

## *Cisco 2600, 3600 and 3700 Series* **Multiport T1/E1 ATM Network Modules with Inverse Multiplexing over ATM**

ALLOW SERVICE PROVIDER AND ENTERPRISE CUSTOMERS TO COST-EFFECTIVELY INCREASE BANDWIDTH, EXTENDING MULTISERVICE CAPABILITIES TO REMOTE BRANCH-OFFICE LOCATIONS USING ATM.

Figure 1 Multiport T1/E1 ATM Network Modules with IMA



### Introduction

Four multiport T1/E1 ATM network modules with Inverse Multiplexing over ATM (IMA) are available for the Cisco 2600, 3600, and 3700 series multiservice access platforms. Available in both four- and eight-port versions, these new multiport ATM modules allow service provider and enterprise customers to cost-effectively increase bandwidth, extending multiservice capabilities to remote-branch-office locations through ATM.

These multiport T1/E1 ATM network modules with IMA add to the broad Cisco portfolio of customer premises equipment (CPE), ATM edge, and central-office products, that allow branch offices to take advantage of the higher

bandwidth and multiservice capabilities available from ATM services. These new ATM modules complement the existing OC-3 and 25-Mbps family of ATM network modules available for the Cisco 2600, 3600 and 3700 series that now offer ATM bandwidth from 1.544-Mbps to 155-Mbps.

The high cost and limited availability of long-distance broadband ATM services have prevented many organizations from taking advantage of ATM's high quality-of-service (QoS) features. In recent years the ATM Forum has defined lower-speed T1/E1 ATM services, but this was an incomplete solution because a single T1/E1 often does not provide sufficient bandwidth to support the additional requirements of multiservice applications. For this reason, many organizations find themselves caught between the bandwidth limitations of narrowband T1/E1 lines and the much higher costs of moving to broadband links.

In response to this the ATM Forum, with Cisco as an active member, defined a standard for IMA. Using the Cisco 2600 and 3600 series multiservice platforms to provide IMA access provides an affordable LAN-to-WAN solution for branch office, campus and ATM Edge applications. Multiport T1/E1 IMA modules enable service providers to deliver critical integrated ATM services combining data, voice and video with ATM's guaranteed QoS features. With multiport IMA deployed as CPE edge, network service providers can deliver unmatched flexibility in the types of services they can offer to their customers.

IMA is an ATM Forum specification that provides a cost-effective and scalable alternative to T3/E3 services by allowing carriers to leverage widely available T1 services over ATM and interoperate with other vendors' standards-based equipment. Multiport T1/E1 IMA can provide organizations with highly desired fractional T3 bandwidth connectivity, which is critical in situations where DS3 or OC-3 fiber connections are either cost-prohibitive, or unavailable between a provider's central office and the customer's premises.

Multiport T1/E1 IMA network modules functionality allows access to ATM WAN uplinks with bandwidth requirements between DS1 and DS3 rates. Each T1 link provides 1.544 Mbps and each E1 link provides 2.048 Mbps connectivity. With IMA's aggregation of multiple T1/E1s, network managers have the ability to increase bandwidth inexpensively to allow wide-area network (WAN) uplinks at speeds ranging from 1.544-Mbps to 16-Mbps full-duplex on a single card.

All four multiport ATM network modules support the ATM Forum Adaptation Layer 5 (AAL5) with ATM QoS categories Unspecified Bit Rate (UBR), Variable Bit Rate (VBR-rt and VBR-nrt), and Available Bit Rate (ABR). VoIP and H.323 video over ATM can be supported using VBR-rt class of service (CoS) parameters with the currently available analog voice/fax network modules with voice interface cards (VICs), or the new T1 digital packet voice trunk network modules with multiflex trunk cards.

The multiport T1/E1 IMA modules' support for VoIP and H.323 video applications provides low latency, jitter-free voice support to enhance throughput, and high-quality, end-to-end voice and video performance. When combined with high-density packet telephony solutions already available on the Cisco 2600 and 3600 series, the multiport ATM network modules provide a seamless end-to-end multiservice solution, interoperable with other ATM Forum IMA version 1.0 products available from Cisco.

