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Digital Switching Systems

Spectrum Peripheral Module

ATM General Description Manual

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Contents

About this document

This document includes general information about the Asynchronous Transfer Mode (ATM) Spectrum Peripheral Module (SPM).

How to check version and issue of this document

The version and issue of the document are indicated by numbers, for example, 01.02.

The first two digits indicate the version. The version number increases each time the document is updated to support a new software release. For example, the first release of a document is 01.01. In the next software release cycle, the first release of the same document is 02.01.

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How this document is organized

This docment is organized into two parts:

- Part 1 contains general information regarding ATM, as well as the fast-packet switching technology and architecture upon which ATM is based.
- Part 2 contains infomation about the SPM ATM resource module, as well as how ATM is supported by the Spectrum Peripheral Module.

Certain features require a more extensive description than is suitable within the scope of this document. In such cases, a brief description of the feature is given, together with a reference to the appropriate publication.

Indication of trademarks in this document

The asterisk after a name denotes a trademarked item. The title page and back cover acknowledge all trademarked items.

References in this document

The following documents are referred to in this document:

- *Hardware Maintenance Manual*, 297-1771-550
- *Data Schema Reference Manual*, 297-1771-851
- *Command Reference Manual*, 297-1771-815
- *Alarm Clearing Procedure Manual*, 297-1771-543
- *Log Reference Manual*, 297-1771-840

1 Introduction

The ATM SPM is an integrated OC-3c based ATM trunking application for the DMS-250 developed upon the DMS-SPM architecture. This next generation application allows existing TDM-based ISUP IMTs to be carried between DMS-250s over manually provisioned Permanent Virtual Paths in an ATM network with the simple addition of an ATM resource module (NTLX73AA) to a Spectrum Peripheral Module (SPM).

This capability allows the DMS-250 platform to seemlessly migrate voice traffic from its current TDM based backbone to an integrated multi-service ATM backbone. A single backbone environment provides a measurable cost improvement—in bandwidth usage and network management, as well as increased optimization of inter-machine facilities through finer granularity.

ATM SPM Standards Compliancy

The ATM SPM has been designed to meet a pertinent subset of the following standards:

Spectrum ATM Platform

- ATM Forum's ATM Trunking Using AAL-1 for Narrowband Services Specification (af-vtoa-0089.000)
- ATM OAM&P Cell Termination/Generation as per ITU-T I.610 and Bellcore GR-1248-CORE
- ATM Cell Insertion/Extraction as per ANSI T1.646

Call Processing

- ANSI ISUP (Narrowband and Wideband) including TR1358

Physical Layer Compliance

- SONET APS as per Bellcore GR-253-CORE
- Transmission Performance Monitoring as per ANSI T1.231

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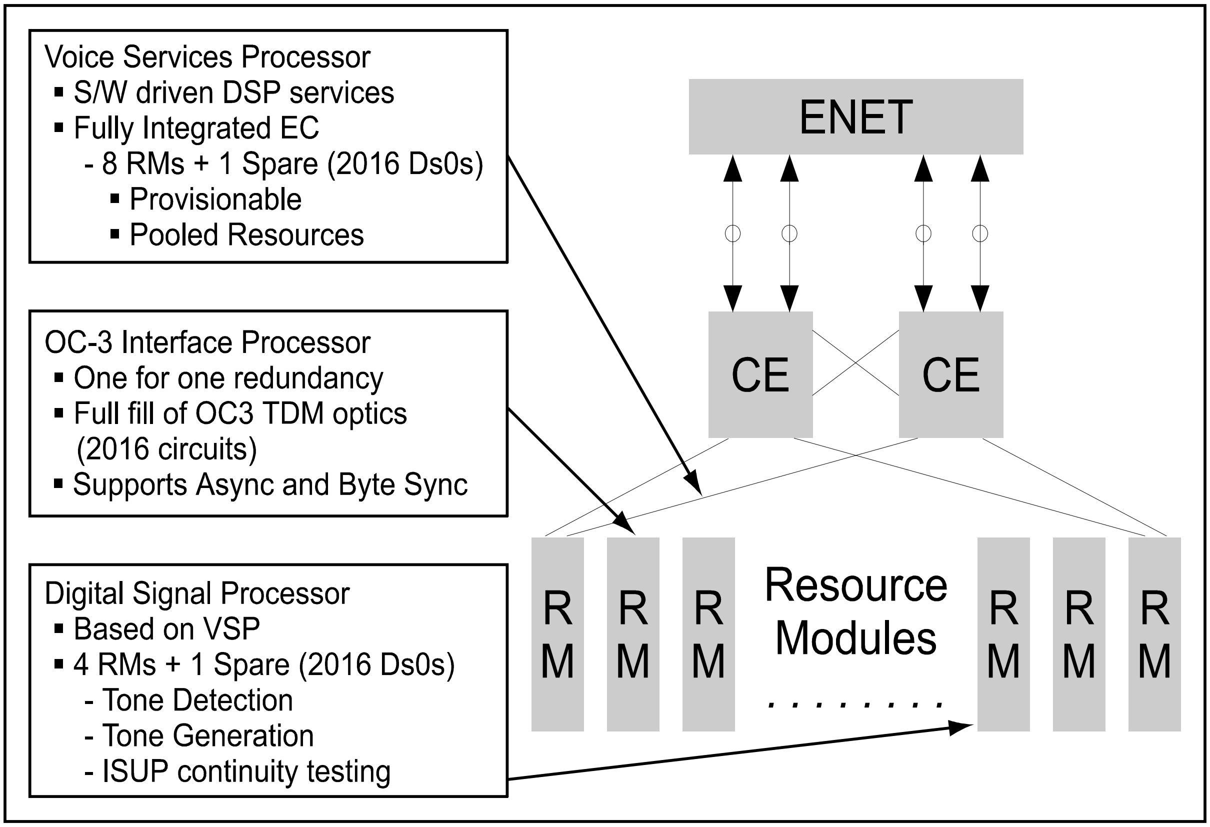
2 DMS-SPM Overview

The DMS-SPM is a new multi-application, high-speed peripheral that supports many interfaces and services on a common platform. Its architecture consists of:

- Redundant duplex Common Equipment Modules (CEMs) which perform centralized SPM control functions
- Various Resource Modules (RMs) which provide processing for other interfaces and services, including the:
  - Voice Service Processor (VSP) module that provides integrated echo cancellation capabilities
  - OC-3 resource module that is a redundant, 1+1 non-revertive, point-to-point OC3 optical interface
  - Digital Signal Processor (DSP) module that provides such services as tone synthesis, integrated testing, continuity testing, and tone reception
  - Asychronous Transfer Mode (ATM) resource module that provides a redundant, 1+1 non-revertive, point-to-point, OC-3c optical interface.

Figure 2-1 DMS SPM Model



3 ATM Overview

What is ATM?

ATM is a network and multiplexing technology originally developed for Broadband-ISDN. It is a cell relay, fast-packet switching technology, capable of transmitting data, voice, and video over a common infrastructure. However, it provides more than a basic transmission protocol, ATM also:

- supports both private and public networks
- uses the same technology for local and wide area networks
- transports voice, video, and data on a common circuit
- delivers bandwidth on demand
- offers low-cost networking and uses low-cost technology.

Network Protocols

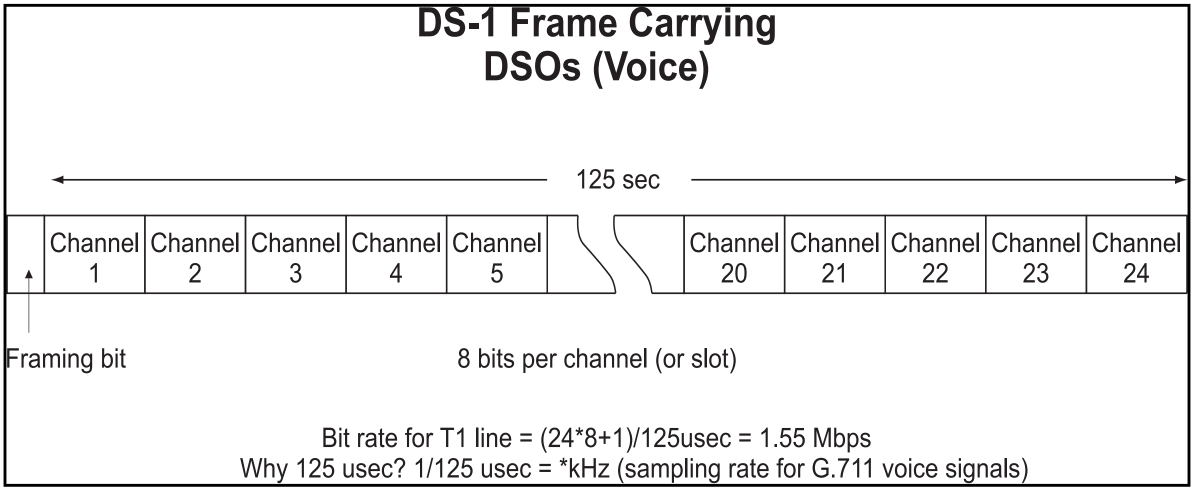
Most networks are either circuit-oriented, delivering delay-sensitive (isochronous) information like video or voice, or are packet-oriented, delivering high-speed data transmission.

STM Networks

The traditional voice multiplexing scheme for digital communication is called Time Division Multiplexing (TDM) or Synchronous Transfer Mode (STM). In a circuit-switched network, bandwidth is engineered to support a predefined level of traffic or Quality of Service (QoS). Once engineered, this bandwidth is allocated for a specific purpose, and it cannot be easily used for other purposes, even in instances where network use is low or doesn't exist.

Bandwidth on an STM network is divided into fundamental units for transmission called time-slots, and these time-slots are organized into repeating frames. Time-slots are fixed length and always assigned to a specific user for the duration of their call. The figure below is an example of a DS-1 frame carrying 24 DSO voice channels. A common level in the North American TDM digital hierarchy.

Figure 3-1 DS-1 Frame with DSOs



Since a time-slot is assigned to a connection, it remains allocated for the duration of the connection. If there isn't data for a particular time-slot within a frame, the slot is still sent, effectively wasting the bandwidth. STM doesn't have a way to assign empty time-slots to other connections.

ATM Networks

Asynchronous transfer mode, on the other hand, divides data into fixed packets, each carrying explicit connection information with its data. Since time-slots are not reserved in an ATM network, bandwidth is used only by connections that need it. ATM is a fast packet switching technology that provides these advantages:

- Fixed size packets (cells)
- Limited control information to lower overhead
- Smaller packets to reduce latency

Fixed size packets or cells provide two important benefits for ATM. First, fixed-sized cells allow an ATM network to handle a combination of voice, data, and video while providing an optimized transmission environment for each information type. Second, valuable processing time isn't wasted on determining where each cell begins and ends. Since the switching hardware always finds addressing information in the cell header, routing decisions occur only once – when a connection is established. Fixed cell size together with the explicit addressing information allow network switches to quickly process each cell, resulting in greater switching speeds and reduce network delays.

