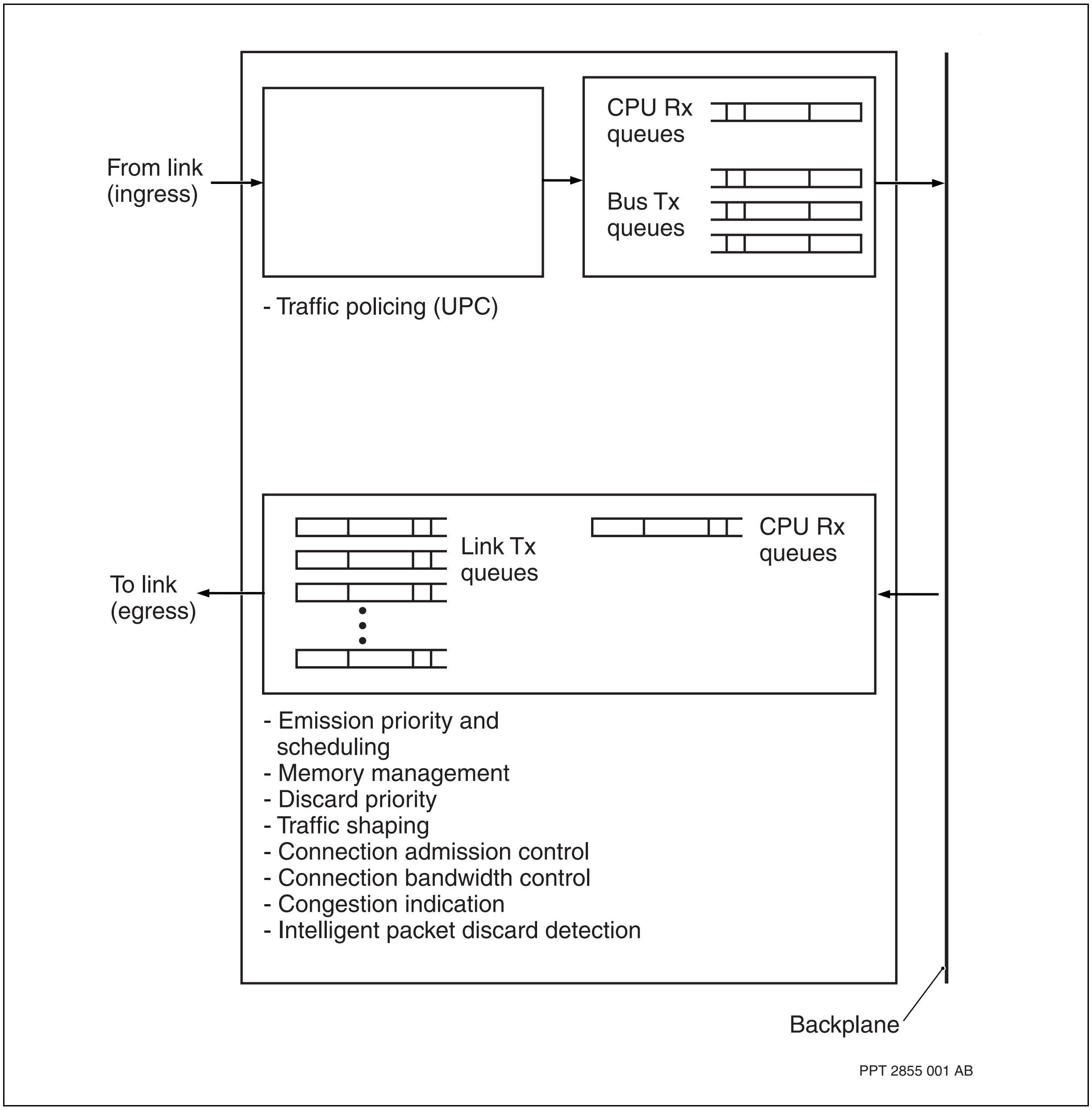
Most traffic management functions apply to both PVC connections and switched connections (including SPVCs), although some features cannot be selected for individual VCCs.

Multiservice Switch supports the ATM Forum *Traffic Management Specification 4.0* (af-tm-0056.000).

The application specific integrated circuit (ASIC) on the function processor defines the traffic management capabilities on Multiservice Switch devices. For information about the types of ATM function processors, see ATM function processors (page 10).

The figure Overview of application points for traffic management controls (page 27) shows where these controls apply along the data path from link ingress to link egress.

