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Chapter Two

Cisco Router Hardware

The Cisco router product line has three flavors. Cisco routers are available as modular, fixed or combination configurations. Along with full router configuration Cisco offers router platforms on personal computer (PC) card format. Additionally, Cisco combines routers and small hubs into one device suitable for small office installations. Key to a successful implementation of Cisco routers in a networking environment is proper placement and configuration of the router. Each Cisco router offering is suited for a specific function. These functions are depicted in Figure 2.1 as core, distribution and access. These functional characteristics make up Cisco's router internetwork architecture.

1. Cisco Router Network Architecture

   Early on in the development of internetworks, an architecture emerged. This architecture for deploying routers was documented into an architecture which Cisco employs and preaches to its customer base. The architecture relies on the ability of the processor in the router and its need for processing routes, filters and physical connections. The architecture places the larger Cisco 7x00 series and 12000 series routers at the center or core of the network. The 4x00 series routers are at the net layer of the network architecture called the distribution layer. Finally, the 25xx, 100x, 7x0 and 200 series routers constitute the access layer of the architecture. While these assignments to the three different layers of the architecture make sense it does not mean that 7x00 series routers can not be used as a distribution or access router. Likewise, in some cases the 4500 and 4700 series router platforms may be used as a core or access router. However, the smaller fixed and combination routers are most suited for the access layer and will not perform the physical or logical requirements of the core or distribution routers.

   1. Core

      The routers that comprise the core layer of the architecture are often referred to as the backbone routers. These routers connect to other core routers providing multiple paths over the backbone between destinations. These routers carry the bulk of WAN traffic between the distribution routers. Core routers are usually configured with several high speed interfaces as shown in Figure 2.2. However, the introduction of ATM and interface cards providing up to OC-12 speeds (622Mbps), core routers may only require two physical interfaces. However, as the section on ATM configuration will reveal, multiple subinterfaces are allowed on each physical interface. The need for the core router to manage many high speed interfaces is still a requirement even with only two physical ATM interfaces.

      The use of Packet over SONET is another alternative to proving a high-spped core using Cisco routers. In large WANs and MANs it is common to have the backbone

built on SONET rings with OC-3, OC-12 and OC-48 connections. Packet over SONET allows for the transmission of IP direct over the SONET network without the use of ATM. This provides a great incentive to corporations that have yet to embrace ATM but have a need for high speed and bandwidth over their backbone. Using Packet over SONET as the backbone transport requires an investment in only routers versus ATM which requires investments in routers and switches.

2. Distribution

   The distribution router functions as the main conduit for a location back to the core. As an example, in Figure 2.3, the distribution router acts as a core router for a campus environment but as a distribution router for a building. Or the distribution router may act solely as a distribution router for a region or campus managing only the transmission of data between the core and the access layers.

3. Access

The outer layer of the architecture is the access layer. It is at this layer that end users gain access to the network resources connected by the routers. A typical example for using access routers is in large buildings or campuses. As depicted in Figure 2.4, access routers connect workgroups and/or floor segments within a building to the distribution router. Access routers also provide remote dial-up connectivity for temporary connections.

2. Online Insertion and Removal (OIR)

   Many networks require 24x7 up time. Powering down a router to replace or add new interface cards causes an outage to all the LAN segments and WAN connections. Cisco IOS along with the hardware has implemented a technique to avoid unnecessary downtime called Online Insertion and Removal (OIR).

   1. Supported Platforms

      OIR is specific to the high-end router platforms. The Cisco 7000, 7200, 7500 and 12000 series routers all support the OIR feature. The OIR feature works with all interface processor boards allowing the router power and non-affected interface cards to remain online and functional.

   2. OIR Process

      Removal of an interface processor board is accomplished at anytime. A new interface processor board is installed in the now available slot and the route processor will recognize that a new board has been installed. If the newly installed board is a higher density or replacement board with equivalent interfaces (i.e., Ethernet), the processor board recognizes that the boards are similar in function and automatically configures the interfaces as to reflect the previous board’s configuration. In this way, OIR reduces operator intervention thereby eliminating configuration input errors on the new interface processor board.

   3. Exceptions to using OIR

   OIR is specific to interface processors for all interface types. OIR does not support the dynamic replacement of a route processor, route switch processor, or a network engine processor. Replacing these boards requires that the router be powered off. However, if you are using the 7507 or 7513 series routers and have taken advantage of the High

System Availability (HSA) feature with Route Switch Processors 2 or 4 (RSP2 or RSP4) removes this restriction. HSA enables these router platforms to operate with two RSP boards. By default the RSP installed in the first RSP slot is the system master and the second RSP slot is the system slave. Using HSA it is now possible to remove an RSP for upgrading or for replacement without disrupting the power to the router or interrupting processing the interface processors.