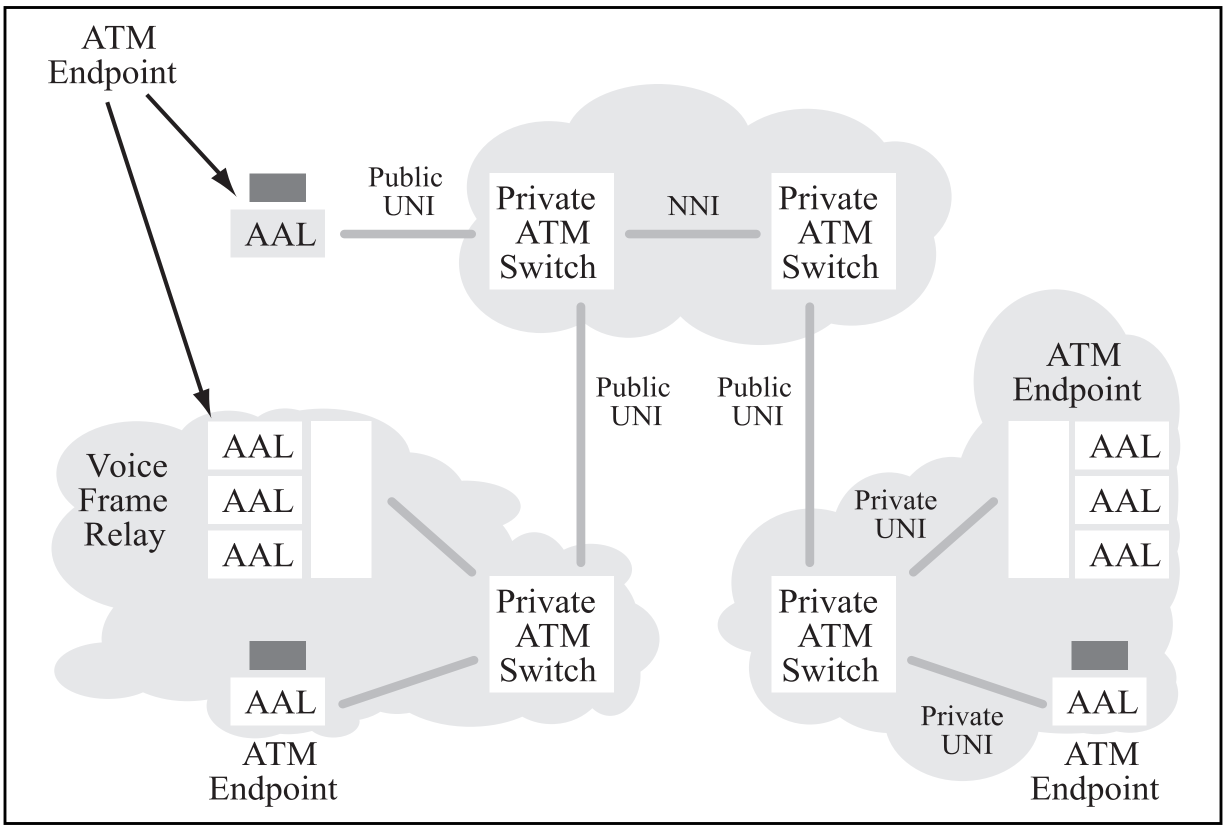
Statistical Multiplexing

To dynamically allocate bandwidth, fast-packet networks use statistical multiplexing to assign several connections to a communication channel or link. This type of multiplexing is possible because it's unlikey that a connection will need all of the bandwidth allocated to the link all of the time. Voice and video traffic is "bursty;" that is, it requires a lot of bandwidth but for only short periods of time. By assigning multiple connections to each link, it's possible to use the bandwidth more efficiently. And if several connections "burst" at the same time, thereby exceeding the bandwidth allocated to a particular link, buffering is used to shape the traffic so data isn't lost. Another advantage to using statistical multiplexing is that since bandwidth isn't preallocated to a connection, like in an STM network, it's available for other applications in the network. ATM networks incorporate statistical multiplexing to use bandwidth more effectively, while providing higher overall performance to each individual connection.

ATM Network Topology

The illustration below is an example of an ATM network and its major components. Each of the components is discussed in this section.

Figure 3-2 ATM Network Major Components



ATM Network Structure

ATM Switches

ATM switches are generally classified for use in either a private or public network. In some cases the difference between a public and private switch is minor, but in other cases it can be significant. Public and private switches differ in the kinds of links they support, in their accounting and control procedures, and in the addressing modes they use. Since public networks usually need much higher throughput than private networks, there is usually a size and capability difference.

ATM Endpoints

The ATM Endpoint component is a piece of end-user equipment that interfaces to an ATM network. An endpoint sends and receives ATM cells on link connections defined by ATM standards. An endpoint component contains an ATM Adaptation Layer (AAL) function. The ATM-SPM product is considered an ATM Endpoint.

User Network Interface (UNI)

The interface between a user and an ATM network is called the User-Network Interface or UNI. There are public and private UNIs. The private UNI defines the communication exchange protocol between a private ATM switch and its users. A user in this case is any customer premise equipment (CPE) packaging information into ATM; e.g. router, multiplexer, or workstation. Users who are not public carriers own private ATM switches, and use them to build local and campus networks. The public UNI defines the communication exchange protocol between an ATM user and a public carrier.

Some link types used for the private UNI only work over very short distances (such as 100 meters). These would be inapplicable to a public network interface. Public ATM networks use E.164 addresses while private networks probably use addressing techniques derived from LANs or from OSI. The public UNI is defined and controlled by the ITU-T. The ATM Forum defines the private UNI.

Network Node Interface (NNI)

- NNI-ISSI is used to connect ATM switches within a local area belonging to the same Telephone Company. In the US, this equates to nodes that are in the same LATA (Local Access Transport Area).
- NNI-ICI 1 is the “intercarrier” interface and typically used to interconnect ATM networks operated by different telephone companies. The NNI-ICI is the same as the ATM Forum’s B-ICI.
- PNNI (private NNI) allows connection of different ATM switches in a private network environment.

ATM Connections

The ATM layer establishes connections across an ATM network by sharing the physical layer's resources. This is done by logical connections between ATM endpoints. Logical connections allow many end-to-end circuits to share the same physical resource when a circuit has traffic to send. Service parameters determine the priority of a circuit's connection. During peak loads, lower priority traffic is held in switch buffers until resources become available.

An ATM cell carries a 48-byte payload and a 5-byte header that contains the necessary addressing information to route a cell through the network. Every cell header contains an address identifier used by an ATM switch to track how the cell moves from one physical link to the next. Since address identifiers are unique, an ATM network can support millions of connections. ATM switches assign address identifiers locally while storing the connectivity information in switching tables. Accordingly, these connections are called "logical connections" or are referred to as "virtual connections."

When an ATM switch reads a cell's address identifier, it looks at its switching table for the appropriate outgoing link. The switch changes the cell's address identifier to the assigned logical address on the new link and sends it to the new link's output buffer. Therefore, before a communication exchanges can occur, the connectivity information must be loaded into a switch. The connectivity information can be setup in a switch either manually or by using a signaled connection setup.

The diagrams below illustrate Virtual Paths (VPs) and Virtual Channels (VCs) according to ITU-T B-ISDN I Series Recommendations. The sections that follow provide definitions for each of these logical concepts within the ATM Domain.

Figure 3-3 VC and VP Concepts (Part 1)