Overview of application points for traffic management controls



Navigation

- Traffic contract (page 28)
- Traffic shaping (page 30)
- Traffic policing (page 30)
- Queue management (page 30)
- Traffic scheduling (page 30)

- Memory management (page 31)
- Packet discard and congestion control (page 30)
- Connection admission control (page 31)
- Bandwidth pool management (page 31)
- Dynamic bandwidth management (page 31)

Traffic contract

A traffic contract defines the traffic characteristics of a connection in the ATM network. The service provider and the subscriber agree on the level of service that each connection must support. The service provider defines the service requirements for each subscriber according to the applications that the network must support. This definition requires translating the communications needs of these applications into a set of traffic characteristics. Nortel Multiservice Switch defines the traffic contract with the following traffic characteristics:

- ATM service categories (page 28)
- Quality of service parameters (page 29)
- Broadband bearer capability parameters (page 29) for switched connections
- Connection traffic descriptors (page 29)

ATM service categories

Nortel Multiservice Switch devices support the following ATM service categories:

- constant bit rate (CBR)—The CBR service category supports real time applications that require tightly constrained delay and delay variation. These applications include voice and video applications. The consistent availability of a fixed quantity of bandwidth is appropriate for CBR service. Cells that the network delays beyond the value for CTD are of significantly reduced value to the application.
- real time variable bit rate (RT-VBR)—The RT-VBR service category also supports for real time applications that require tightly constrained delay and delay variation.These applications include voice and video applications. The network expects sources to transmit at a rate that varies with time. Standards describe this source as bursty. Cells that the network delays beyond the value for CTD are of significantly reduced value to the application. Real-time VBR service can support statistical multiplexing of real time sources.
- non-real time variable bit rate (NRT-VBR)—The NRT-VBR service category supports non-real time applications that have bursty traffic characteristics and that standards characterize in terms of a PCR, SCR,

and MBS. For cells that the network transfers within the traffic contract, the application expects a low cell loss ratio. For all connections, the application expects a limit to the mean cell transfer delay. Non-real time VBR service support statistical multiplexing of connections.

- unspecified bit rate (UBR)—The UBR service category supports non-real time applications. The network expects UBR sources to be bursty. UBR service supports a high degree of statistical multiplexing among sources. UBR service does not specify traffic related service guarantees, and does not define numerical commitments with respect to cell loss ratio or cell transfer delay.

  The UBR service category with a minimum desired cell rate (MDCR) attribute provides an MDCR through which an application can indicate to the ATM network a preference for minimum bandwidth.

Quality of service parameters

Nortel Multiservice Switch devices support the following quality of service parameters:

- cell loss ratio (CLR)
- cell transfer delay (CTD)
- minimum cell rate (MCR)

Broadband bearer capability parameters

Nortel Multiservice Switch devices support the following broadband bearer capability (BBC) parameters for switched connections:

- bearer class
- transfer capability
- clipping
- best effort
- frame discard (in the transmit and receive directions)

Connection traffic descriptors

Nortel Multiservice Switch devices support the following connection traffic descriptors:

- peak cell rate (PCR)
- sustained cell rate (SCR)
- maximum burst size (MBS)
- cell delay variation tolerance (CDVT)

Traffic shaping

Nortel Multiservice Switch devices’ traffic shaping strategies ensure that transmitted traffic conforms to subscribed traffic parameters by regulating the emission interval of cells transmitted on the link. By pacing the transmission of cells, the service provider avoids cell discard at points where traffic policing applies. A device’s traffic shaping strategies also allow the network manager to balance the quality of service requirements against network costs. Multiservice Switch supports traffic shaping in all supported service categories.

Traffic policing

Nortel Multiservice Switch devices’ traffic policing strategies protect network resources from traffic demands that exceed the ones defined through the traffic contract. Multiservice Switch devices employ usage parameter control (UPC) to evaluate both the traffic at the end user access point and the validity of the ATM connection. Devices detect violations of negotiated parameters and take appropriate actions, such as cell tagging or cell discarding. Multiservice Switch devices support traffic policing in all supported service categories.

Queue management

Network nodes require appropriate traffic scheduling policies to meet the contracted ATM service category. On Nortel Multiservice Switch ATM function processors, queues exist at both the incoming and outgoing link sides and both to and from the Multiservice Switch device’s bus. The device’s traffic scheduling policies are based on a system of emission and discard priorities. This system guarantees fairness between the different service categories and between connections in a given service category. The device implements queue management based on the type of function processor.

Traffic scheduling

The service provider requires appropriate traffic scheduling policies to meet the contracted ATM service category for each node in the network. On Nortel Multiservice Switch device ATM function processors, there are queues at both the incoming and outgoing link sides and both to and from the bus. The device’s scheduling policy is based on a system of emission and discard priorities. This system applies different urgency priorities to different traffic types so that each application can use the correct ATM service category to meet the urgency and value requirements.

Packet discard and congestion control

Nortel Multiservice Switch devices apply congestion control when incoming traffic is greater than the outgoing link can handle. The primary purpose of congestion management is to provide good throughput and delay performance while maintaining a fair allocation of network resources to connections. Multiservice Switch devices support the following packet discard policies:

- early packet discard (EPD)
- partial packet discard (PPD)
- late packet discard (LPD)
- weighted random early detection (WRED)

Memory management

Nortel Multiservice Switch devices support resource control mechanisms that manage the queue and memory resources. These resources monitor and control the link, processor, bus, and memory resources on the function processor. The device's resource control mechanisms permit you to configure ATM queue management connection pools and frame connection resources for subconnections, and Multiservice Switch dynamic packet routing system (DPRS) connections.

Connection admission control

Connection admission control (CAC) is the traffic management technique for accepting or rejecting connections at call setup. The CAC accepts or rejects calls based on the bandwidth requirement of the connection as defined in the traffic contract. The CAC for ATM on Nortel Multiservice Switch devices help to ensure service guarantees. With a correctly configured CAC, the device can refuse a new connection if there is a high risk that the new connection can prevent the network from maintaining the required level of service for established connections. Multiservice Switch devices support a CAC for permanent connections, switched connections, and connections associated with virtual path termination (VPT).

