

# Cisco 3600 Series ATM OC-3 Network Modules

## Introduction

In late 1996 Cisco Systems introduced the Cisco 3600 series family of modular, cost-effective, and high-performance dial access routers targeted at regional and branch office and small to medium-sized Internet Service Providers (ISPs). Over the next two years, the Cisco 3600 series announced further extensions to the platform with support for Fast Ethernet, voice/fax over IP, internal digital and analog modems, high-density asynchronous dial, ATM25/ADSL, and High-Speed Serial Interface (HSSI), adding multifunction capabilities to the initial dial-access solutions.

Now, with the announcement of three new versions of ATM OC-3 network modules, the Cisco 3600 series further expands its flexibility as a multifunctional branch office solution for service provider and enterprise customers. These new modules add to the broad portfolio of Cisco ATM Customer Provided Equipment (CPE) and central office products, that allow branch offices to take advantage of the higher bandwidth and quality of service (QoS) available with ATM services. High-speed ATM access on the Cisco 3600 provides cost-effective, value-added, high-speed managed router services to both enterprise and service provider customers.

The new ATM OC-3 network modules address the growing demand for improved ATM QoS features, combined with the advanced Layer 3 class of service (CoS) capabilities provided by a router. Users now have the ability with the Cisco 3600 series to provide robust QoS mechanisms for prioritization of traffic from legacy and high-speed LANs over an ATM network. These new network modules allow the Cisco 3600 series to enter the high-speed ATM access market by providing solutions that enable ATM broadband services to fit into many companies communications budgets, not just the very large corporations. Managers can now cost-effectively terminate high-speed ATM on the Cisco

3600, providing robust QoS features for applications at the branch-office LAN such as videoconferencing, distance learning, video broadcast, and voice/fax over IP over ATM applications.

The OC-3 ATM network modules developed for the Cisco 3600 modular access routers provides a single-port SONET and SDH-based OC-3c/STM-1 interface for worldwide use. These modules are designed to support the convergence of data, voice, and video services that allow customers to migrate existing voice and video traffic onto a corporate data network for substantial cost savings.

Figure 1 Cisco 3600 Series ATM OC-3 Network Modules



Table 1 These ATM Network Modules are Being Introduced

Product Number	Description
NM-1A-OC3MM	Single-Port 155-Mbps ATM OC-3 Multimode Network Module
NM-1A-OC3SMI	Single-Port 155-Mbps ATM OC-3 Single-Mode Intermediate Reach Network Module
NM-1A-OC3SML	Single-Port ATM 155-Mbps OC-3 Single-Mode Long-Reach Network Module

## Features at a Glance

- RFC 1483 support for multiple encapsulations over ATM
- RFC 1577 support for routing over ATM
- ATM service classes: UBR, UBR+, VBR-rt, VBR-nrt, ABR, and CBR (data only)
- ATM Forum UNI 3.0, UNI 3.1, and UNI 4.0
- AAL5 ATM adaptation layer
- Up to 1024 simultaneous Virtual Circuits (VCs)
- Layer 2 per-VC queuing and traffic shaping
- ATM PVCs and SVCs
- Permanent Virtual Paths (PVPs) (up to three)
- LANE 2.0 client and server
- F4 and F5 Operations and Maintenance (OAM) cell support
- ABR SVCs
- MPOA client and server
- Tag Switching (MPLS when approved)
- IETF PPP over ATM
- Next Hop Resolution Protocol (NHRP)
- ATM bandwidth (resource) manager
- Interim Local Management Interface (ILMI)
- ATM UNI 4.0 traffic management
- Frame User to Network Interface (FUNI)

## ATM OC-3 Network Module Features and Benefits

The ATM OC-3 network modules provides robust ATM QoS capabilities of Layer 2 per-VC queuing, bandwidth management, and robust ATM service categories such as UBR+, VBR-rt, VBR-nrt, and ABR. With these new ATM service categories, users have more flexible access to network resources and can achieve a compromise between performance and cost. Additionally, network operators are able to share network resources among different customers and fulfill their needs in a cost-effective manner. Users can now better optimize the application requirements as compared to the network capabilities and can select a specific combination of traffic and performance parameters.