3. Cisco 12000 Series

The 12000 series router platform is built in support of providing gigabit (Gb) speeds across WAN and MAN backbones. The Cisco 12000 series is targeted at scaling Internet and enterprise backbones at speeds up to 2.4 Gbps. This is the aggregate bandwidth of an OC-48 SONET connection. The Cisco 12000 series is optimized for IP only networks and thereby provides a high-speed backbone infrastructure for IP based networks. The ability to handle OC-3 through OC-48 SONET connections enables network engineers to expand the backbone switching capacity with a range from 5 to 60 Gbps. Since the 12000 eries is built for providing core backbone it is designed for maximum uptime and minimal disruption. These features are found in the its architeture for:

- Redundant switch fabric design
- Line card redundancy
- Dual Gigabit Route Processors
- Online software configuration

The speeds of the Cisco 12000 series routers is possible from the synchronized circuitry of two cards. The Clock and scheduler card (CSC) and the Switch Fabric Card (SFC). Both the CSC and SFC provide an OC-12 switching bandwidth between the line cards for the system. Each type of card has a switching capacity of 15 Gbps.

A minimum of one CSC is required in the router. The CSC performs the following functions for the router:

- System Clock - clicking sent to all line cards, GRP and SFCs. It synchronizes data transfer between the various components of the system. In redundant mode the CSC clocks are synchronized for fail over.
- Schedule - The scheduler function handles requests form the line cards and schedules when the line card can have access to the switch fabric.

The Switch Fabric Card provides the following functionality for the router:

- Contains only switching fabric.
- Carries traffic between line cards and GRP.
- Receives scheduling and clocking form the CSC.

The chassis configuration of the Cisco 12000 router comes with an upper cage and lower cage. The upper cage is used mostly for the line cards to connect to the network in addition to the Gigabit Route Processor (GRP) card. The lower cage supplements the ability for the 12000 series router to perform switching by having extra slots for the SFC installs. For more information on the specific cage configurations of the 12000 series router consult the section specific to the model.

The 12000 series comes in three models. These are the 12004, 12008 and 12012.

1. Cisco 12004 Series

The Cisco 12004 series is the smallest of the 12000 line. It provides a total of four interface slots and two slots for Gigabit Router Processors. The 12004 supports all the available interfaces of the 12000 series. The 12004 is usually used in IP SONET backbone networks with minimal connectivity requirements. Typically the 12004 is used for OC-3 and OC-12 interface connections. The 12004 has an IP datagram switching capacity of 5 Gbps. In a single CSC configuration the 12004 supports OC-12 data rates and a 1.25 Gbps switching capacity. Using redundant CSCs in the two center slots of the upper cage and three SFCs in the lower cage the 12004 can support OC-48 data rates with a switching capacity of 5 Gbps. In a redundant GRP configuration the 12004 has two line card slots available for network connectivity.

2. Cisco 12008 Series (picture h7689.gif 7691.gif 7690.gif)

   The Cisco 12008 can switch IP data grams in the range of 10-40 Gbps. Minimal configuration requirement for the Cisco 12008 are the presence of a single GRP and a single Clock and scheduler card (CSC). As shown in Figure 2.5 the CSC must be placed in either of the two center slots in the upper cage of the 12008. A second CSC may be placed in the open CSC slot for redundancy. The GRP may be placed in any of the remaining slots. A second GRP may be installed for redundancy in any of the remaining slots. Using redundant GRPs leaves 6 available slots for line card connectivity to the network. The lower cage houses the three optional slots for used by SFCs.

   Installation of a second CSC does not increase the switching capacity but provides redundancy. The addition of the three SFCs enables the router to move from an OC-12 with a switching capacity of 10 Gbps to support of an OC-48 data rate with switching capacity to 40 Gbps with full redundancy should either CSC fail or a single SFC fail.

3. Cisco 12012 Series (h11017 h10476)

   The Cisco 12012 has the capacity to switch IP datagrams anywhere from 15 to 60 Gbps. The increase in interface density of the 12012 is created by expanding the lower cage. The lower cage of the 12012 contains five keyed slots for placing the CSC in slots 0 or 1 and the SFCs in slots 2-4. The GRP is still installed in the upper cage. In a redundant GRP configuration there are 10 open line card slots for network connections. The single CSC configuration supports OC-12 data rate and a capacity of 15 Gbps switching. A redundant CSC configuration with three SFCs installed enable the 12012 to support OC-48 data rates and a switching capacity of 60 Gbps.