#### **Multiport T1/E1 ATM Network Modules: New Features at a Glance**

- Supported on all Cisco 2600 and 3600 series multiservice platforms
- Supports four or eight T1/E1 ATM ports
- Support for ATM Forum IMA Version 1.0
- Up to 16-Mbps full-duplex bandwidth with an 8-port E1 IMA network module
- Supports UBR, VBR-rt, VBR-nrt, and ABR ATM CoS
- Maximum of four active IMA groups on both four- and eight-port versions
- Integrated CSU/DSU on T1 versions
- Integrated DSU for E1 versions
- ATM Forum User Network Interface (UNI) 3.0, UNI 3.1, and UNI 4.0 signaling
- ATM Adaptation Layer 5 (AAL5)
- Permanent Virtual Circuits (PVCs) and Switched Virtual Circuits (SVCs)
- Request For Comments (RFC) 1483 support for multiple encapsulations over ATM
- RFC 1577 support for Routing over ATM
- Maximum of 256 Virtual Circuits (VCs) per interface with up to 1024 simultaneous reassemblies per card
- Maximum differential delay tolerance of up to 200-ms
- F4 and F5 Operation, Administration, and Maintenance (OAM) cell support
- Cyclic Redundancy Check(CRC)32 error checking of AAL5 and CRC10 checking of operations and management (OAM) cells
- Internet Engineering Task Force (IETF) Point-to-Point Protocol (PPP) over ATM
- Multiprotocol over ATM (MPOA) client and server
- LAN emulation (LANE) 2.0 client only
- Tag Switching (packet interfaces only)
- Interim Local Management Interface (ILMI)
- Next Hop Resolution Protocol (NHRP)
- ATM bandwidth (resource) manager

#### **IMA Benefits**

The multiport T1/E1 ATM offers the following benefits:

- Inexpensive ATM access
- A migration path to higher bandwidth without the need to change transport facilities
- ATM Forum Version 1.0 standards compliant (AF-PHY-0086.000) for multivendor interoperability
- Integrated CSU/DSU on T1 versions and integrated DSU on E1 versions
- The addition and deletion of links without service disruption
- Support for link failures and automatic link recovery without loss of data
- Greater internetworking design flexibility and scalability for LAN-to-WAN connectivity
- Efficient prioritization of mission-critical data provided by ATM's QoS features
- Simplifies network management
- Eliminates third-party inverse multiplexing devices

## Orderability, Availability, Compatibility, Minimum Software, and Memory Requirements

Table 1 Multiport T1/E1 ATM Product Numbers and Description

| Product Number        | Description                                                           |
|-----------------------|-----------------------------------------------------------------------|
| <b>NM-4T1-IMA (=)</b> | 4-port T1 ATM network module with Inverse Multiplexing over ATM (IMA) |
| <b>NM-4E1-IMA (=)</b> | 4-port E1 ATM network module with IMA                                 |

| Product Number        | Description                           |
|-----------------------|---------------------------------------|
| <b>NM-8T1-IMA (=)</b> | 8-port T1 ATM network module with IMA |
| <b>NM-8E1-IMA (=)</b> | 8-port E1 ATM network module with IMA |

Table 2 Multiport T1/E1 ATM platforms supported, Cisco IOS® Release, Memory and Maximum Number Supported