The ATM OC-3 network modules are ideal for connecting directly to ATM Wide Area Network (WAN) at large, remote, branch office sites to a central site via a public or privately owned ATM WAN or for connections to a colocated Cisco ATM switch to provide Integrated Circuit Emulation Service (CES) data, voice, and video support. Voice over IP (VoIP) over ATM applications is supported using the currently available voice/fax network modules and associated voice interface cards. Support is also provided for

other advanced ATM Layer 2 features such as Internet Engineering Task Force (IETF) Point-to-Point Protocol (PPP) over ATM, Tag Switching, multiprotocol over ATM (MPOA), and multilayer switching (MLS) enhancing ATM performance for enterprise and service providers.

These ATM network modules also allow the Cisco 3600 series modular access routers to provide advanced Cisco IOS® features, such as Committed Access Rate (CAR), RSVP, Cisco Express Forwarding (CEF), and Cisco IOS Firewall Feature Set to provide the customer with end-to-end QoS.

The benefits of a high-speed ATM connection from branch office to a regional or corporate headquarters include the transfer of high-speed data and support for new multimedia applications including voice, video, and distance-learning applications. Using an ATM transport allows for application-specific QoS to be used, especially important for the next generation of delay-sensitive multimedia traffic. The integration of VoIP over ATM and data applications over ATM is ideal for delivering low latency, jitter-free voice support due to ATM's support for high transmission speeds, prioritization techniques, and built-in QoS features.

The combination of Layer 2 and Layer 3 QoS features with the Cisco 3600 series ATM OC-3 network modules allows service providers to effectively manage the bandwidth at the edges of the network while implementing value-added Layer 3 services. With advanced traffic-shaping features and support for many ATM service classes (including VBR-rt, VBR-nrt, and ABR), the ATM OC-3 network modules can be effectively deployed as ATM edge router devices in the service provider network.

The Cisco 3600 series with OC-3 ATM network modules can be used by service providers in a Tag Switching environment. Tag Switching enables routers at the edge of a network to apply simple tags to packets, while devices in the core of the network switch packets according to these tags. Switches, such as ATM switches, or existing routers, can perform Tag Switching in the core. These systems will run Tag Switching software, which communicates with tag routers on the edge using a Tag Distribution Protocol. For multiservice networks, Tag Switching enables a Cisco 3600 to provide ATM, Frame Relay, and IP Internet service all on a single platform in a highly scalable way. Supporting all of these services on a common platform provides operational cost savings and deployment ease to multiservice providers.

Cisco IOS VPN features combined with traffic-shaping features are key in ensuring that traffic from one customer does not impact traffic from another. Lower operating costs are provided with the Cisco 3600's central management capabilities. The Cisco 3600 and its interfaces can be managed with CiscoWorks and CiscoWorks2000 Network Management. In addition, by providing support for ATM specific MIBs including RFC 1406, 1595, 1695, and 2233, network managers have control over network statistics and the ability to configure and tune the network for a central location.

Comprehensive debugging tools available in Cisco IOS can substantially reduce time and costs associated with ATM network problem isolation and correction.

### Customer Applications

The following diagrams describe four applications for deployment of high-speed OC-3 ATM network modules for the Cisco 3600 series for integrated data, voice, and video for large branch office, campus edge router, VoIP over ATM, and co-located router with ATM switch solutions.

The OC-3 ATM network modules can be deployed in public or private ATM WANs to support transparent LAN services (TLS) where data rate requirements range between 10 and 80 Mbps.

Figure 2 Directly Connected ATM WAN for Large Branch- and Remote-Office Applications