Bandwidth pool management

Nortel Multiservice Switch devices support partitioning the bandwidth capacity on each port into pools. Through configuration, you can assign each pool a percentage of the capacity and map each service category to a given pool. This configuration allows you to set limits on the capacity that the node allocates to a given service category and to prevent other traffic from using bandwidth. The device supports configuring the bandwidth pools for permanent connections, switched connections, and connections associated with virtual path termination.

Dynamic bandwidth management

If the bandwidth reduces so that the switch can no longer support existing connection, Nortel Multiservice Switch devices identify lower priority connections that can terminate or can support bandwidth reduction. This capability reduces potential congestion at the ATM interface and maintains network performance. The device's connection bandwidth control (CBC) function defines how connections respond to continuous changes in bandwidth.

ATM accounting

ATM accounting allows a service provider to bill end-users based on the amount of network resources they use. Usage-based accounting is provided for Nortel Multiservice Switch ATM SVC and SPVC connections, and PVC and PVP connections.

There may be several ATM FPs in a Multiservice Switch node. Each FP has its own independent, accounting subsystem that can generate records for the ATM connections on that FP. For a connection that traverses more than one interface on one or more nodes, accounting can be turned on at one end of the interface (single-ended accounting) or at both ends of the interface (double-ended accounting). Accounting can also be turned on at intermediate interfaces, although, for performance reasons, this setup is not recommended.

The accounting records are spooled to the node disk using the data collection system (DCS). DCS has a central spooler on the CP and agents on each FP, including the ATM FPs.

Accounting records are transferred from the node disk to the management data provider (MDP) on the Nortel Multiservice Data Manager. The MDP system converts the accounting records to the standard bulk data format (BDF) and stores them on the MDP. In this format the files can be handled by the customer's billing server and transferred to either a billing host or a network engineering host. The customer uses their own software packages to post-process the (standard) BDF files containing accounting data. Accounting records can also be used for statistics purposes and to inspect quality of service parameters (QoS).

For more information about Multiservice Switch accounting, see NN10600-560 *Nortel Multiservice Switch 7400/15000/20000 Accounting*.

Navigation

ATM accounting concepts

See the following sections for information about ATM accounting concepts:

ATM call

For accounting purposes, ATM, SVC, SPVC, and PVC connections are each considered one call. However, when cleared (but not de-provisioned), an SPVC connection has the ability to re-establish itself. In this case the new (re-established) SPVC connection is considered to be another call (note that it may even take another route).

A PVC connection is also considered a call. In the case of a PVC, the call ends when the PVC is deleted through configuring.

Each individual call has a unique call correlation tag in its accounting record. For more information about call correlation tags, see Call correlation tag (CCT) (page 36).

Accounting meter

The accounting meter is a software entity associated with an ATM connection point on a particular ATM interface. For each connection that comes up, if accounting is enabled at that moment on that interface, a meter is created. The meter stores usage data about the connection as well as other information that will be needed to generate accounting records. Based on each meter one or more accounting records will be generated for that connection (call).

The generation of an accounting record is controlled by the meter’s internal timer (which expires after 12 hours) or by the configurable time-of-day accounting (TODA) schedule. If no TODA is configured, the meter’s internal 12-hour timer is used.

When an SVC or SPVC connection is cleared, its final accounting record is generated. The final accounting record for PVC is generated when it is deleted.

Accounting record

An accounting record is a data record containing information on end-user traffic for a given connection over a certain period of time. This time period is known as the accounting interval. The accounting record is created by the accounting meter at the end of each accounting interval, as well as when the connection is cleared (or deleted, in the case of a PVC).

The ATM accounting record contains information such as the customer identifier, *AtmIf* component number, traffic information (descriptors and QoS), cell counts, time stamps, the elapsed time, and the call termination cause value.

For details on accounting records accessible on the user's billing server, see 241-6001-309 *Nortel Multiservice Data Manager Management Data Provider* and 241-6001-806 *Nortel Multiservice Data Manager Management Data Provider Data Formats Reference for DPN*.

Per-ATM interface accounting

Accounting can be enabled or disabled for each ATM interface. Accounting needs to be turned on at the ATM interfaces at both ends of a connection to produce two accounting records, one at each end.

Enabling or disabling accounting per ATM interface rather than per node provides flexibility. Usually, *Uni* or basic interfaces to users have accounting turned on, whereas *Iisp* or basic interfaces to other nodes in the network have accounting turned off. If needed, accounting can be turned on for intermediate *Iisp* interfaces too; however, for performance reasons, this setup is *not* recommended.

When there are both switched and permanent connections on the same ATM interface, it is possible to enable or disable accounting individually for each connection type. For example, accounting can be:

- disabled for permanent connections if the user wants flat-rate billing for PVCs
- enabled on the UNI for switched connections to obtain usage-based billing of SVCs

Attention: Enabling accounting in the *Vcs* (virtual circuit system) component has no effect on ATM accounting. ATM accounting is only enabled through the *AtmIf* component.