4. Usage

The 12000 series is placed at the very core of the network. Since it is optimized for IP traffic it must be designed that IP traffic only flows through these routers. For example, in a network that is based on IP and SNA the SNA data must be transported using RSRB or DLSw+ with TCP or FST encapsulation techniques. In this manner, the high speed backbone can be used for connecting remote locations to the main data centers. Likewise, using Voice over IP the router or PBX must encapsulate the voice data into IP prior to delivering it to the 12000 series backbone routers. Based on this type of usage the 12000 series is ideal for:

- ☐ Internet service providers (ISPs)
- ☐ Carriers providing Internet services and utilities

- Competitive access providers (CAPs)
- Enterprise wide-area network (WAN) backbones
- Metropolitan-area network (MAN) backbones

1. Switch Processors (h10547 h10548

   The Cisco 12000 Gigabit Route Processor is based on the IDT R5000 Reduced Instruction St Computer (RISC) CPU. This processor has an external bus clock speed of 100MHz and an internal clock speed of 200 MHz. All the models of the Cisco 12000 series routers use the same GRP card. The GRP may be installed in any slot of the 12012 except for the far right slot. This is reserved for the alarm card. Normal practice is to install the first GRP in the far left slot. On the 12008 the GRP may be installed in any availabel slot of the upper cage except for the two center slots. These are reserved for the Clock and Scheduler Cards.

2. Memory

   Each GRP comes with a base of 64 MB of dynamic random-access memory (DRAM) which is upgradeable to 256MB of parity-protected extended data output (EDO) DRAM. The DRAM is provided in two dual in-line memory module (DIMM) format running at 60 nanoseconds (ns). The GRP uses the DRAM for storing systems software (Cisco IOS), configuration files, and line card routing tables. The Cisco IOS runs from DRAM. Table 2.x lists the DRAM socket locations and DRAM configuariotns for upgrading from 64 MB to 256MB.

Total DRAM	DRAM Socket	Number of DIMMs
64 MB	U39 (bank 1)	1 (64 MB DIMM)
128 MB	U39 (bank 1) and U42 (bank 2)	2 (64 MB DIMM)
128 MB	U39 (bank 1)	1 (128 MB DIMM)
256 MB	U39 (bank 1) and U42 (bank 2)	2 (128 MB DIMM)

   Table 2.x: DRAM update configurations.

   In addition to DRAM the GRP also includes Static RAM (SRAM) and Non-volatile RAM (NVRAM). The SRAM provides 512KB of secondary CPU cache memory functions. The SRAM can not be configured by the user nor can it be upgraded in the field. The SRAM is primarily a staging area for routing table updates to and from the line cards. The NVRAM stores router configurations, system cache information and read only memory (ROM) monitor variables in 512 KB. Information stored in NVRAM is available even after the router loses power. SRAM and DRAM lose the information stored within them. Like SRAM the NVRAM can not be configured by the user nor can it be upgraded.

   The GRP also utilizes flash memory. There is 8 MB of single inline memory modules (SIMM) on the GRP for storing Cisco IOS software images as well as saving router configurations and other type of end user files. Additionally, the only board flash memory can be coupled with the ability to use 20 MB PCMCIA flash memory cards that install on two slots on the GRP with a total capacity of 40 MB. Each card can be used for storing Cisco IOS software images and other files

required by the router for operation.

For operational support the GRP enables remote access to the Cisco 12000 router through either an auxiliary dial-up port in an IEEE 802.3 10/100 Mbps Ethernet port for Telnet connections. In addition the GRP has an RS-232 console port connection for direct serial connectivity form a PC to the router.

The GRP can be installed in any of the slots available in the upper cage of the Cisco 12000 series routers. The exception to this is the Cisco 12012 where the GRP can not be installed in the far right slot. This slot is reserved for the alarm card.

3. Line Cards

Each line card is comprised of several functions equivalent on each card. The line card uses for burst buffers to prevent packet dropping when there is an instantaneous increase in back-to-back small packets queued for transmission. Burst buffers increase throughput and maintain an even packet burst for packets arriving on Layer 3 switch processing.

Each line card contains two silicon queuing engines one for receive and one for transmit. The receiving engine moves packets form burst buffers to the switch fabric. The transmit moves the packets from the switch fabric to the transmit interface. The silicon engines also manages the movement of IP packets in buffer memory. Buffer memory defaults to 32 MB split evenly between receive and transmit buffers. The amount of buffer memory in use is configurable up to 64 MB for receive and 64 MB for transmit.

An application-specific integrated circuit (ASIC) is used for supporting the high-speed process required to perform layer 2 switching. To assist in the decision making an IDT R5000 200 MHz RISC processor is on the line card to make forwarding decisions based on the Cisco Express Forwarding table and the Layer 2 and Layer 3 information in the packet. The GRP is constantly updating the table based on information gathered from the routing table.

The line card also contains a switch fabric interface. This is the same 1.25 Gbps full-duplex data path used by the GRP. When a packet is on the proper queue the switch fabric requests the CSC for scheduling the transfer of the packet across the switching fabric.