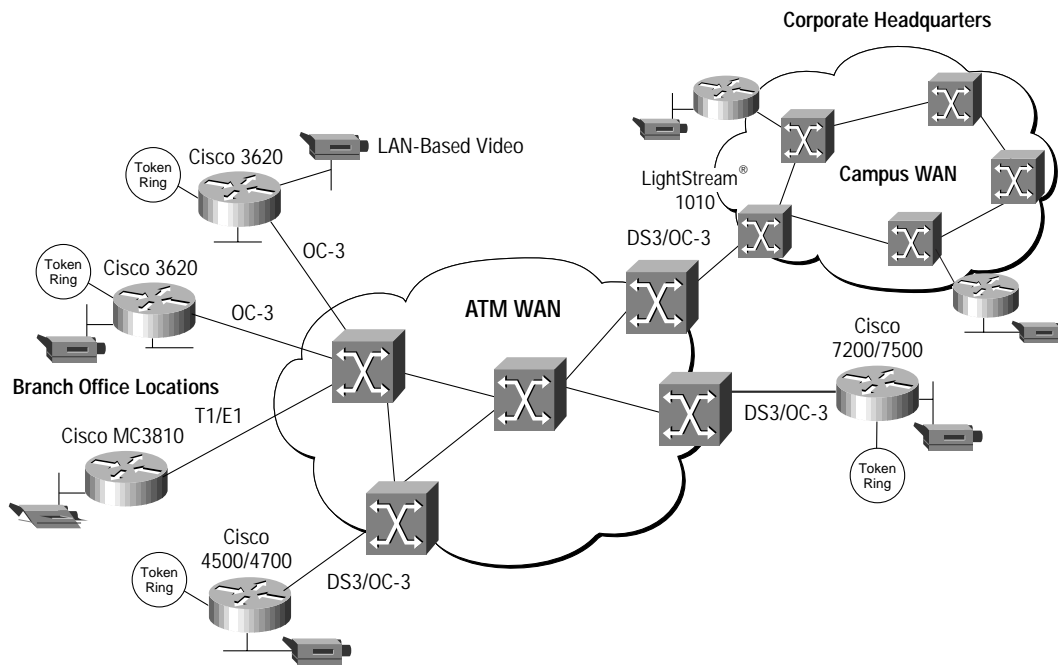
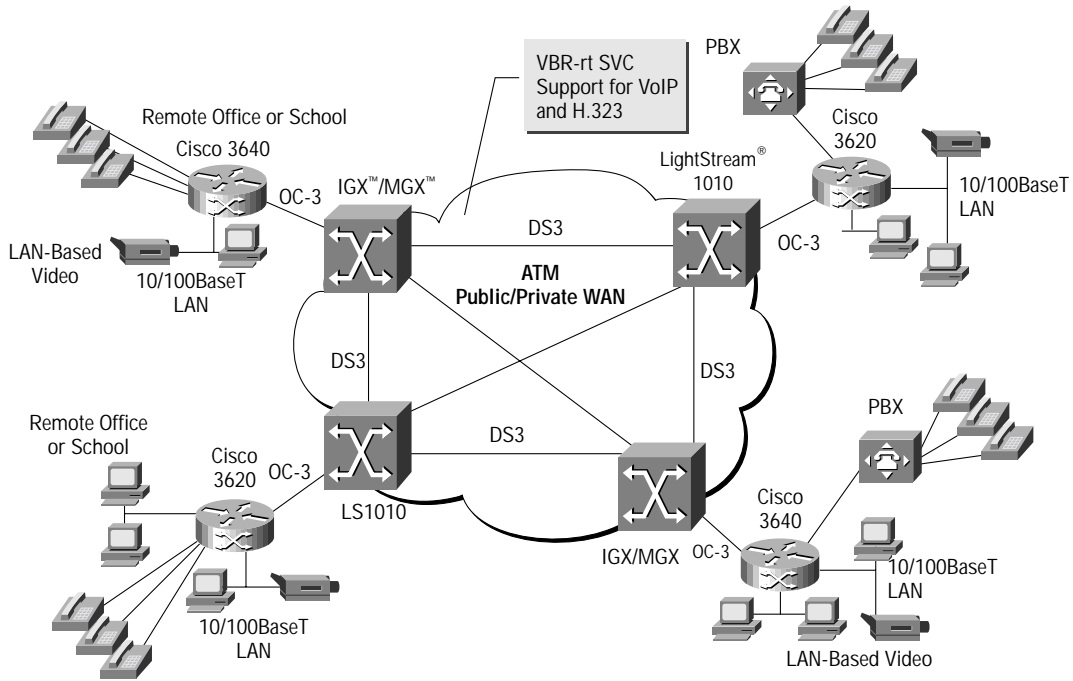
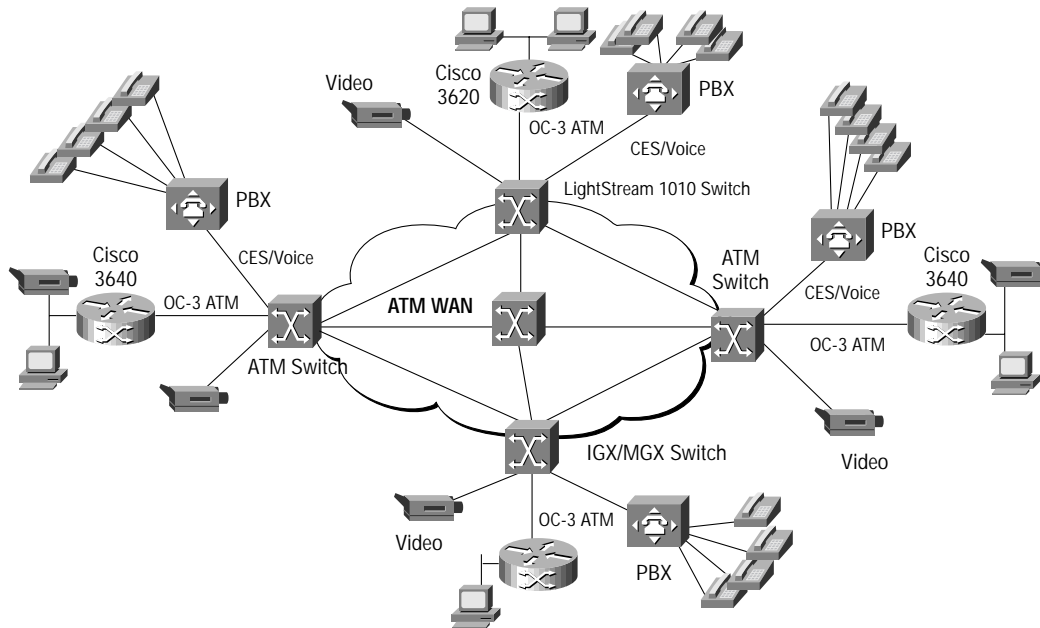