Collection times

When accounting is enabled for an ATM interface, the following events trigger the generation of accounting records:

- a TODA changeover, when TODA is enabled
- the expiry of a 12-hours-per-connection timer, when TODA is disabled
- the end of a call

The interval between two consecutive events that trigger the generation of an accounting record, or between the start of the call and the first event, is called the accounting interval (for that record and call).

Cell counts

The accounting information in the record reflects the ATM traffic for the corresponding accounting interval. Only cell counts are provided (no frame counts for the ATM Adaptation Layer (AAL)). For a description of the information that appears in the ATM accounting record, see 241-6001-806 *Nortel Multiservice Data Manager Management Data Provider Data Formats Reference for DPN*.

Call correlation tag (CCT)

There is no on-switch correlation of the accounting information collected at different interfaces along the connection. Instead, a call correlation tag (an identifier, unique per call) is provided in the accounting record to facilitate the off-switch correlation of the records belonging to the same call.

The following items describe the relationship between the call correlation tag and the generated accounting records:

- Since the interfaces where ATM accounting is done are specified by configuring, there can be more points along the connection where accounting information is produced. However, except for the call correlation tag, the various points along the connection do not exchange accounting information between themselves.
- Single-ended accounting (only one end generating accounting records, with no feedback from the other end) is possible, but does not always provide enough information. A potential lack of information exists because there is no guarantee that the whole ingress traffic (number of cells) will successfully deliver to the other end of the connection.
- With the ATM accounting feature, accounting data collection can be enabled at both the ingress and egress points of a connection (double-ended accounting). The records are generated independently at the two ends. In this case, the records generated at the two ends need to be correlated (off-switch) using the call correlation tag.

- Furthermore, for test or study or other reasons, an ATM interface that is an intermediate point for a traversing connection can be configured to enable accounting. In this case, there may be three or more accounting records for that connection for each accounting interval (coming from different ATM interfaces). The accounting records will be marked as generated by originating, intermediate, or terminating points, but there will be no on-switch correlation of these records. Again, the call correlation tag should be used for off-switch correlation of these records.

Attention: For performance reasons, generating accounting records at intermediate nodes is *not* recommended.

- For SVCs and SPVCs, the call correlation tag is automatically generated by the originating node and distributed to all connection points along the path of the call. Because there is no signalling infrastructure to generate a call correlation tag for a PVC, it must be configured. The network operator must configure the two end points of the PVC connection with the same unique correlation tag, even if one end-point is a non-Nortel Multiservice Switch node. If no correlation tag is configured for a PVC, there will be no accounting records generated for that PVC.

Generating reports

Accounting records for ATM are generated per connection point, SVC or SPVC and when one of the following events occurs:

- the TODA changeover occurs, if TODA is enabled in DCS
- the accounting timer expires once every 12 hours (per connection) if TODA is disabled
- the call clears

The first two records are called non-final accounting records and the third one is the final accounting record for the call. For most SVC calls (which are usually short) there will be only one accounting record generated at the end, called an initial-and-final accounting record. Information is provided in the accounting record to distinguish between these types of accounting records.

The following sections provide a description of the interfaces that generate ATM accounting records and interface situations. Configuring affects some of the attributes in the accounting records and also the operation. For more information, see NN10600-710 *Nortel Multiservice Switch 7400/15000/20000 ATM Configuration Management*.

For more information, see the following sections:

- Interfaces that generate accounting records (page 38)

- Typical interfaces situation (page 38)
- Other interface situations (page 39)

Interfaces that generate accounting records

As stated previously, the aim is to configure double-ended accounting, in order to have accounting records reflect the amount of data actually transported from end-to-end.

With double-ended accounting egress (transmit) cell counts at the two ends reflect the actual traffic delivered in the two directions. By comparing them to the two ingress (receive) counts, the difference shows the number of cells discarded by the network. The “discarded” cell counts in the accounting records only reflect the number of cells discarded locally, at one interface.

Since the interfaces that generate accounting records (interfaces with accounting enabled) are specified through configuration, there may be more than two interfaces along the connection that generate accounting records. There may be records from the two end points (relative to one network) and also from any number of intermediate points. In this case, it is important for the downstream processing system to be able to distinguish between the points, since the relevant cell counts are those from the end points (interfaces at the edge of the network).