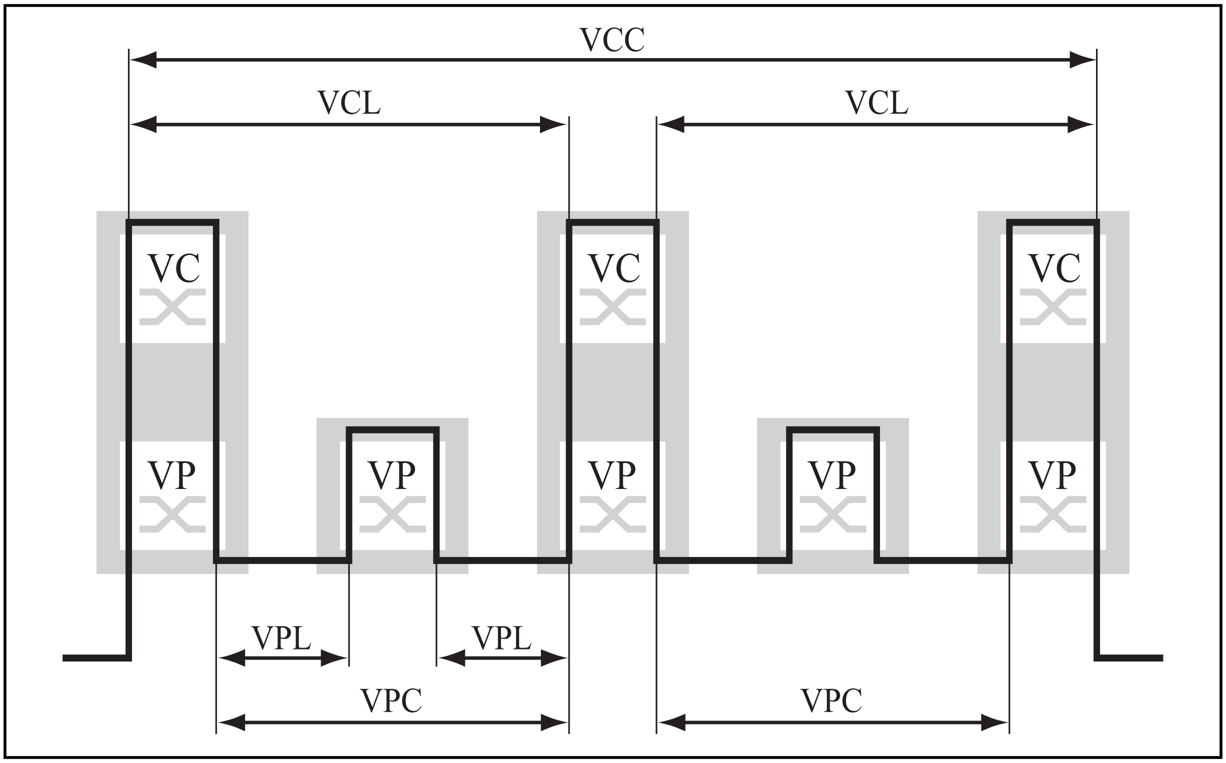
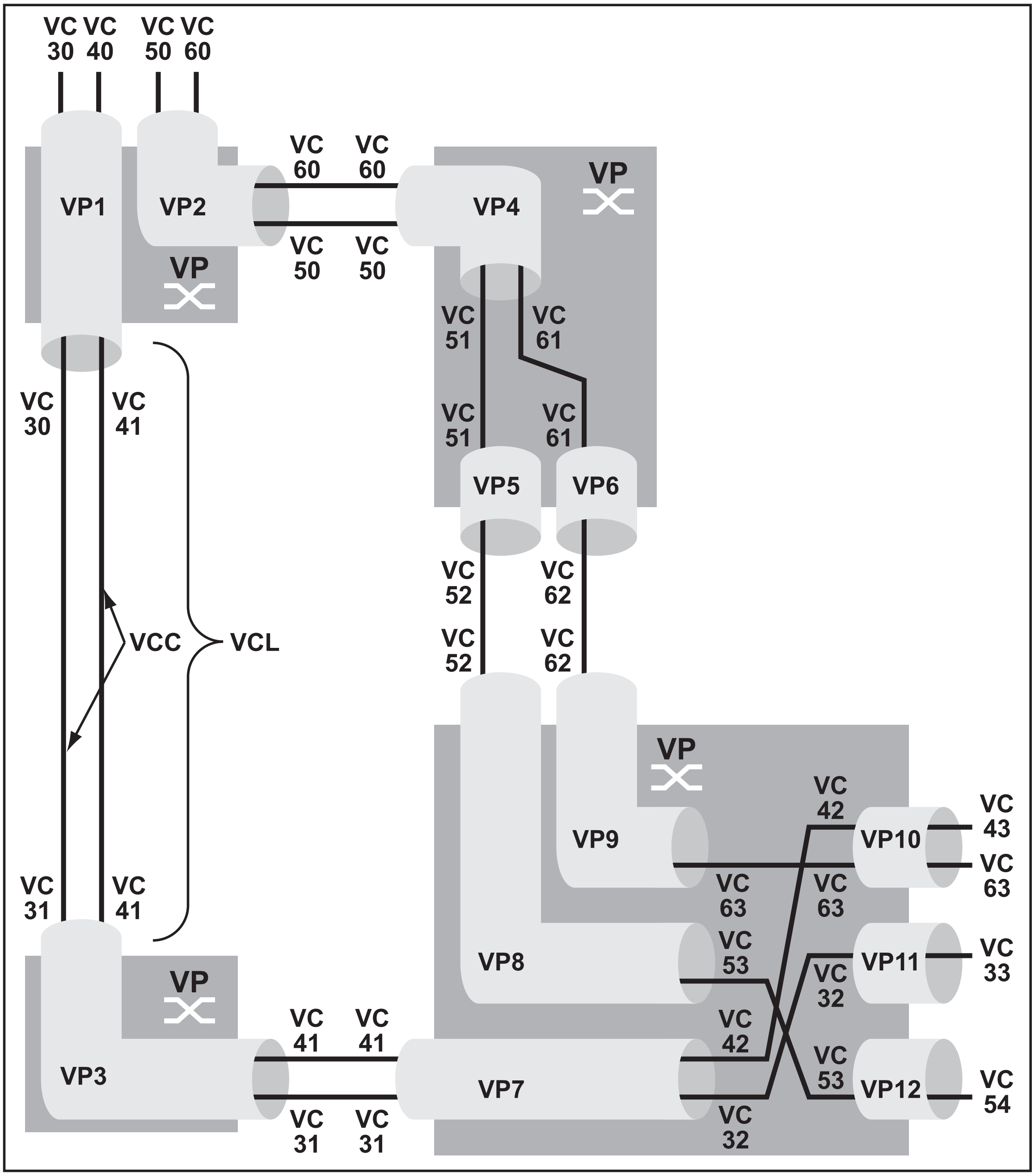


Figure 3-4 VC and VP Concepts (Part 2)



ATM Cell Size

The ATM fixed cell size is fixed at 53-bytes because of a conflict which occurred during the standardization process within the CCITT (now the ITU-T, International Telecommunications Union-Telecommunications Sector). The U.S. Exchange Carriers Standards Association (ECSA) proposed a 64-byte payload because it was optimal for data networks and efficient memory transfer. The European Telecommunications Standards Institute (ETSI) proposed a 32-byte payload because it was optimal for voice applications, eliminating both speaker and listener echo. A 48-byte payload was selected because it was mathematically suited for both uses, as well as the halfway point between 32 and 48. The upper bound for an acceptable overhead was 10-percent of payload or 5-bytes; therefore, the size of an ATM cell was (48+5) or 53-bytes.

Permanent Virtual Connections

A connection loaded manually into an ATM switch is called a permanent virtual connection (PVC). All of the connection information must be loaded into the switching tables before the ATM network can carry any cells. Once the connection information is loaded the virtual path remains until it is removed.

Switched Virtual Connections

Some ATM virtual connections are set up on a call-by-call basis, and these are called switched virtual connections (SVC). These connections use signaling messages between devices and the network to exchange information about the type of connection request and when the connection will be needed. SVC users include the desired connection destination in a call setup message using a global address.

Virtual Paths and Virtual Channels

ATM is a connection-oriented protocol, and it uses a connection identifier in every cell to explicitly associate a cell with a given route. The address identifier in the cell header consists of two parts: a virtual channel identifier (VCI); and a virtual path identifier (VPI). The VCI identifies virtual channels in an ATM link, whereas the VPI identifies the virtual path in an ATM link. Since a virtual path can contain many virtual channels, the VPI is the higher order address.

Virtual Channel Link (VCL)

A VCL exists from the point where a VCI value is assigned to where it is translated or terminated. Since it exists within a virtual path it may pass through a number of ATM switches. A virtual channel link is also unidirectional.

Virtual Path Link (VPL)

A VPL exists between the point where the VPI value is assigned and where it is translated or terminated. In practice, this means that a VPL exists only within a point-to-point link between ATM switches. When a link arrives in an ATM node the VPI is always replaced; although, it may be replaced with the same value it had before

Virtual Path Terminator (VPT)

The VPT terminates a virtual path, making the virtual channels available for separate and independent routing.

Virtual Channel Connection (VCC)

A Virtual Channel Connection (VCC) is an ATM connection where switching is performed using both the VPI/VCI fields in the cell header. A Permanent VCC is one that is provisioned through a network management function and is left up indefinitely.

Virtual Path Connection (VPC)

A Virtual Path Connection (VPC) is an ATM connection where switching is performed using the VPI field located in the cell header. A Permanent VPC is one that is provisioned through a network management function and is left up indefinitely.

ATM Adaptation Concepts

In order for ATM to support many kinds of services with different traffic characteristics and system requirements, it is necessary to adapt the different classes of applications to the ATM layer. The ATM Adaptation Layer (AAL) performs this service-dependent function. Five types of AALs were originally recommended by the CCITT, but two of these have been merged into one.

A brief description of the different layers follows:

- **AAL1 –** Supports connection-oriented services that require constant bit rates and have specific timing and delay requirements. For example, constant bit rate services like DS1 or DS3 transport.
- **AAL2 –** This adaptation is a method for carrying voice over ATM. It consists of variable size packets (max: 64 bytes) encapsulated within the ATM payload. This was previously called Composite ATM or AAL-CU. The ITU specification that describes this is ITU-T I.363.2.
- **AAL 3/4 –** This AAL is intended for both connectionless and data protocols. Originally two distinct adaptation layers AAL3 and AAL4, these have been merged into a single AAL. The name of each AAL was kept for historical reasons.

- **AAL 5 –** Supports high-speed data protocols but gives up some error recovery capabilities and built-in retransmission methods. These tradeoffs provide smaller bandwidth overhead, simpler processing requirements, and reduced implementation complexity.

This release of the ATM SPM uses AAL-1 with Single Channel Adaptation. AAL1 has two primary modes of operation: structured and unstructured. A description of each of these types of operating modes follows.

Structured Data Transfer (SDT)

The AAL-1 Structured Data Transfer protocol is defined by the ITU. This protocol can receive an integer multiple of octets, transmit this data across an ATM network and reconstruct the original grouping of octets at a receiving site. When recovering a single voice channel (DS0) from an AAL-1, SDT adapted ATM cell stream, identifying the number of octets grouped together is straight forward—one octet is expected at a time.

When multiple octets (DS0s) are grouped together to provide wider a bandwidth connection, identifying the octet boundaries of a connection requires additional information, which must be transmitted with the user data. This is an example of Nx64 connection in a public voice network. The AAL-1 SDT identifies boundaries by considering each group of octets (that is, the “N” DS0s transmitted together) as a structure; it then periodically transmit a pointer referencing the start of a structure boundary.

The knowledge of the size of a structure is established when the ATM Virtual Circuit is established. The single-octet data stream (voice) is a special case because its structure size is one. Since the boundaries occur every 8 bits, pointers are not transmitted with voice. Both the Pointer and Non-Pointer format of AAL-1 SDT include a sequence number (modulo 8) as their first byte in the cell payload, and this is used to determine error conditions such as lost or misdirected cells.

Unstructured Data Transfer (UDT)

Unstructured data transfer is used to accommodate constant rate bit streams without regard to the individual octets within those bit streams. As such, UDT is useful for carrying DS1 type traffic through an ATM network.

Single Channel Adaptation (SCA)

Single Channel Adaptation is commonly used to map a single voice channel (or DS0) to a virtual circuit. For ATM SPM, this type of adaptation is accomplished using AAL-1 SDT without including pointers. This adaptation method accumulates 47-octets from a DS0 stream, prepends a sequence number, and maps the payload to an ATM cell. Since each ATM cell has samples from only one DSO, echo cancellation must be added to this application to account for the packing delay.

Circuit Emulation

Circuit Emulation refers to the transport of existing carrier structures over an ATM network. For North America and Europe this refers to the transport of DS1/E1 or DS3/E3. Circuit Emulation carries constant bit rate data over AAL-1 as either Structured or Unstructured data. When transporting Structured data, Circuit Emulation has the ability to transfer fractional DS1/E1. When transporting Unstructured data, it refers to carrying either a 1.544 Megabits per second or 2.048 Megabits per second (DS1/E1) bit stream. The ATM-SPM initial release doesn't support Circuit Emulation.