Figure 3 VoIP, Video, and Data Integration Over High-Speed ATM



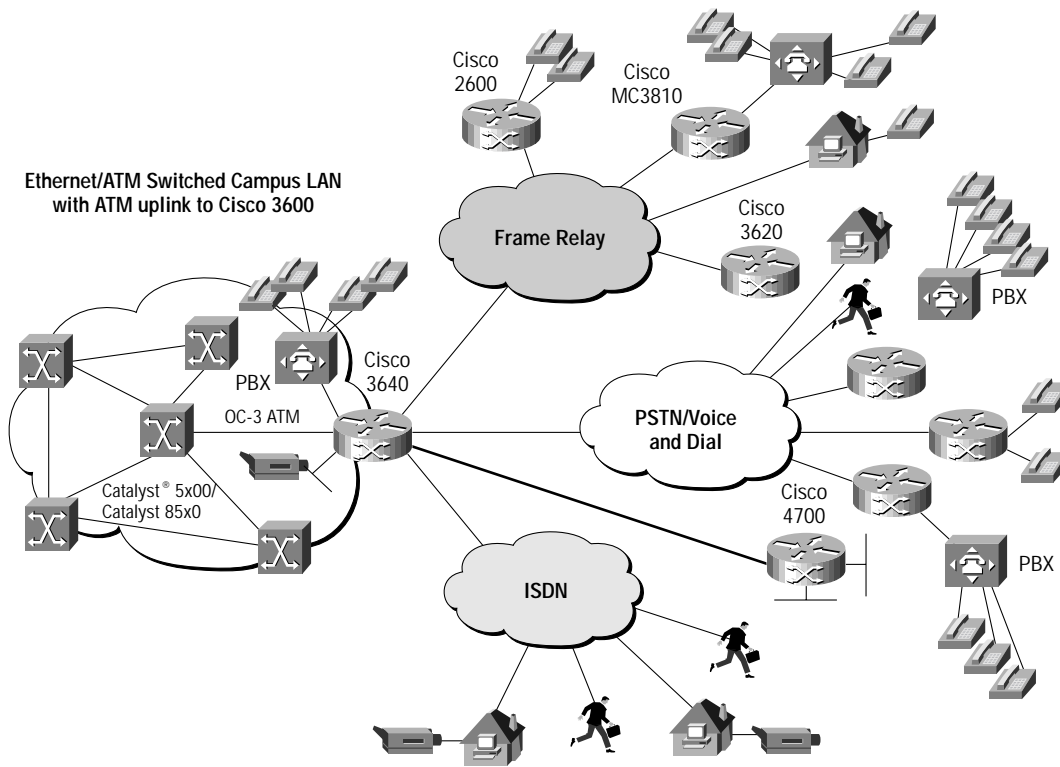
Currently up to 12 voice ports are supported on the Cisco 3640 with an OC-3 ATM configured network module. Voice/Fax over IP over ATM can be supported using VBR-rt CoS SVCs for VoIP and H.323 applications across the ATM WAN.