| Product                  | Cisco IOS Software version required | IOS Feature Sets required           | Minimum DRAM Memory                                                                              | Maximum supported |
|--------------------------|-------------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------------|-------------------|
| <b>Cisco 2600 series</b> | 12.0(5)T                            | Any Cisco IOS "Plus" Feature Sets   | Dependent on minimum DRAM memory requirements for specific IOS release and feature set selected. | 1                 |
| <b>Cisco 2691</b>        | 12.2(8)T                            | Any 2691 Cisco IOS Plus feature set | Dependent on minimum DRAM memory requirements for specific IOS release and feature set selected. | 1                 |
| <b>Cisco 3620</b>        | 12.0(5)T                            | Any Cisco IOS "Plus" Feature Sets   | Dependent on minimum DRAM memory requirements for specific IOS release and feature set selected. | 1                 |
| <b>Cisco 3640</b>        | 12.0(5)T                            | Any Cisco IOS "Plus" Feature Sets   | Dependent on minimum DRAM memory requirements for specific IOS release and feature set selected. | 3                 |
| <b>Cisco 3660</b>        | 12.0(5)T                            | Any 3660 Cisco IOS Plus feature set | Dependent on minimum DRAM memory requirements for specific IOS release and feature set selected. | 2                 |
| <b>Cisco 3725</b>        | 12.2(8)T                            | Any 3700 Cisco IOS Plus feature set | 128 MB                                                                                           | 2                 |
| <b>Cisco 3745</b>        | 12.2(8)T                            | Any 3700 Cisco IOS Plus feature set | 128 MB                                                                                           | 4                 |

**Note:** Due to a compatibility problem between the Cisco 3620 PCMCIA controller and the multiport T1/E1 ATM network modules, any T1/E1 ATM network module ordered as a spare to be used in a Cisco 3620 will require revision level E (rev E) PCMCIA controller in the Cisco 3620 chassis. The current revision of the PCMCIA can be viewed using Cisco command line interface (CLI) commands "show

version, or show diag." This Request for Material Authorization (RMA) process can be initiated with a call to the TAC, and is free.

All Cisco 3620s shipped from the factory starting in April 1999 include the rev E PCMCIA controller and are compatible with the T1/E1 ATM network modules.

Table 3 Cisco ATM Forum IMA Version 1.0 Product Compatibility Matrix

| Cisco Product                   | Description                            | Cisco IOS Software Release Supported |
|---------------------------------|----------------------------------------|--------------------------------------|
| Cisco 2600 and 3600 Series      | 4 and 8-port T1/E1 ATM network modules | 12.0(5)T                             |
| Cisco 7200 and 7500             | 8-port T1/E1 ATM port adapters         | 12.0(5)XE, 12.1(1)T                  |
| Light Stream® (LS)1010 and 8500 | 8-port IMA PAM                         | Q3CY99                               |
| MGX™ 8220 AXIS Shelf            | 8-port IMA (AUSM/AUSM-B)               | Release 5.x                          |
| MGX 8850                        | 8-port IMA (AUSM/B)                    | Release 1.1                          |

## Physical Specifications

### Bandwidths Supported

- NM-4T1-IMA, NM-8T1-IMA: from 1.544 to 12.352 Mbps, in 1.544 Mbps increments
- NM-4E1-IMA, NM-8E1-IMA: from 2.048 to 16.384 Mbps, in 2.048 Mbps increments

### T1 Interfaces Physical Specifications

- Line rate: 1.544 Mbps + 50bps
- Line code: binary 8-zero substitution (B8ZS) per ANSI T1.408
- Line framing: extended superframe format (extended superframe (ESF) 24-frame multiframe) per ANSI T1.408
- Input jitter tolerance: per ATT TR 62411
- Output jitter generation: per ATT TR62411 using normal mode sync
- Physical layer alarms: Loss of signal (LoS), out of frame (OF), alarm indication signal (AIS) remote defect identification (RDI)

### E1 Interfaces Physical Characteristics

- Line rate: 2.048 Mbps + 50 bps
- Line code: HDB3, AMI
- Line framing: 16-frame multiframe per ITU G.704
- Input jitter tolerance: per ITU G.823 for 2.048 Mbps operation
- Output jitter generation: per ITU G.823 for 2.048 Mbps operation
- Physical layer alarms: LoS, OF, AIS, RDI

### Multipoint T1/E1 ATM Network Module LED Descriptions

All four network modules have an enable (EN) LED. The enable LED indicates that the module has passed its self-tests and is available to the router. T1/E1 IMA network modules have the additional LEDs shown in Table 4.