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4 ATM-SPM Overview

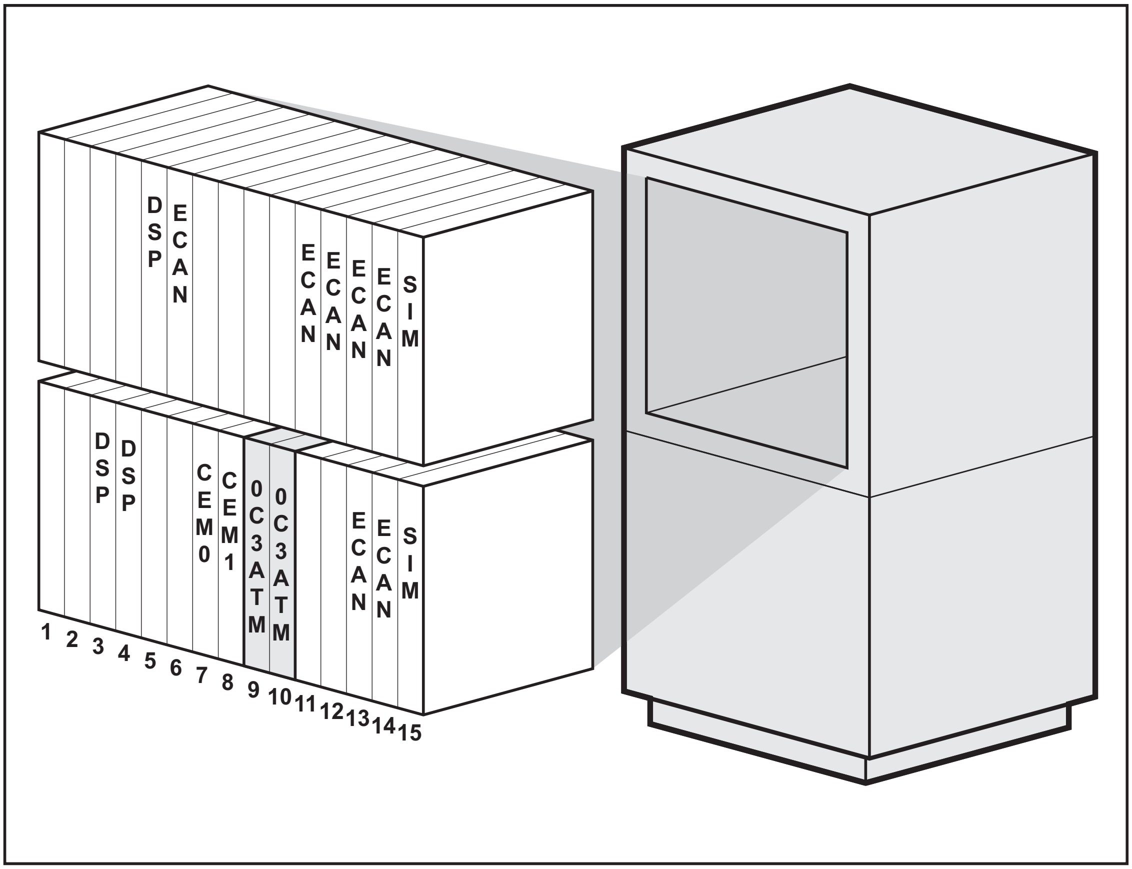
ATM-SPM Architecture

The ATM-SPM architecturally consists of a newly developed ATM resource module for the DMS-SPM base, and includes these features:

- VSP/DSP RM Functionality
- Echo Cancellation
- Tone Detection and Synthesis
- Continuity testing for ISUP and service test applications

The following figure shows that the existing OC-3 TDM modules in SPM are replaced with the ATM RMs in slots 9 and 10. For more detail, see the *Hardware Maintenance Reference Manual*, NTP 297-1771-550.

Figure 4-1 Location of ATM Modules in SPM

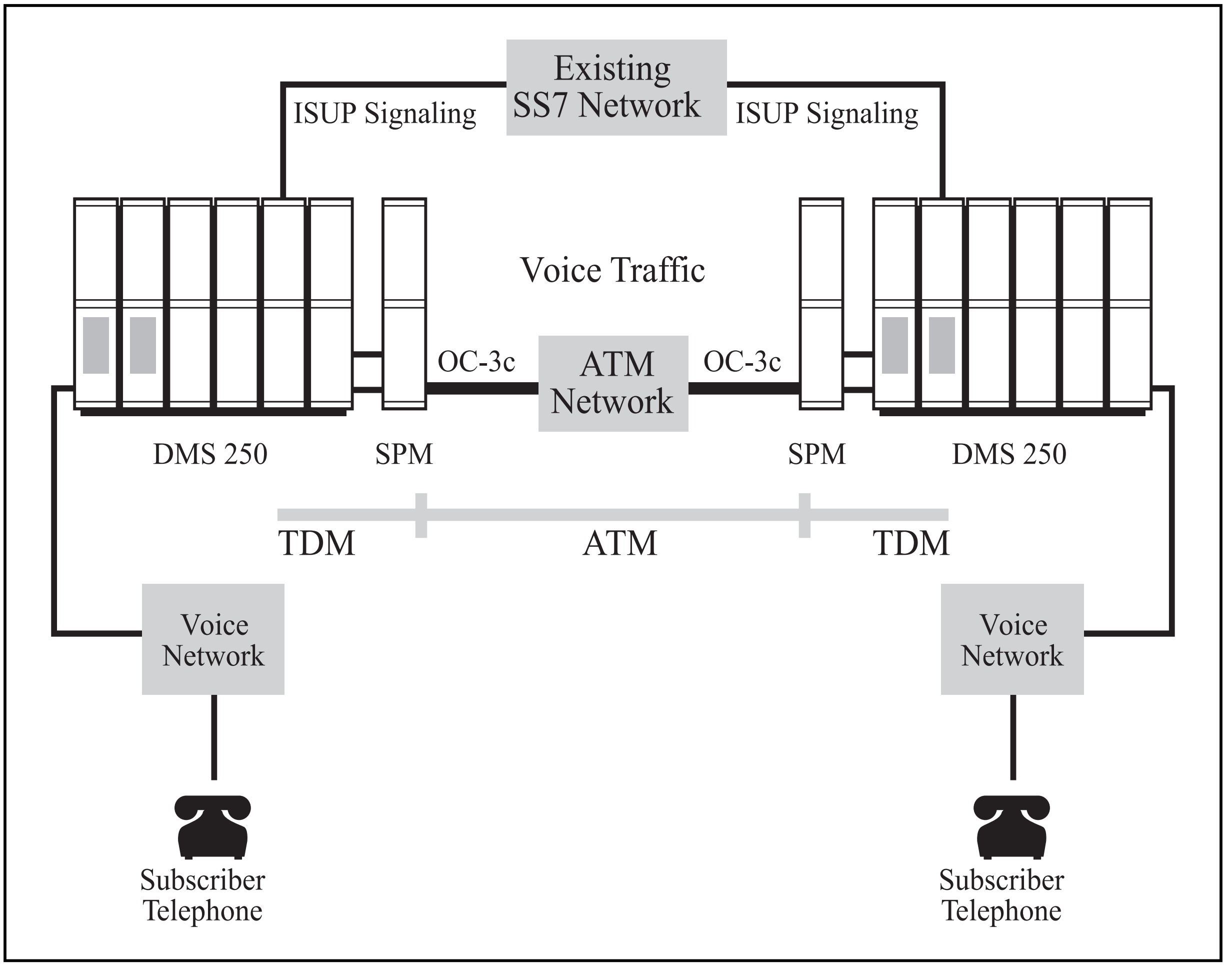


ATM-SPM Network Perspective

The ATM SPM resource modules allow two DMS-250s to establish an ATM trunking application that can be used to carry ISUP IMT traffic. An AAL1 ATM trunk is setup in an ATM network using a permanent virtual path. The PVP is defined by parameters in the MNATMCON table. This table, together with the TRKMEM and C7TRKMEM tables, map a DS0 connection to a specific VPI/VCI value. The VPI/VCI forms the address of the ATM cells that carry the TDM based DS0 samples between DMS-250s.

Using a call-flow diagram, the existing SS7 network is used to negotiate the call. Once the connection is accepted, a message sent to the ATM-SPM to enable the conversion of the TDM to ATM cells with VPI/VCI values determined by the datafill above. The ATM cells are then sent over the ATM network to another ATM-SPM where the process is reversed. (See the figure below.)

Figure 4-2 SPM to SPM Using ATM Backbone



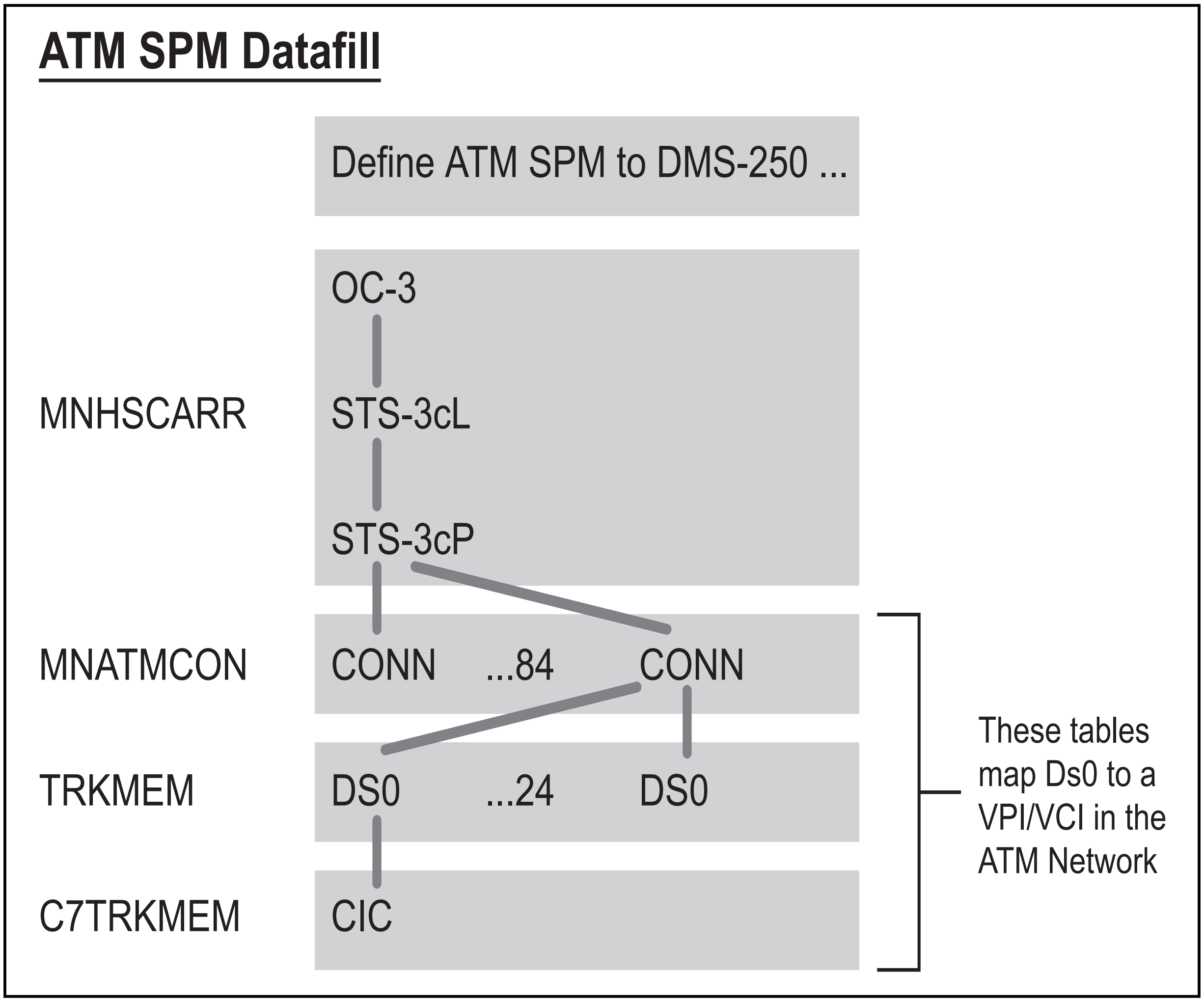
ATM-SPM OAM Perspective

The ATM-SPM is completely integrated into the DMS-250, so the ATM RMs can be managed using the existing DMS OAM infrastructure.