Figure 4 CES Data, Voice, and Video Integration with Colocated Cisco ATM Switches



When colocated with an ATM WAN switch, the Cisco 3600 with OC-3 ATM interfaces provides legacy and high-speed LAN connectivity, along with ISDN and hybrid dial-access concentration, Frame Relay, PPP, X25, or HDLC access, VoIP, synchronous and asynchronous WAN aggregation, ATM25, or HSSI.

Figure 5 Campus ATM Edge Router Integration of Voice, Dial, and WAN Applications



Positioned on the edge of an ATM or Ethernet-switched network, the Cisco 3600 with high-speed ATM provides the ability to support a wide range of voice and data connectivity options such as ISDN and hybrid dial-access concentration, Frame Relay, PPP, X25, or HDLC access, VoIP, voice over Frame Relay (VoFR), synchronous and asynchronous WAN aggregation, ATM25, or HSSI.

**ATM Traffic-Shaping Feature**

Traffic shaping is a function typically provided on ATM edge devices to ensure that bursty traffic conforms to predefined parameters. Traffic shaping ensures that traffic from one VC does not adversely impact another resulting in data loss. This function is very important when connecting to an ATM WAN or public ATM network; especially when the ATM switches enable traffic policing that will discard all traffic that exceeds the predetermined contract at the ingress of the switch.

The OC-3 network modules support Layer 2 per-VC queuing and implement traffic shaping functionality using UBR, UBR+, VBR-rt, VBR-nrt, ABR, or CBR ATM traffic classes. Each of these service classes has a unique way to shape traffic to specific customer requirements. For each

ATM service class, the ATM OC-3 network modules support highly configurable parameters: peak cell rate (PCR), sustainable cell rate (SCR), maximum burst size (MBS), and minimum cell rate (MCR). These parameters can be defined based on the specific bandwidth requirements of an individual VC as needed for a specific application. Supporting traffic shaping in the hardware means that there is no performance degradation when shaping is enabled.

The Layer 2 per-VC queuing support for ATM traffic shaping has a simple mechanism in place that ensures that one, or a few, VCs do not consume all the transmit resources on the router. This is done by limiting the number of transmit buffers available on a per-connection basis. This prohibits a single VC or VP from oversubscribing all the transmit resources of the interface. The OC-3 network modules have only one transmit queue for all VCs. The minimum configurable bandwidth is 64 Kbps. Even though a contiguous range of bandwidth can be configured, the granularity is limited to 37 Kbps.

### Advanced Bandwidth Management Feature

Advanced bandwidth management mechanisms in the ATM OC-3 network modules architecture allow for the support of bursty, client/server traffic while supporting applications that require guaranteed or best-effort service. The ATM OC-3 network modules' bandwidth management capabilities exceed those of existing ATM interface in midrange routers.

This new feature provides the ability to keep track of the bandwidth used by a VC on a per-interface basis. It prevents the oversubscription of the ATM link and is configurable by the user. Bandwidth Manager for CBR is turned on automatically for all interfaces supporting CBR. All other ATM service categories need to be manually configured. The total bandwidth allocated on the interface is tracked by aggregating the values specified below for each VC. Whenever a new VC is requested, the requested rate is checked against the available rate to ensure the available bandwidth is not exceeded.