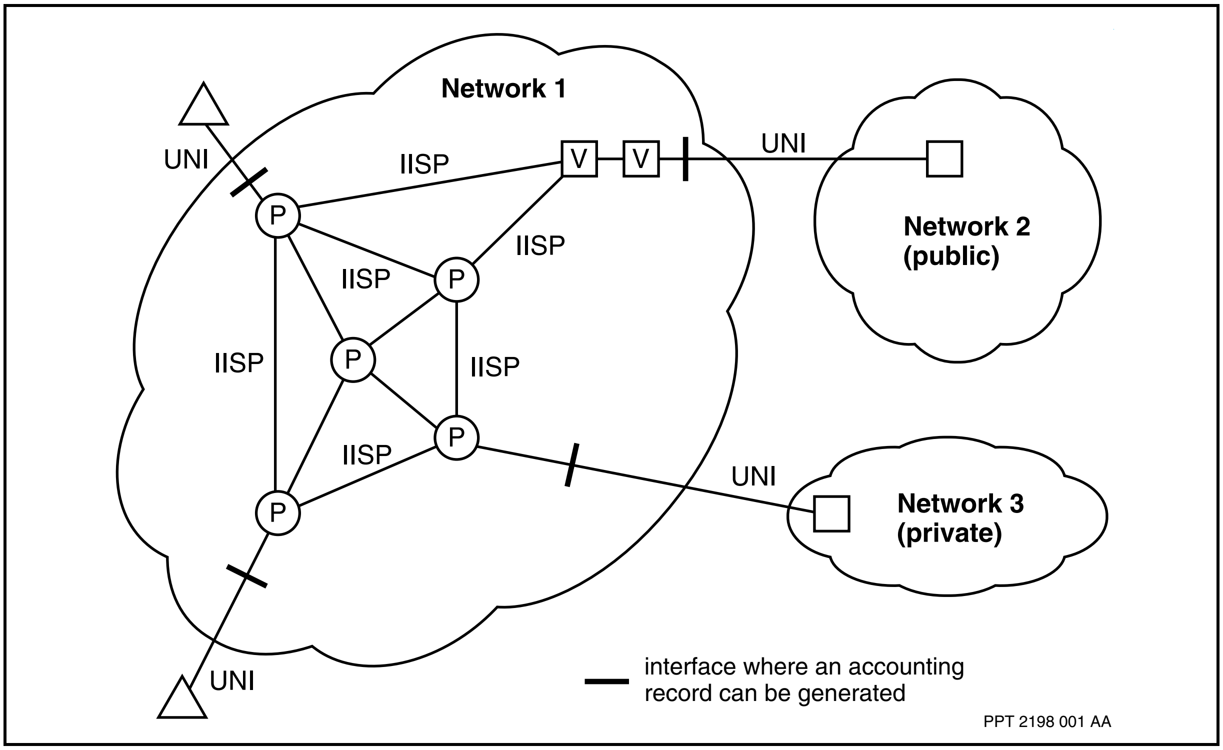
Typical interfaces situation

The typical situation for SVCs or SPVCs exists when all the interfaces to entities outside the network are *Uni* and all the interfaces between nodes inside the network are *Iisp*, as shown in the figure, Interfaces should generate accounting records (page 39). In the corresponding PVC situation, all interfaces are basic interfaces.

There are nodes which have *Uni* or basic interfaces to entities outside the network. They can be considered edge nodes. Others are inner nodes, which are only connected to edge nodes and to other inner nodes, for example the first node of the backbone.

It then makes sense to generate accounting records at the *Uni* or basic interfaces of edge nodes. In this way there will be exactly two records per call (namely, at the edge interfaces in the network), containing both the ingress and egress counts. The post-processing system will not get confused by too many records per call.

Interfaces should generate accounting records



Other interface situations

The typical situation is not always true in practice, for example:

- Two inner nodes could still be connected through a *Uni* interface.
- Nodes between two networks (for example networks 1 and 3 in the figure Interfaces should generate accounting records (page 39) could be connected by means of an *Iisp* interface.
- The network may consist not only of Nortel Multiservice Switch devices, but also of other vendors' devices which may not generate accounting records (for example, they do not support accounting or have some proprietary accounting system).

Since these situations may occur, a device cannot automatically determine whether it is an edge or an inner node, whether to generate accounting records or not and, if it does, whether to mark the records as from an originating, intermediate, or terminating connection point. Some configuring is necessary.

ATM billing policies

With the information in the accounting record several billing policies can be implemented.

Usage-based billing can take into account the time, the cell counts or both. The total duration of the call is available, but also the time the call spent in each interval of the TODA schedule (assuming it spans more than one TODA interval, for which there are different tariffs). Counts are distinct for cells with CLP=0 (high-priority traffic, which can be subject to a different tariff).

The traffic descriptors are also included in the accounting record, and billing can make use of them. For example, the higher the quality of service, the more expensive the call.

For double-ended accounting, configuring needs to be done such that at least two accounting records (at the two ends) are issued. A call correlation tag enables downstream processing systems to correlate records issued for the same call. For SVCs and SPVCs, the call correlation tag is automatically generated by the originating node and distributed to all connection points along the path of the call. Because there is no signalling infrastructure to generate a call correlation tag for a PVC, it must be configured. The network operator must configure the two end points of the PVC connection with the same unique correlation tag, even if one end point is a non-Nortel Multiservice Switch node. If no correlation tag is configured for a PVC, there will be no accounting records generated for that PVC.

Accounting records from the intermediate nodes can be discarded or used for test, study or audit purposes. Retaining the accounting records from the two ends, billing can be done based only on the transmit counts, which reflect the traffic that was actually delivered to the customer.

With single-ended accounting, billing has to consider both the transmit and the receive counts (at one end). In one of the directions, the count does not accurately reflect the traffic that was actually delivered. However, single-ended accounting eliminates the overhead of correlating the accounting records in downstream systems.

Additional flexibility is provided by including in the accounting records some values which have been configured (at the interface level) for accounting purposes. Thus, when enabling accounting, one or more of five reasons can be specified (billing, test, study, audit, and force). The customer can use these reasons for the internal tagging of the accounting records. For example, the customer's downstream system can identify records tagged test or audit and clone them or redirect them to special processing. Similarly, information denoted as accounting class and data service exchange appears in the accounting record with the values that have been configured at the interface level.