ATM-SPM Datafill

The ATM-SPM utilizes a unique mapping scheme to map the SS7 Channel ID Code (CIC) to an ATM Virtual Channel Identifier (VCI) during the call setup. A system's administrator can datafill manually derived PVPs, which can then be downloaded to an ATM-RM using the OAM&P management functions. The figure below provides a graphical summary of the mapping scheme. For more detail, see the *Data Schema Reference Manual*, NTP 297-1771-851.

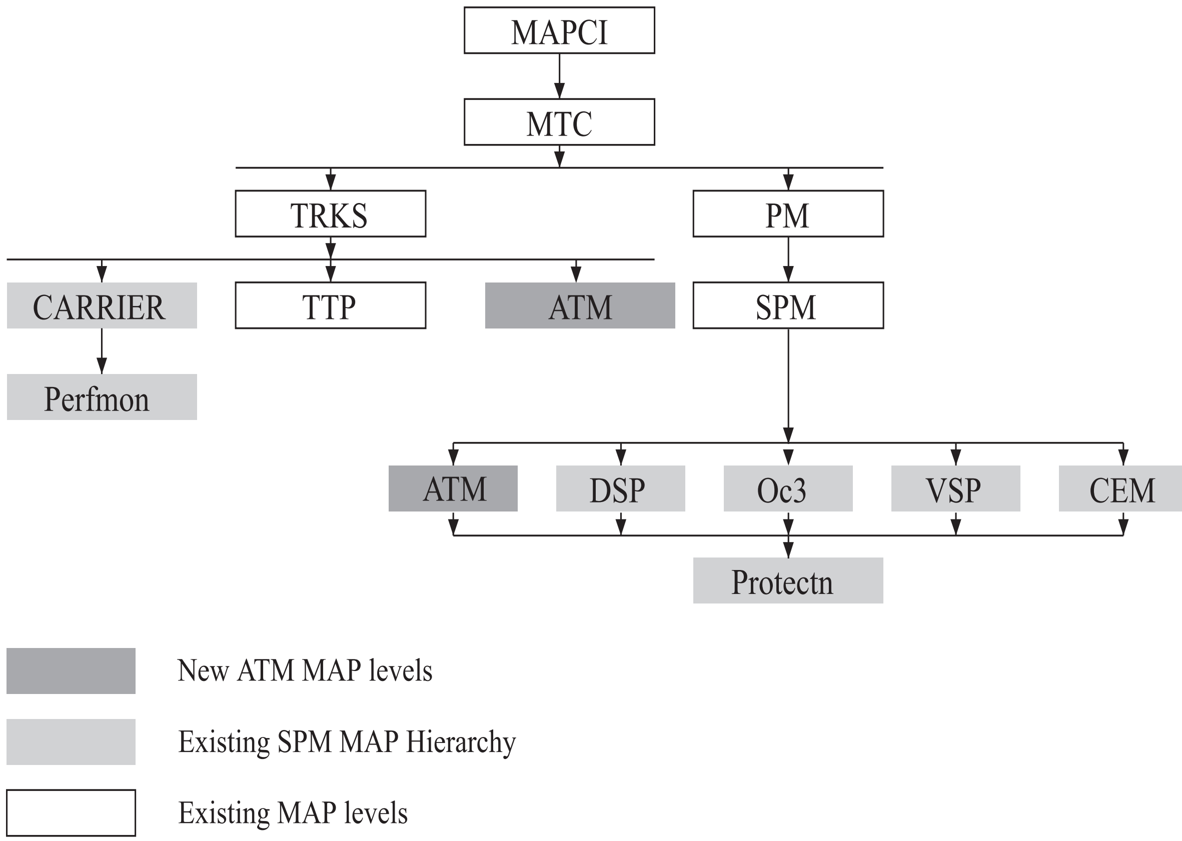
Figure 4-3 ATM SPM Datafill



ATM-SPM Map

The ATM RM MAP structure conforms to the standard MAP interface used for the OCS, DSP, and VSP HMI. Two new levels have been added to the MAP interface so the ATM resource modules can be managed. For more detail, see the *Command Reference Manual*, NTP 297-1771-815.

Figure 4-4 ATM-SPM Map



ATM-SPM Logs

Three new log messages have been created for the ATM application.

SPM 502 Log

The SPM 502 log records a change of state for an ATM connection. Only ATM connections that are in-service (InSv) are available for DSO assignment.

SPM 503 Log

The SPM 503 log records a change of state in the STS3c SONET carrier. A single STS3c, the parent carrier, carries all ATM traffic for a particular SPM, and any change in the parent carrier's state affects all of the associated ATM connections.

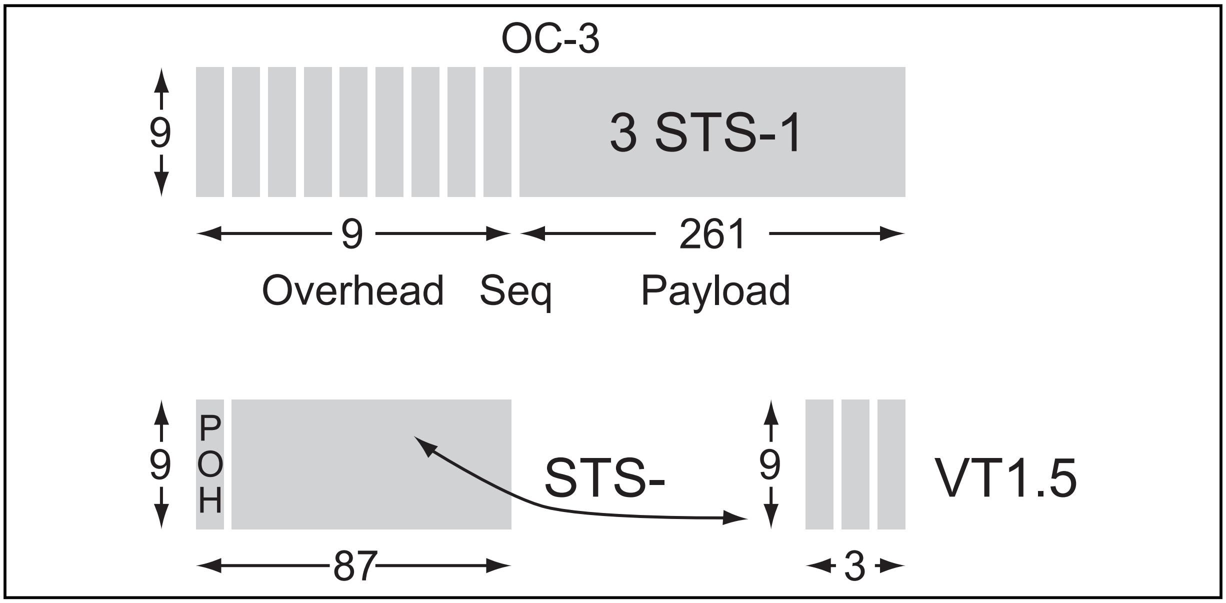
SPM 504 Log

The SPM 504 log records when both of the ATM resource modules go out-of-service. If both ATM RMs are down, then the SONET parent carrier will be out-of-service; consequently, all ATM connections will be unavailable for call processing.

OC-3c Sonet Frame and AAL1/SCA Adaption

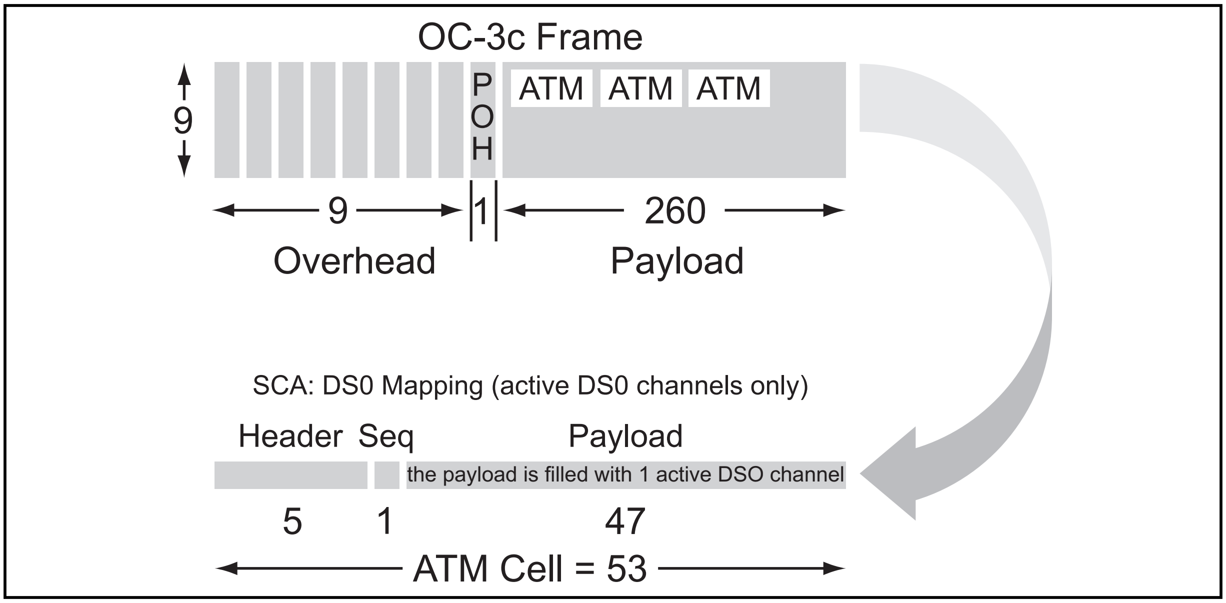
The ATM SPM uses an OC-3 Concatenated (OC-3c) SONET frame. The figure below represents an OC-3 frame that has the normal columns of overhead and a Synchronous Payload Envelope (SPE). The payload envelope is filled with three STS-1 frames. These frames have associated overhead, as well as virtual tributaries (VT-1.5) for subrate DS-1s.