### ATM Layer Management

Operations and management (OAM) cells are used for ATM layer end-to-end link management messages. This is necessary to ensure that the remote connection is alive and functioning. Support is provided for both OAM F4 and F5 flows. During segmentation the OAM cells have the highest priority, and will be transmitted ahead of other queued up data. During reassembly, the OAM traffic will be routed to a global OAM receive buffer pool of 512 64-byte buffers.

## Orderability, Availability, Software, and Memory Requirements

Table 2 ATM- OC-3 Network Modules for Cisco 3600 Series Routers

Part Number	Descriptions	Orderable/Available Date	IOS Requirement
NM-1A-OC3MM (=)	Single-Port ATM OC-3c/STM1 Multimode Network Module	March 1999	12.0(3)T Plus feature sets
NM-1A-OC3SMI (=)	Single-Port ATM OC-3c/STM1 Single-Mode, Intermediate Reach Network Module	March 1999	12.0(3)T Plus feature sets
NM-1A-OC3SMI (=)	Single-Port ATM OC-3c/STM1 Single-Mode, Long-Reach Network Module	March 1999	12.0(3)T Plus feature sets

**Note:** no additional DRAM memory is required to support the OC-3 ATM network modules, other than Cisco IOS Release 12.0(3)T Plus specified minimum memory requirements. More detailed information of 12.0(3)T feature set memory requirements are available in the Cisco 3600 series 12.0(3)T Product Specific Release Notes.

## Technical Specifications

### ATM OC-3 Network Module System Requirements

- Only supported on the Cisco 3600 series routers at this time
- Not supported on the Cisco 2600 series
- No slot placement restrictions on either platform
- Maximum recommended on a single Cisco 3640 and Cisco 3620 is one
- Max two high-speed network modules in a Cisco 3640 (includes Fast Ethernet, ATM, HSSI)
- Requires Plus feature sets of Cisco IOS Release 12.0(3)T or above
- Operates in conjunction with all currently available Cisco 3600 network modules and WAN interface cards (WICs)

### Physical Characteristics

- One OC-3c/STM-1 SC type connector per network module
- Support SDH G.707 and G.708 specifications
- 4 LEDs including:
  - Enabled—Network module is seated correctly and is communicating to the bus
  - RCLK—Carrier detect
  - FERF—Far end Rx failure
  - OOF—Out of frame error condition
  - AIS—Alarm indication
- Maximum distance support of 2 km for Multimode, 15 km for single-mode, Intermediate reach, and 45 km for single-mode, long-reach versions.

### ATM Standards Supported

- Multiprotocol encapsulation with support for Logical Link Control/Subnetwork Access Protocol (LLC/SNAP) encapsulation and VC multiplexing (Internet Engineering Task Force [IETF] RFC 1483)
- Classical IP and Address Resolution Protocol (ARP) over ATM; client and ARP server (IETF RFC 1577; IETF RFC 1755; IETF RFC 1626)
- MPOA for IP, Novell IPX, DECnet, AppleTalk Phases 1 and 2, Connectionless Network Service (CLNS), Xerox Network Systems (XNS), and Banyan VINES via IETF RFC 1483
- ATM Forum LAN Emulation (LANE) including LEC, BUS, LES, and LECS
- IETF PPP over ATM
- MPOA
- Tag Switching/MPLS (when approved)

### ATM Services

- ATM Forum UNI 3.0, 3.1 and 4.0 signaling for point-to-point and point-to-multipoint virtual circuits
- ATM Forum UNI 4.0 signaling for ABR SVCs
- ATM Forum ILMI for address prefix acquisition and ATM service address registration with UNI-compliant switches throughout the ATM network
- ATM network service access point (NSAP) E.164 address support
- F4 (virtual path) and F5 (virtual connection) OAM cell segment and end-to-end flows, remote defect identification (RDI), and alarm indication signal (AIS)