For more information, see NN10600-710 *Nortel Multiservice Switch 7400/15000/20000 ATM Configuration Management*.

Circuit ID and the accounting record

A circuit identifier (ID) is a 64-byte field in ASCII format that enables the user to assign a meaningful name to a circuit for any connection type.

The circuit ID can be configured through the *correlationTag* attribute at:

- each hop of a connection for PVP and PVC connections. It is the network administrator's responsibility to configure the two connection end points with the same unique circuit ID.
- the originating end point of the connection for SPVP and SPVC connections. As this identifier is not signaled to the other end, the accounting record for the other end point will not contain the circuit ID.

A call correlation tag represented by the *callConnId* attribute is another field available in the accounting record which enables downstream processing systems to correlate records issued for the same call. In the accounting record, it is available in hexadecimal format. For each PVP and PVC connection that is to be accounted, this identifier takes the value of the *correlationTag* attribute configured to the end point. Therefore, whatever value is configured for the *correlationTag* attribute, it will also be stored as the correlation tag (*callConnId* attribute) in the accounting record for that connection.

The *callConnId* and the circuit ID are the same only when it is a permanent connection. In the case of a soft connection, the circuit ID is the value that is configured and the *callConnId* attribute which is unique per call is automatically generated by the originating node and distributed to all connection points along the call. Therefore, the *callConnId* for soft connections does not match the circuit ID configured to the end point. For an SVC or destination end point of an SPVP or SPVC connection, the accounting record contains the *circuitId* attribute with a blank field because you cannot configure the *circuitId* attribute at those points.

The *circuitId* attribute will only include a value in the accounting record if a value is configured for it, otherwise the *circuitId* attribute will contain an empty string. However, the circuit ID feature is not essential to ATM accounting. A circuit ID can be configured without enabling accounting and accounting can be enabled without having to configure a *circuitId* attribute. However, it is necessary to configure the *circuitId* attribute when the connection type is a PVC or PVP connection and you require accounting records for that connection.

A *circuitId* attribute can be changed on an active permanent connection without bringing down the connection. Although, changing a *circuitId* attribute does not result in the immediate generation of an accounting record for SPVC and SPVP connections. Instead, the value is included in the next accounting record that is generated. For PVC and PVP connections, a final record for the old circuit ID is generated immediately. The next record will include the new circuit ID.

There is no on-switch correlation between the accounting records generated for the same call by two or more interfaces. However, the *callConnId* field in the accounting record facilitates an off-switch correlation. For soft connections, the node generates a *callConnId* attribute for every call and for the permanent connections, the *callConnId* attribute copies the circuit ID value configured to the connection end points.

Attention: For permanent connections, the user needs to enable accounting first and then configure the circuit ID through the *correlationTag* attribute. For soft connections, it is not necessary to enable accounting prior to configuring the circuit ID. Although, accounting needs to be enabled before the connection is up. Otherwise, the connection will not register with the accounting system.

For more information about configuring circuit ID, see NN10600-710 *Nortel Multiservice Switch 7400/15000/20000 ATM Configuration Management*.

Accounting situations

Several situations exist that affect the generation of accounting records. For more troubleshooting information see:

- What happens when node time changes (page 42)
- What happens on CP switchover (page 43)
- What happens when accounting is turned off and on again (page 44)
- What happens in congestion situations (page 44)
- What happens to hitless services accounting records during an equipment protection switchover (page 45)

What happens when node time changes

In TODA mode, if the node time is adjusted such that it is advanced past a TODA table entry, then the accounting record corresponding to that table entry is still generated, after the time has been adjusted. For example, if there is a TODA changeover at 10:00 but at 9:55 the node time is adjusted forward by 10 minutes, then after the adjustment, at 10:05, an accounting record for the 10:00 changeover is generated. However, the time stamp on that record shows 10:05, the actual time, rather than 10:00, the time the TODA changeover was skipped.

If the forward time adjustment skips more than one TODA changeover, multiple records are not generated. Only one record, corresponding to the last changeover, is generated.

If the node time is adjusted such that it is moved back by at least 10 seconds past a TODA table entry, the accounting record corresponding to that table entry is generated immediately if there has been no TODA record generated in the last 59 minutes. The record is not generated again at 10:00. The DCS agent ensures that TODA records do not occur closer than 59 minutes apart.

In timer mode, when TODA is disabled, intermediate accounting records are generated every 12 hours for a connection that stays up for a long time. The interval between two intermediate accounting records (12 hours) stays the same even if the node time is adjusted. For example, if an accounting record is generated at 9:00 a.m. the next one is due at 9:00 p.m. But if in the meantime the time is moved forward by 2 hours, the next record will be generated at 11:00 p.m. which is when 12 hours actually elapsed.

As a general rule, the start-time and end-time fields in the accounting record always represent the node (network) time at the start and end of the recording interval and, as such, they are affected by time changes (manual or automatic time adjustments). However, for switched connections, the elapsed time always corresponds to the exact length of the accounting interval, since it is calculated from a different clock source, one that is not affected by the node time adjustments. For permanent connections, the elapsed time corresponds to the time during which the connection was enabled (during the accounting interval).