Figure 4-5 OC-3 Frame



In contrast, the OC-3c frame represented below has several columns of overhead and a Synchronous Payload Envelope (SPE) like the OC-3 frame; however, the SPE does not have an STS-1, it has one additional column of overhead and 260 columns of bandwidth available for its payload. The ATM SPM uses this additional bandwidth for ATM cells. The ATM cells are formated with VPI/VCI header infomation, a sequence number using the AAL-1/Single Channel Adaption (SCA) method. Since SCA is used, only samples from the same DSO are loaded into each ATM cell.

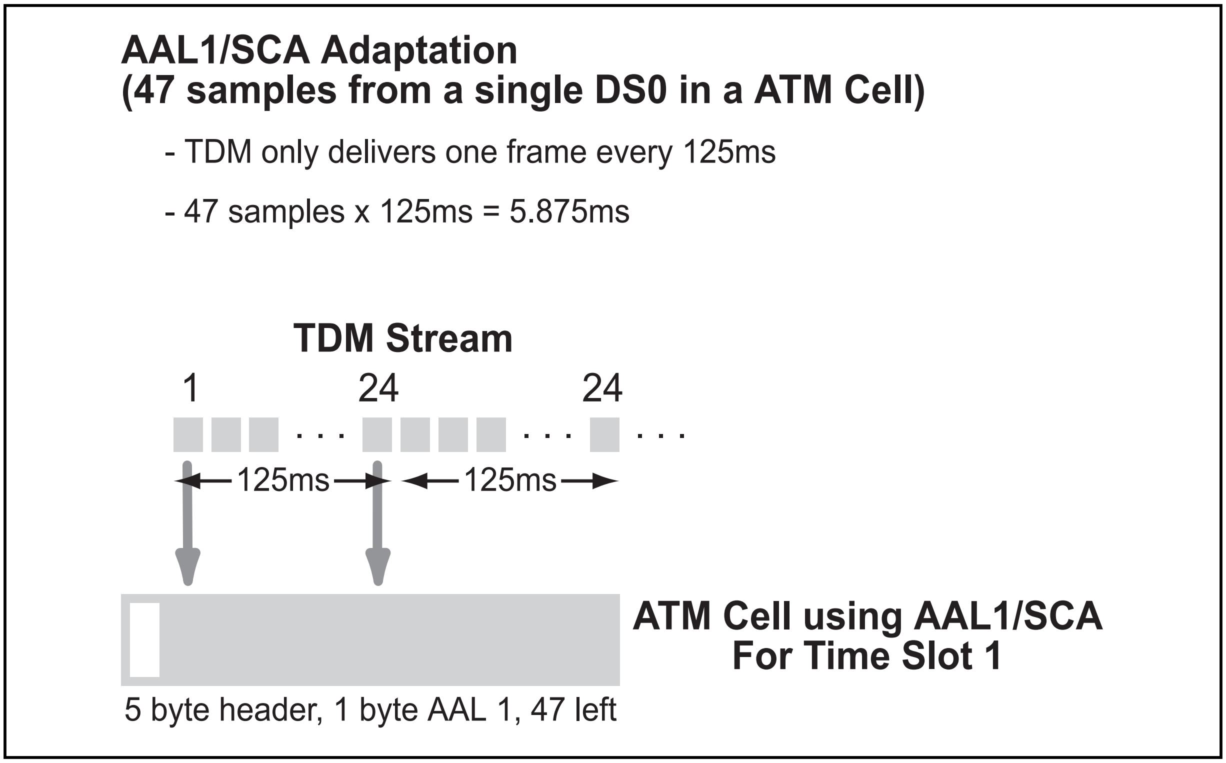
Figure 4-6 OC-3c Frame



Echo Cancellation

Since ATM-SPM uses a single channel adaptation (SCA), each ATM cell creates a delay of approximately 6 ms during the segmentation process. TDM delivers a sample every 125 ms, and 47 samples are required to complete the payload of an ATM cell – 47*125ms = 5.8 ms. Segmentation delay, together with associated network delays, results in an echo cancellation requirement for this application.

Figure 4-7 ATM Segmentation Delay



5 ATM-SPM Hardware

Overview

The hardware required for the ATM trunking application is built upon the SPM platform. No updates or changes are required to the SPM platform for the ATM function. However one new module is required, an OC-3c ATM resource module (ATM RM). The Nortel Product Engineering Code is NTLX73AA.

ATM Resource Module

The ATM resource module provides a SONET OC-3c physical interface that allows direct connection to the ATM network. This RM provides interworking functionality between the cell-based ATM network and the traditional TDM switching network.

The hardware architecture of the new resource module maps DS0s to ATM cells using the ATM Adaptation Layer 1, Structured Data Transfer (AAL-1 SDT). For single DS0 and voice calls the SDT Non-Pointer (Non-P) format, commonly called Single Channel Adaptation (SCA), is used. For Nx64 calls, which combine multiple DS0s into a single channel, the SDT Pointer (P) format is used.

The principle functions of the ATM RM are:

- Interface to an OC-3c single mode fiber
- Termination of ATM Forum Specified SONET transport and path overhead
- Termination of ATM OAM cells
- Map DS0s to ATM cells using AAL-1 SDT “P” format for Nx64 connections and AAL-1 SDT “Non-P” format for SCA / voice connections.

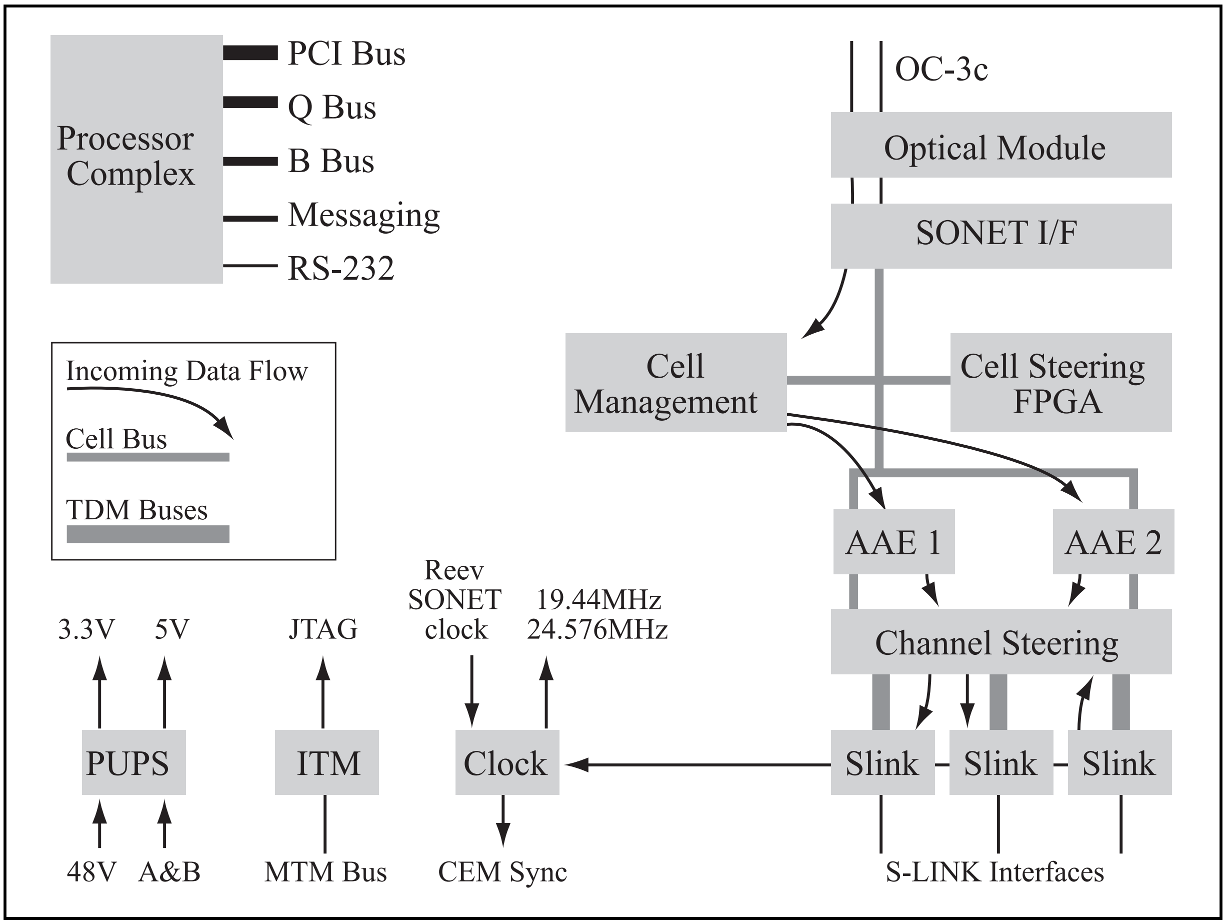
The ATM RM provides the following features:

- AAL-1 processing via the ATM Adaptation Entity (AAE) ASIC
- 100 MHz PowerPC 603e based processing engine (120SPECint92)
- 32 Megabytes of on board DRAM

- 16 Megabytes of FLASH memory for on-board storage of program load (fast initialization)
- Integrated test and maintenance support via an IEEE 1149.1 compliant JTAG boundary scan master
- On-board point-of-use power supply (PUPS)
- Support for 2016 DS0s (This limit allows for non-blocking trunking operation). Capability to handle 2048 DS0s.

A functional block diagram of the ATM RM is shown in below:

Figure 5-1 ATM RM Functional Block



Optical Module

The optical module performs the electro-optic conversions of the OC-3c interface. The transmitter and receiver are intermediate, short-reach devices that operate at a nominal wavelength of 1310nm and at a data rate of 155.52Mb/s. The module supports single mode fiber interfaces conforming to T1.646. The NTLX73AA does not provide support for multi-mode fiber.

SONET Interface

The SONET interface block provides the SONET OC-3c termination function and ATM cell recovery. Its SONET interface is connected to the optical module, and it interfaces to the cell bus on the system side.

This block performs the following functions:

- Electrical serial STS-3c interface
- Clock and data recovery
- SONET transport and path overhead extraction and injection
- ATM cell extraction, header check sequence (HCS) checking, and idle cell filtering
- Detection / Insertion of error conditions such as LOS, OOF, LOF, AIS, RDI, LOP, etc.
- Counting of BIP and HCS errors.