### Network Management

- The ATM OC-3 network modules will support the following Management Information Buses (MIBs):
  - MIB II
  - Synchronous Optical Network (SONET) MIB
  - ATM MIB
  - ATM ILMI MIB
  - LANE MIB
  - RFC 406, 1595, 1695, and 2233
- CiscoWorks2000 and CiscoWorks network management integration
- Enhanced setup configuration
- Text-based command-line interface (CLI)

### Positioning

A maximum of one ATM OC-3 network module is recommended on both the Cisco 3640 and 3620. The Cisco 3620 and 3640 will not support full 155-Mbps OC-3 line rates. The actual maximum supported speed ranges between 20 and 80 Mbps, depending on packet size. Layer 2 traffic shaping, bandwidth management, and improved ATM CoS features including UBR, UBR+, VBR-rt, VBR-nrt, CBR, and ABR of the OC-3 ATM network modules on the Cisco 3600 series make it an ideal choice for service providers who want to provide differentiated, end-to-end solutions that combine the performance and traffic management benefits of Layer 2 switching with the intelligence, scalability, and functionality of Layer 3 routing. The Cisco 3600 series ATM OC-3 network modules should be considered in situations where a multiservice platform with VoIP, hybrid dial access with integrated modems, or integrated DSU/CSU functionality is required.

## Summary

The Cisco 3600 is a multifunction platform with the ability to support hybrid dial access, LAN-to-LAN routing, WAN aggregation, multiservice functions, and ATM connectivity in the same chassis. Additional benefits include increased modularity, scalability, investment protection, and flexibility. With the addition of these three new ATM network modules to the Cisco 3600 series modular access routers, companies can extend their investments in Cisco 3600 products and take advantage of the higher bandwidth and QoS features available with ATM services.

## Appendix A

### Cisco 3600 Family Overview, Network Module, and WIC Summary

The following tables detail the range of platforms and current network modules available in the Cisco 3600 series.

Table 3 The Cisco 3600 Platforms

Feature	Cisco 3640	Cisco 3620
Processor Type	100-MHz IDT R4700 RISC	80-MHz IDT R4700 RISC
Flash Memory	4 MB, upgradable to 32 MB	4 MB, upgradable to 32 MB
System Memory	32-MB DRAM, upgradable to 128-MB DRAM	32-MB DRAM, upgradable to 64-MB DRAM
Network Module Slots	4 slots	2 slots
Power	AC, DC, Redundant Power Option	AC, DC, Redundant Power Option
Dimensions	3.44 x 17.5 x 15.75 in. (H x W x D)	1.69 x 17.5 x 14.25 in. (H x W x D)
Performance	50 to 70 Kpps	20 to 40 Kpps
Console and Auxiliary Ports (up to 115.2 kbps)	Yes	Yes
Rack and Wall Mounting	Yes	Yes
Dual Type II PCMCIA Card Slots	Yes	Yes

### The Cisco 3600 Network Modules

Table 4 Cisco 3600 Series Network Modules

Network Module	Description
NM-1A-OC3MM	One-port 155-Mbps multimode OC-3 ATM network module

Network Module	Description
NM-1A-OC3SMI	One-port 155-Mbps single-mode intermediate-reach network module
NM-1A-OC3SML	One-port 155-Mbps single-mode long-reach network module
NM-1ATM-25	One-port ATM 25-Mbps network module
NM-1HSSI	One-port high-density serial interface network module
NM-16A	16-port high-density async network module
NM-32A	32-port high-density async network module
NM-4T	Four-port serial network module
NM-4A/S	Four-port async/sync serial network module
NM-8A/S	Eight-port async/sync serial network module

Table 5 LAN Network Modules and Mixed-Media LAN/WAN Network Modules

Network Module	Description
NM-1FE-FX	One-port Fast Ethernet network module (10/100BaseFX only)
NM-1FE-TX	One-port Fast Ethernet network module (10/100BaseTX only)
NM-4E	Four-port Ethernet network module
NM-1E	One-port Ethernet network module
NM-1E2W	One-port Ethernet, 2 WAN card slot network module
NM-2E2W	Two-port Ethernet, 2 WAN card slot network module
NM-1E1R2W	One-port Ethernet, one-port Token Ring, 2 WAN card slot network module