Also, when TODA is enabled, note that if an ATM FP is running at capacity, a TODA changeover can create a backlog of accounting records to be spooled on disk. This backlog occurs because, besides the accounting records generated on call clears, on a TODA changeover accounting records for all active connections are generated (contact your Nortel Networks account representative for the maximum number of ATM connections and connection points permitted per ATM FP). This backlog of records needs to be spooled to disk at a later time, when the FP is running below capacity. If the FP keeps running at capacity forever (sustained call setup/clear rate), the backlog of records generated on TODA changeovers increases until there is no memory and accounting is stopped. Accounting only resumes when the memory shortage is over.

What happens on CP switchover

The CP switchover is handled by the spooling system. However, any records that exist only in the memory of the failed CP are lost. Only records that recorded on disk are preserved during a CP switchover.

As for accounting itself, even when a TODA changeover notification is lost because of a CP switchover, there is no fatal impact. The cell counts for each connection continue to record the traffic. The counts are reported in the next or in the final accounting record, which is issued anyway. In this case, the record contains the accumulated cell counts over two accounting intervals.

What happens when accounting is turned off and on again

The following items apply, at the interface (*AtmIf* component) level:

- When accounting is turned off, accounting record generation stops immediately, which means that for existing connections no final accounting records are generated.
- When accounting is turned back on again, only connections created from that time onwards will be accounted. Connections that already existed when accounting was turned on will not generate accounting records. Particularly SPVCs, which tend to last longer, do not resume accounting, unless they are cleared and set up again, as it happens for example when the *AtmIf* component is de-provisioned and re-provisioned or the ATM FP is reset.

What happens in congestion situations

When link congestion occurs, SVC requests may be dropped by the device. ATM accounting does not issue accounting records for unsuccessful call attempts.

In case there is not enough memory to generate an accounting record, the ATM accounting system will not generate the record but it will not prevent the call from going through. Clearing or not clearing the call is decided by the SVC handler (the ATM networking software), depending on the resources available to handle the call.

The exact moment when accounting record generation is suspended for lack of memory is marked by the “minor qualityOfService thresholdCrossed” alarm (see alarm number 70140000 in NN10600-500 *Nortel Multiservice Switch 6400/7400/15000/20000 Alarms Reference*). After this alarm is issued

- no accounting records are generated for existing connections
- no accounting meters are created for new connections, which implies that no accounting records are generated for these connections either
- no additional (per call) alarms are issued, since there would be too many of them

This situation lasts until the memory alarm is cleared. After that, accounting is resumed but only for connections that have an accounting meter, meaning connections that already existed when the memory alarm was triggered.

Connections that were set up during the memory shortage and that continue to exist after the memory alarm is cleared will not be accounted, because the loss of the accounting meter is unrecoverable.

When memory shortage causes an intermediate accounting record to be skipped, the situation is recovered by the next accounting record issued for that connection (assuming the memory usage goes back to normal). Since the cell counts are accumulated in hardware, the next record will correctly reflect the traffic during the (extended) accounting interval.

What happens to hitless services accounting records during an equipment protection switchover

For Nortel Multiservice Switch 1500 and 2000 devices, the following ATM services offer a hitless service:

- PVCs (VCCs, VPCs and VPT VCC (basic and standard) connections)
- point-to-point SVCs
- source and destination SPVCs
- point-to-point SVPs
- source and destination SPVPs

A service is hitless when the software that provides the service can run uninterrupted, even when the hardware providing the service changes.

See NN10600-550 *Nortel Multiservice Switch 7400/15000/20000 Common Configuration Procedures* for a description of hitless services and hot, warm, and cold standby applications and features.

Hitless services minimize the interruption of cell forwarding only. As with all Multiservice Switch services during an FP switchover, all applications that were running on the FP can lose administrative data, even if that application is providing hitless services. This includes partial accounting records and any accounting records that reside in the memory of the FP before the FP switchover.

Standards

Nortel Multiservice Switch ATM conforms to several standards. See the following sections for related documents.

Navigation

ATM Forum specifications

See the following ATM Forum documents for additional information on ATM technical descriptions and standards:

- *Addendum to Traffic Management V4.0 for ABR parameter negotiation* (af-tm-0077.000), ATM Forum Technical Committee, 1997
- *Traffic Management Specification Version 4.0* (af-tm-0056.000), ATM Forum Technical Committee, 1996
- *ATM Addressing: Reference Guide* (STR-RA-ADDR-01.09), ATM Forum Technical Committee, December 1998
- *Integrated Local Management Interface (ILMI) Specification Version 4.0* (af-ilmi-0065.000), ATM Forum Technical Committee, 1996
- *Interim Inter-switch Signaling Protocol (IISP) Specification Version 1.0,* (af-pnni-0026.000), ATM Forum Technical Committee, 1994
- *Private Network-Network Interface (PNNI) Specification Version 1.0* (af-pnni-0055.000), ATM Forum Technical Committee, 1996
- *PNNI V1.0 Errata and PICS* (af-pnni-0081.000), ATM Forum Technical Committee, 1997
- *User-to-Network Interface Specification Version 3.0* (af-uni-0010.001), ATM Forum Technical Committee, 1993
- *User-to-Network Interface Specification Version 3.1* (af-uni-0010.002), ATM Forum Technical Committee, 1993