Cell Management

The Cell Management block processes all cell traffic in the ATM RM. It provides the following functions:

- VPI/VCI address translation and the insertion of prepend bytes used by the ATM RM to route cells to the various cell termination blocks
- Termination and generation of OA&M cells
- Cell counting on per VC and total basis. Counting is performed for various valid and error conditions

Cell Steering FPGA

The cell steering Field Programmable Gate Array (FPGA) is responsible for controlling the cell flow on the cell bus. It uses the interface control signals from all of the devices attached to the cell bus as well as the bytes appended to each cells in the Cell Management block to determine the proper destination for each cell.

Cell Termination Blocks

These blocks terminate the various ATM cell streams and convert them to a non-cell format.

AAE ASIC and DSO Formatter

The AAE ASIC is a custom device that performs the AAL-1 SDT cell format to TDM data format conversion. Each ASIC can support up to 1024 Virtual Circuit (VC) connections and up to 1024 DS0 channels on its TDM interface. The ATM RM uses two AAEs to accommodate the necessary 2016 DS0s and associated VCs. Each device performs VC to DS0 mapping based on software configuration, and each has support for cell suppression on idle connections without removing the associated map entry.

Each AAE device also has the capability of mapping multiple DS0 channels to a single SDT VC effectively creating an Nx64 connection. Active TDM channels from the two AAE devices are indicated by an “in-use” bit associated with each of the AAEs 2048 channel TDM streams. The in-use bit is active when the ATM RM’s processor has identified a channel that is established and active within the AAE device.

Channel Steering

The Channel Steering block controls the mapping of DS0s between the S-LINK interface and the AAEs. Of the 2304 DS0s supplied to the ATM RM, 2048 are available for mapping to ATM cells using the existing OC-3 RM channel selection scheme. These do not require direct software control since they’re based on the in-use bits provided by the termination blocks.

For the outgoing direction (towards the span), the S-LINK channels are presented to the AAEs. Each block is responsible for utilizing the proper channels. For the incoming direction (from the span), the channel steering circuitry selects the data from the appropriate source based on the in-use indications provided by the mapping functions. Software is responsible for ensuring that each AAE is programmed so that only one block attempts to use a given DS0. The Channel Steering block also provides pseudo-random test data (PRD) insertion capability towards the ATM interface, as well as PRD checking on received data. Fixed data test pattern capability is also provided.

S-LINK Interface

The S-Link interface consists of three SPM standard SLIF-S ASICs. These ASICs interface the ATM RM to the Common Equipment Module (CEM) in the SPM. They provide DS0 connectivity, an interface to the system clock, as well as the SPM messaging infrastructure. The ATM RM has access to 2304 DS0 channels.

Processor Complex

The processor complex is responsible for the local initialization, configuration, and maintenance of the resource module, and it communicates the CEM via the S-LINK messaging facility. A 100 MHz PowerPC 603e is integrated with a level 2 cache memory, a bus bridge, and a main memory controller. The system has 32-MBytes of DRAM for program and data storage for the processor. Also 16MB of flash memory provides non-volatile storage of boot-code, internal fault information, and configuration of programmable logic.

The Processor Complex block includes functions to accommodate the various bus formats used on the resource module. In addition, it also provides serial access for messaging through the SLIF-S and the RS-232 debug interface.

Integrated Test Master (ITM)

The Integrated Test Master (ITM) ASIC provides an interface for the system Module Test and Maintenance (MTM) bus and ATM RM. It provides backplane access to the RM's reset LEDs, the internal JTAG scan chain, and the Module Information Memory (MIM). These functions can also be accessed and controlled using the local processor complex.

Clock

The clock generates the various clock rates required for the module. It uses the S-LINK clock as a reference and produces most notably the 19.44 MHz clock needed for the OC-3c interface. The recovered 8KHz clock from the span is transmitted to the CEM for use as a synchronization reference.

Power

As with all SPM modules, the ATM RM will convert -48V, available from the SPM backplane, to 5 and 3.3V sources for module circuitry. Power conversion on the RM is done using a DC-to-DC Point-of-Use Power Supply (PUPS). The SPM backplane feeds dual battery supplies to the ATM RM for fault tolerance. For safety and fault isolation, the -48V is fused on the ATM RM.

Module Design for EMC

The ATM RM meets applicable regulatory guidelines. The ATM RM provides EM shielding for the circuit packs and the integrated circuits (ICs). This shielding is part of the EMC strategy to meet the emissions and immunity requirements. Apertures in the modules are designed to prevent leakage of high-frequency noise beyond the necessary level (the level provided in the EMC budget). The module shielding reduces emissions from the circuit packs and ICs, but it doesn't prevent noise conducted on the cables. However, the module which is at frame ground is required to reference filters or shields on the cables. The modules will be referenced to frame ground through a gasket to the multi-layer backplane (with external ground layers) and through guide pins.

Synchronization Requirements

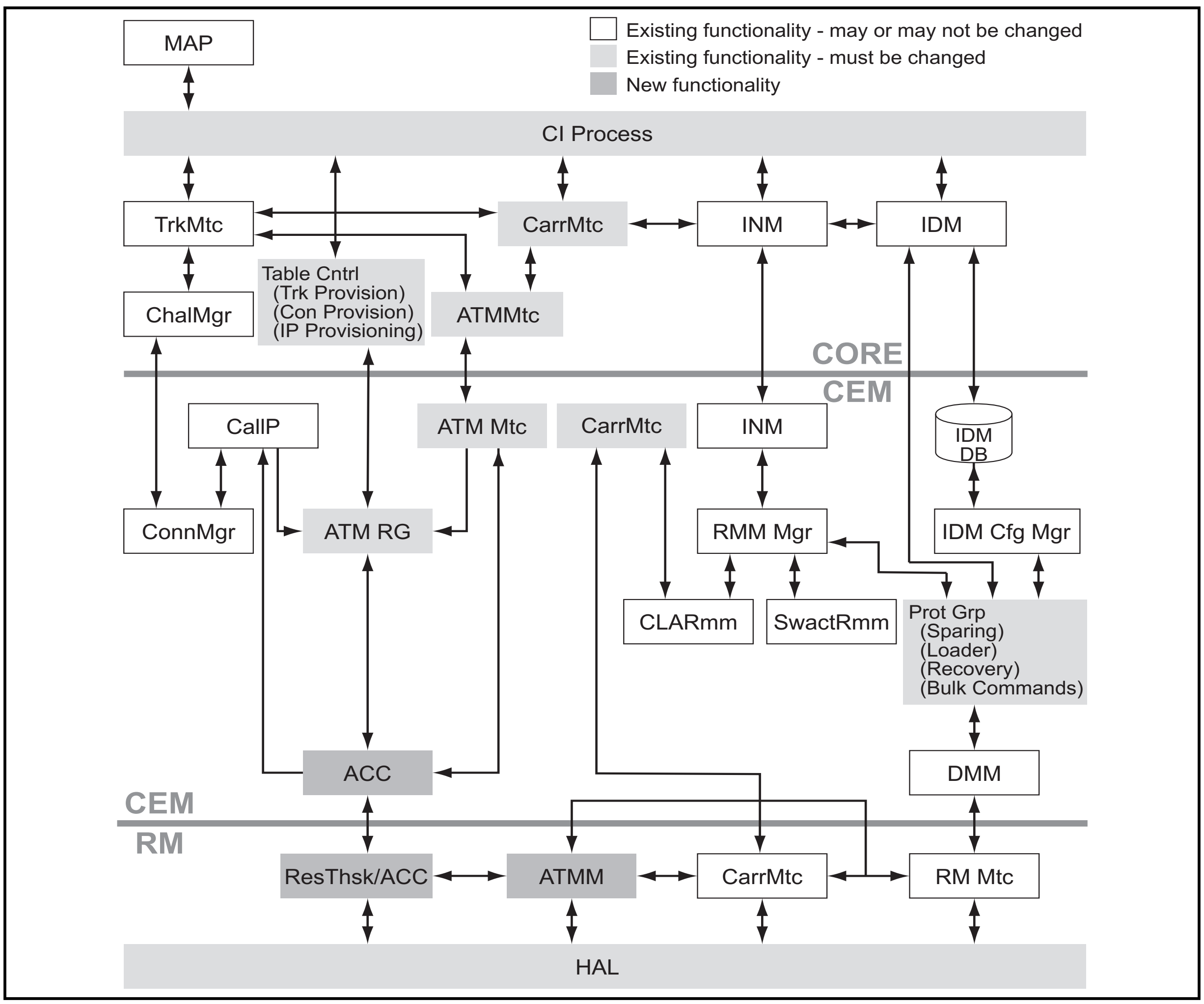
There are no unique synchronization requirements or features related to the ATM RM. Refer to the SPM documentation for more information regarding SPM synchronization.

6 ATM-SPM Software

ATM-SPM Functional Architecture

Within the SPM platform, the ATM software is divided into functional areas. These functional areas may be in either the CM, CEM, RM or all. See the figure below.

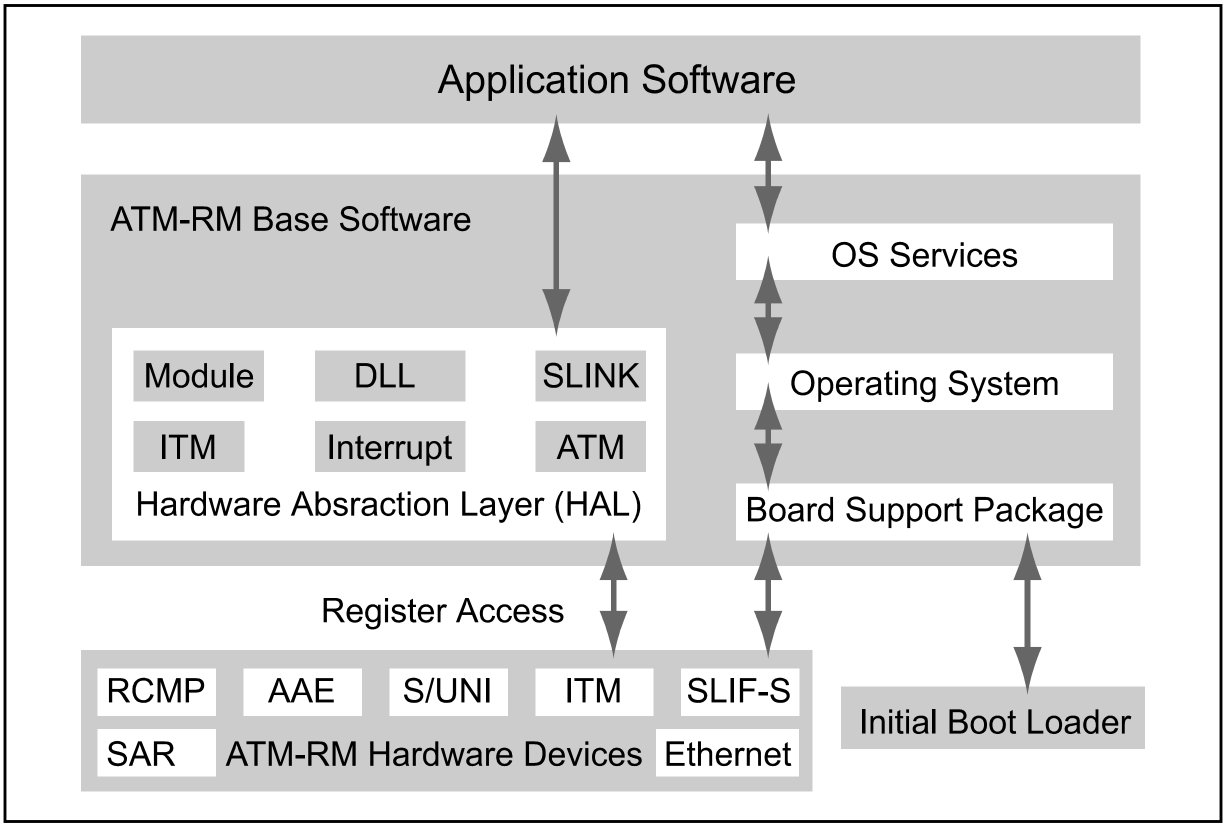
Figure 6-1 ATM Software Functional Areas



RM Base Software Description

The Base software on the ATM-RM consists of the following general areas.