Table 6 ISDN and Channelized Serial Network Modules

Network Module	Description
NM-1CT1	One-port channelized T1/ISDN PRI network module
NM-1CT1-CSU	One-port channelized T1/ISDN PRI with CSU network module
NM-2CT1	Two-port channelized T1/ISDN PRI network module
NM-2CT1-CSU	Two-port channelized T1/ISDN PRI with CSU network module
NM-1CE1B	One-port channelized E1/ISDN PRI balanced network module
NM-1CE1U	One-port channelized E1/ISDN PRI unbalanced network module

Table 6 ISDN and Channelized Serial Network Modules (Continued)

Network Module	Description
NM-2CE1B	Two-port channelized E1/ISDN PRI balanced network module
NM-2CE1U	Two-port channelized E1/ISDN PRI unbalanced network module
NM-1FE1CT1	One-port 10/100BaseTX Ethernet with one-port PRI/channelized T1
NM-1FE1CT1-CSU	One-port 10/100BaseTX Ethernet with one-port PRI/channelized T1 with integrated CSU
NM-1FE2CT1	One-port 10/100BaseTX Ethernet with two-port PRI/channelized T1
NM-1FE2CT1-CSU	One-port 10/100BaseTX Ethernet with two-port PRI/channelized T1 with integrated CSUs
NM-1FE1CE1B	One-Port 10/100BaseTX Ethernet with one-port PRI/channelized E1 balanced mode (120 ohm)
NM-1FE2CE1B	One-port 10/100BaseTX Ethernet with two-port PRI/channelized E1 balanced mode (120 ohm)
NM-1FE1CE1U	One-port 10/100BaseTX Ethernet with one-port PRI/channelized E1 unbalanced mode (75 ohm)
NM-1FE2CE1U	One-port 10/100BaseTX Ethernet with two-port PRI/channelized unbalanced mode (75 ohm)
NM-4B-S/T	Four-port ISDN BRI network module
NM-4B-U	Four-port ISDN BRI with NT-1 network module
NM-8B-S/T	Eight-port ISDN BRI network module (S/T interface)
NM-8AM	Eight-port analog modem network module
NM-16AM	16-port analog modem network module
MMTL-3600/2600-8	Modem Management Technology License for 8 modems
MMTL-3600/2600-16	Modem Management Technology License for 16 modems
NM-8B-U	Eight-port ISDN BRI with NT-1 network module (U interface)
NM-6DM	Six digital modem network modules
NM-12DM	12 digital modem network modules
NM-18DM	18 digital modem network modules
NM-24DM	24 digital modem network modules
NM-30DM	30 digital modem network modules
MICA-6MOD(=)	Six digital modem upgrade cards

Table 7 Voice Network Modules and Voice Interface Cards (VICs)

Part Number	Description
NM-1V	One voice/fax interface card slot network module
NM-2V	Two voice/fax interface card slot network module
VIC-2FXS	Two-port FXS voice/fax interface card

Part Number	Description
VIC-2FXO	Two-port FXO voice/fax interface card
VIC-2E/M	Two-port E&M voice/fax interface card
VIC-2FXO-M3	Two-port voice interface card—FXO for Australia
VIC-2FXO-EU	Two-port voice interface card— FXO for Europe
VIC-2BRI-S/T-TE	Two-port voice interface card—BRI (terminal)

Table 8 Other

Part Number	Description
<b>PWR600-AC-RPS-NCAB</b>	600W redundant power supply option (requires Cisco 3600 RPS chassis)
<b>NM-COMPR</b>	Compression network module

**WAN Interface Cards**

WAN interface cards are available as daughter cards to the mixed-media LAN/WAN network modules. Up to two WAN interfaces cards can be installed on a single mixed-media LAN/WAN network module. The WAN interface cards are not included in the price of the mixed-media network modules.

Part Number	Description
<b>Serial WIC</b>	
WIC-1T	One-port sync serial
WIC-1DSU-T1	One-port sync serial with build in CSU/DSU
WIC-1DSU-56K4	One-port, four-wire 56-kbps CSU/DSU
<b>ISDN WIC</b>	
WIC-1B-S/T	One-port ISDN BRI
WIC-1B-U	One-port ISDN BRI with NT1



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