- *User-Network Interface Signalling Specification Version 4.0* (af-sig-0061.000), ATM Forum Technical Committee, 1996
- *PNNI Addendum for the Network Call Correlation Identifier* (BTD-CS-PNNI-NCCI-01.03), ATM Forum Technical Committee, July 1996
- *Baseline document of edge-based rerouting for point-to-point connections (DRAFT),* LTD-CS-PNNI-Reroute-01.09, ATM Forum Technical Committee, October 1999
- ATM Inter-Network Interface (AINI) Specification, (af-cs-0.125.000), ATM Forum Technical Committee, 1999

ITU recommendations

See the following International Telecommunication Union (ITU) documents for additional information on ATM technical descriptions and standards:

- ITU-T Recommendation Q.761-Q.764, *B-ISDN User Part*
- ITU-T Recommendation I.113, *Vocabulary of Terms for Broadband Aspects of ISDN*
- ITU-T Recommendation I.121, *Broadband Aspects of ISDN*
- ITU-T Recommendation I.150, *B-ISDN ATM Functional Characteristics*, 1993
- ITU-T Recommendation I.356, *B-ISDN ATM Layer Cell Transfer Performance*
- ITU-T Recommendation I.357, *B-ISDN Semi-Permanent Connection Availability*
- ITU-T Recommendation I.361, *B-ISDN, ATM Layer Specification*, 1993
- ITU-T Recommendation I.362, *B-ISDN ATM Adaptation Layer (AAL) Functional Description*
- ITU-T Recommendation I.363, *B-ISDN ATM Adaptation Layer (AAL) Specification, 1993*
- ITU-T Recommendation I.364, *B-ISDN Broadband Connectionless Data Service on B-ISDN*
- ITU-T Recommendation I.371, *B-ISDN Traffic Control and Resource Management*
- ITU-T Recommendation I.413, *B-ISDN User-Network Interface*
- ITU-T Recommendation I.432, *B-ISDN User-Network Interface Physical Layer Specification*
- ITU-T Recommendation I.555, *Frame Relaying Bearer Service Interworking*

- ITU-T Recommendation I.610, *B-ISDN Operation and Maintenance Principles and Functions*
- ITU-T Recommendation I.630, *Automatic Protection Switching*
- ITU-T Recommendation I.731, *Types and General Characteristics of ATM Equipment*
- ITU-T Recommendation I.732 *Functional Characteristics of ATM Equipment*
- ITU-T Recommendation Q.2110, *B-ISDN - ATM Adaptation Layer - Service Specific Connection Oriented Protocol*, 1994
- ITU-T Recommendation Q.2130, *B-ISDN Signalling ATM Adaptation Layer - Service Specific Coordination Function for support of signalling at the user-to-network interface*, 1994
- ITU-T Recommendation Q.2610, *Common Aspects of B-ISDN Application Protocols for Access Signaling and Network Signalling and Interworking*, 1995
- ITU-T Recommendation Q.2931, *B-ISDN User-Network Interface Layer 3 Specification for Basic Call/Bearer Control*, 1995
- ITU-T Recommendation Q.2951, *Stage 3 Description for Number Identification Supplementary Services Using B-ISDN DSS2 Basic Call*, 1995
- ITU-T Recommendation Q.2962, *B-ISDN DSS2 Connection Characteristics Negotiation During Establishment Phase*, 1996
- ITU-T Recommendation Q.2971, *B-ISDN DSS2 UNI Layer 3 Specification for Point-to-Multipoint Call/Connection Control*, 1996

IETF RFC references

See the following request for comment (RFC) documents for additional information on ATM technical descriptions and standards:

- IETF RFC 1483 “Multiprotocol Encapsulation over ATM Adaptation Layer 5”, Juha Heinan, July 1993
- IETF RFC 1573 “Evolution of the Interface Group of MIB-II”, K. McCloghrie and F. Kastenholz, January 1994
- IETF RFC 1695 “Definitions of Managed Objects for ATM Management Version 8.0 using SMIv2”, M. Ahmed and K. Tesink, August 1994
- IETF RFC 1902 “Structure of Management Information for Version 2 of the Simple Network Management Protocol (SNMPv2)”, SNMPv2 Working Group, January 1996
- IETF RFC 1903 “Textual Conventions for Version 2 of the Simple Network Management Protocol (SNMPv2)”, SNMPv2 Working Group, January 1996

- IETF RFC 1904 “Conformance Statements for Version 2 of the Simple Network Management Protocol (SNMPv2)”, SNMPv2 Working Group, January 1996

Other references

See the following documents for additional information on ATM technical descriptions, standards, and benchmarks:

- IEEE 802-1990 “IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture”
- *Telcordia GR-1110-CORE*
- *Performance Evaluation of Connection Admission Control Techniques in ATM networks*, B. Jamoussi. S. Rabie, and O. Aboul-Magd, GLOBECOMM’96, November, 1996

Nortel Multiservice Switch 7400/15000/20000

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