Figure 6-2 ATM RM Base Software



- **Operating System (OS)** — The ATM-RM uses the VRTX Operating System.
- **OS Services** — This consists of base utilities and common services and helps to isolate the application software from OS-dependent functions.
- **Board Support Package** — The Board Support Package (BSP) creates an insulating layer between the OS Services and the specific hardware implementations. This eases the transition for new hardware introduction.
- **Initial Boot Loader (IBL)** — The IBL is the smallest possible set of non-downloadable firmware necessary to allow download of firmware in the field.

- **Hardware Abstraction Layer (HAL)** — The HAL serves to isolate hardware specific routines from the application layers above. Typically, the HAL consists of both a physical device driver for a particular hardware chip, and a logical device driver which interfaces to the application software. For the ATM-RM, the ATM-HAL was designed with a logical device driver interface and physical device drivers for the following hardware:
  - — SONET / User Network Interface (S/UNI) ASIC
  - — Routing, Control, Monitoring, and Policing (RCMP) ASIC
  - — ATM Adaptation Entity (AAE) ASIC

The “Application Software” consists of software that is ‘above’ the HAL and OS, including:

- Resource Module Maintenance
- Carrier Maintenance
- ATM Maintenance
- Resource Messaging Router
- Call Processing

ATM Connection Provisioning Software Description

Provisioning for the ATM RM consists of these areas:

- Datafilling the ATM RM device in existing Node/device tables in the DMS CORE
- Datafilling the ATM Connections in a new table MNATMCON
- Datafilling the DS0s in Table TRKMEM
- Datafilling the OC3c/STS3c in the existing Carrier Maintenance Table MNHSCARR.

The ATM-SPM requires that a PVP and PVC pair be permanently mapped to a DSO 64Kb/s voice channel via provisioning. The PVC is represented by a permanent Virtual Channel Identifier (VCI) and the PVP is represented by a permanent Virtual Path Identifier (VPI).

These values will be manually negotiated with the ATM Network Management and then mapped via provisioning to the set of available DS0 channels. An administrator in the DMS/SPM office must obtain the VPI/VCI pair information directly from the ATM switch administrator.

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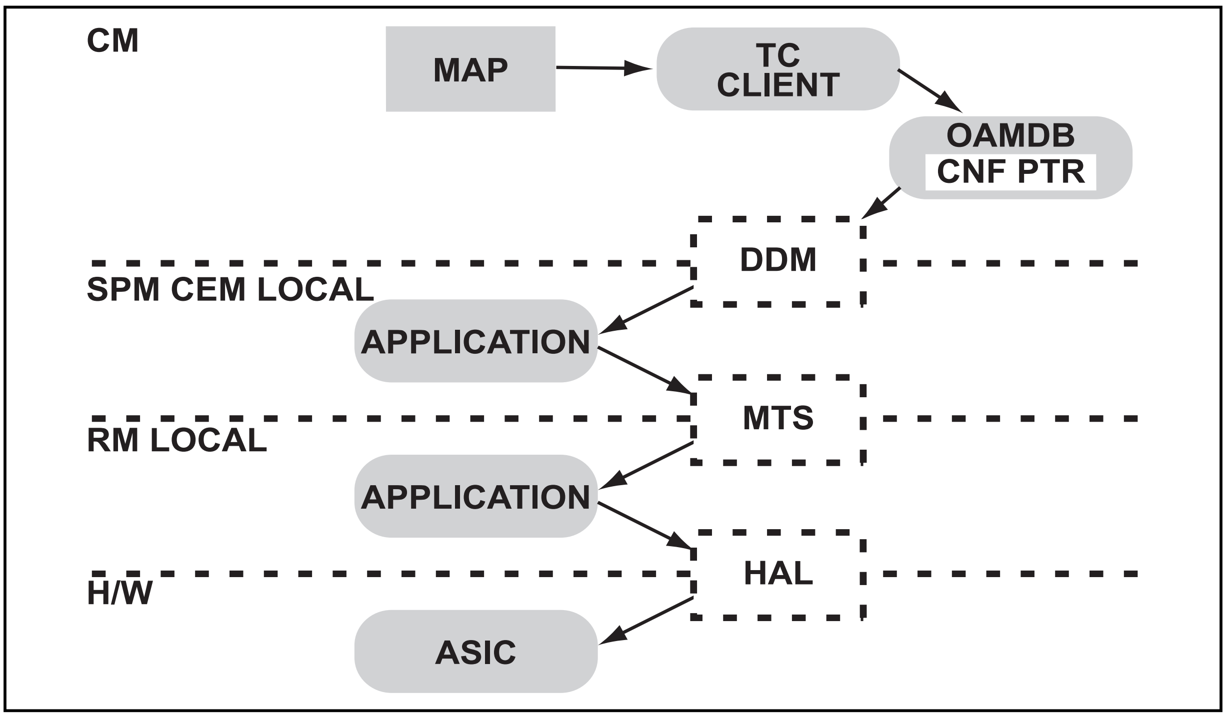
- the setting and clearing of alarms
- on-demand wideband applications (supported only by PVP Connections).

The MNATMCON table defines each ATM connection for a DMS switch. Each connection is a VPC with bandwidth for up to 24 DS0 channels. The table maps a VPI to an ATM Connection number and DS0 to a particular ATM connection number or VPI. Table C7TRKMEM maps a ISUP CIC (Circuit Identification Code) to a particular DS0. This CIC becomes the VCI of a virtual channel on the associated VPI. Once the mapping is complete, the information must be downloaded to the CEM and transported to the ATM-RM. The table below summarizes the mapping and download between the CORE, the CEM, and the RM.

Figure 6-3 Mapping & Download Relationships



CM Software Functions

The software in the CM provides the following functions:

- Provides a user interface to manually configure the DS0 to VPI/VCI mapping (i.e. existing Table Control software - TRKMEM, C7TRKMEM, and new table MNATMCON)
- Provides a mechanism to permanently store the VPI/VCI information (i.e. use of the existing OAM Database designed as part of SPM Release 01)
- Ensures that the provisioned data is handled properly during ONPs and RESTARTS
- rovides a mechanism that can transport the data when changes have been made in the configuration table. This ties into the current method for static and dynamic data download (i.e. the Data Distribution Manager).

CEM Software Functions

The CEM software provides the following functionality:

- Provides for maintenance on the ATM connections
- Provides interfaces to the resources available on the ATM RM
- Provides a method to transfer the data to the ATM RM's local software for configuration.

RM Functions

The ATM RM software handles most of the functionality required by the ATM switch (for example, ATM specific OAM and alarms). The RM's local software is required to perform the following functions:

- Inform the HAL of the ATM AAL-1 connection on an 'as needed' basis
- Provide a means to receive the configuration data for ATM from the CEM
- Provide the actual work needed to do maintenance on ATM connections.

Call Control Management Software Description

The CEM and ATM RM's local software functions are described in:

- CEM Software Functions
- RM Software Functions

RM Maintenance Software Description

The ATM RM is maintained by the combination of the existing Integrated Node Maintenance (INM) subsystem and the Integrated Device Maintenance (IDM) subsystem.

ATM RM Provisioning Software Description

The ATM RM device provisioning is the same as the device provisioning for other SPM devices, such as OC3, DSP, and VSP. This is currently handled via existing Table Control software.

Wideband Support Software Description

Definition

A wideband call is a call in which N number of 64 kb/s channels are used to provide greater bandwidth. Each channel is a DS0, and all channels involved in a call must be on the same DS1. Since there are 24 DS0s in a DS1, the bandwidth of a wideband call ranges from 2x64 kb/s to 24x64 kb/s. A wideband call is also known as an Nx64 call. In ATM-SPM, the ATM connections are similar to DS1s in that both are capable of carrying a maximum of 24 DS0s. Thus, wideband support over ATM connections is similar to wideband support over DS1s.

Wideband Grouping

Wideband grouping is also called time-slot arrangement and must be datafilled in table TRKGRP. Three different types of time-slot arrangements are supported to fit an Nx64 call in a DS1:

- **Fixed —** N time-slots are contiguous. The block of time slots lie on specific time slot boundary. N = 2, 6, and 24 are supported. For example, acceptable boundaries of a 6x64 call are one of the following sets of time slots: 1-6, 7-12, 13-18, 19-24
- **Floating —** N time-slots are contiguous. The block of time slots can be anywhere on the DS1
- **Flexible —** N time-slots can be non-contiguous on the DS1. 2 <= N <=24.

Wideband Support on OC-3 ATM Interface

The ATM-SPM emulates a DS1 carrier using a VP for wideband support on the ATM interface Accordingly, the size of a wideband VP equals 24 DS0s, and a wideband call can include from 2 to 24 DS0s. Multiple VPs must be datafilled to mimic multiple carriers in a wideband trunk group.

Alarm Software Description

The ATM RM alarm reporting system is the same as other resource modules within the SPM framework. There are additional alarms which are set and cleared that are specific to ATM. For more detail, see the *Alarm Clearing Procedure Manual*, NTP 297-1771-543.

Log Reporting Software Description

The ATM RM log reporting system is the same as other resource modules withing the SPM framework. For more detail, see the *Log Reference Manual*, NTP 297-1771-840.

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Spectrum Peripheral Module

ATM General Description Manual

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