Table 4 T1/E1 IMA Network Module LED Meaning

| LED | Color  | Description                                                                                    |
|-----|--------|------------------------------------------------------------------------------------------------|
| AL  | Yellow | Alarm indicating loss of signal, loss of frame, or unavailability because of excessive errors. |
| LP  | Yellow | Controller local loopback.                                                                     |
| CD  | Green  | Carrier received on telco links.                                                               |
| EN  | Green  | Enabled—Network module is communicating correctly to the bus                                   |

### ATM Alarm Signals supported

- LoS
- Loss of frame (LF)
- Loss of signaling multiframe
- Loss of CRC multiframe
- Reception of remote alarm signal
- Remote multiframe alarm signal
- Alarm indication signal (AIS)
- Timeslot 16 AIS

### Diagnostics and Loopback Modes

Multiple loopback modes are supported for diagnostics, fault isolation, and network compliance. The Line Interface Unit (LIU) supports five loopback modes. Each port can loopback the incoming signal through the front connector (RJ-45) and the LIU in several ways:

- Local loop—The transmit data and clock inputs from the framer are looped back to the receive data and clock outputs.
- Analog loopback—The receiver inputs from the telco line are disconnected and transmitter outputs are routed back into the receiver inputs.

- Remote loopback—The clock and data recovered from the line inputs are routed back to the line outputs. This mode is customer enabled.
- Network loopback—The clock and data recovered from the line inputs are routed back to the line outputs. This mode detects a loopback data pattern from the input data stream.
- Dual loopback—Two dual loopback modes supported
  - Payload loopback—Will loopback the data stream from the receiver station back to the transmitter section. The looped data will pass the receiver, transmitter, and framers.
  - Line loopback—Will loopback the data stream from the receiver section back to the transmitter section (not including the framers).
- RJ-45 external loopback—An external RJ-45 loopback plug can be used to loopback clocks and data.

Cable Pinouts and Specifications

Male RJ-45 connections are standard for the T1 and E1 versions. The T1/E1 ATM network modules support either 75 ohm (E1 coax), 100 ohm (T1 twisted pair), and 120 ohm (E1 twisted pair) connections. The E1 network modules are designed to transmit and receive 2.048-Mbps signals through both 120-ohm cable and 75-ohm coax cable. A common RJ-45 connector is used for the E1 120-ohm, 75-ohm, and T1 100-ohm.

Table 5 T1 ATM Male RJ-45 Connector Pinouts

| Pin | Signal          |
|-----|-----------------|
| 1   | RX Tip          |
| 2   | RX Ring         |
| 3   | Jumpered ground |
| 4   | TX tip          |
| 5   | TX ring         |
| 6   | Jumpered ground |
| 7   | Unused          |
| 8   | Unused          |

Table 6 E1 ATM Male RJ-45 – 75-ohm BNC Connector Pinouts

| Pin | Signal    |
|-----|-----------|
| 1   | RX signal |

| Pin | Signal                    |
|-----|---------------------------|
| 2   | Tied to RX shield (pin 3) |
| 3   | RX shield                 |
| 4   | TX signal                 |
| 5   | Tied to TX shield         |
| 6   | TX shield                 |
| 7   | Unused                    |
| 8   | Unused                    |

**Note:** Jumper on the E1 ATM network module must be set to 75 ohm mode.

Table 7 Custom Cable Pinout Description

| T1/E1 Board Cable End |           | Network End |                  |           |           |
|-----------------------|-----------|-------------|------------------|-----------|-----------|
| RJ-45                 |           | DB-15       | Null Modem DB-15 | BNC       |           |
| Pin                   | Signal    | Pin         | Pin              | Signal    |           |
| 1                     | RX Tip    | 3           | 1                | RX Tip    |           |
| 2                     | RX Ring   | 11          | 9                | RX Shield | RX Ring   |
| 3                     | RX Shield | 4           | 2                | RX Shield | RX Shield |
| 4                     | TX Tip    | 1           | 3                | TX Tip    | TX Tip    |
| 5                     | TX Ring   | 9           | 11               | TX Shield | TX Ring   |
| 6                     | TX Shield | 2           | 4                | TX Shield | TX Shield |



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