There is also a maintenance bus module on the line card that provides the master Mbus module of the GRP with requested information. The type of information reported in temperature, and voltage. In addition the Mbus on the line card stores the serial number, hardware revision level and other pertinent information about the card in EEPROM.

In addition each line card maintains the Cisco Express Forwarding (CEF) table. The table is built on routing table information provided by the GRP and is used to make forwarding decisions.

There are six available line cards for connecting the 12000 series router to the network. These are:

- Quad OC-3c/STM-1c Packet-Over-SONET (POS) (h10781.gif)
- Quad OC-3 ATM Line Card
- OC-12c/STM-4c Packet-Over-SONET (POS)
- OC-12c/STM-4c Asynchronous Transfer Mode (ATM)
- OC-48c/STM 16 Optical IP Interface Card
- Channelized OC-12 Line Card

The Quad OC-3c/STM-1c Packet-Over-SONET (POS) is shown in Figure 2.6

. The card has four ports for interfacing directly to the SONET providers equipment. The Quad OC-3c/STM-1c Packet-Over-SONET (POS) line card must be ordered for either single mode or multimode SC fiber connection. Each mode supports full-duplex transmission. The card uses for 128 KB burst buffers to prevent packet dropping when there is an instantaneous increase in back-to-back small packets queued for transmission.

The Quad OC-3 ATM Line Card shown in Figure 2.7 (h10781) performs ATM segmentation and Reassembly functions for ATM connectivity. Segmentation is the process of converting packets to ATM cells. Reassembly is the process of converting ATM cells to packets. The Quad OC-3 ATM Line Card can handle up to 4000 simultaneous reassemblies of an average packet size of 280 bytes. To perform this ability the Segmentation and Reassembly is performed on ASIC. The ASICs also allow each of the four ports on the Quad OC-3 ATM Line Card to support 2000 active virtual circuits. The card must be ordered as either single mode or multimode fiber connection. The Quad OC-3 ATM Line Card supports a burst buffer of 4 MB.

The OC-12c/STM-4c Packet-Over-SONET (POS) illustrated in Figure 2.8 (h10782.gif) has a one duplex SC single- or multimode fiber connection. The port supports OC-12c at 622 Mbps data rate. The OC-12c/STM-4c Packet-Over-SONET (POS) has a burst buffer of 512 KB.

The OC-48c/STM 16 Optical IP Interface Card shown in Figure 2.9 (15424.gif) a single duplex SC or FC single mode fiber connection. The top port is the transmit (TX) connection and the bottom port is the receive (RX) connection. The interface supports a full 2.5 Gbps optimized for transporting packet over SONET (POS). The burst buffer on the OC-48c/STM-16 Optical Interface Card is 512 KB with a default buffer memory of 32 MB for receive and 32 MB for transmit. Cisco IOS software Release 11.2(14)GS1 and line card microcode Version 1.14 is required for complete support of all features. The typical maximum distance the line card can sustain is 1.2miles or 2 kilometers.

The Channelized OC-12 Line Card shown in Figure 2.10 (11704.gif) supports only single mode full-duplex SC connections at 622 Mbps. Its burst buffer size is 512 KB. The forwarding processor on the Channelized OC-12 Line Card is an IDT R5000 RISC processor rated a 250 MHz.

1. Software Support

The Cisco IOS software for the Cisco 12000 series routers is optimized for transporting IP traffic. The first release of Cisco IOS supporting the Cisco 12000 series platform is the 11.2 release. The Cisco IOS Release 11.2 supports the following IP IOS functions:

- Routing Protocols

Interior: RIP, OSPF, IS-IS, ISO/CLNP, EIGRP, EGP

Exterior: BGP

- Routed Protocols

TCP/IP, UDP/IP

- BGP4 Support

Route Reflections

MED (Multi-Exit Discriminators)

Communities

DPA (Destination Preference Attribute)

Flat/Weighted Route Dampening

Confederations

Next Hop-Self

GP Multipath

Static Routing (IGP)
- Management

SNMP, Telnet, MIB II

1. Cisco 7500 Series

   The Cisco 7500 series router is the high-end routing platform for supporting corporate enterprise wide networks as well as a keystone for the Internet backbone itself. The port capacity and available interface types enable the 7500 to serve all layers of Cisco's routing architecture. The speed with which the 7500 series processes packets between the various interfaces is the use of high-speed bus architectures.. The architecture is called the Cisco Extended Bus (CyBus). The CyBus supports any combination of interface processors on the 7500 series platform. The CyBus ahs an aggregate throughput of 1.067Gbps. The 7500 series encompasses three models: Cisco 7505, Cisco 7507 and the high-end of the platform is Cisco 7513. Each model has a specific location for the RSP boards. The 7500 series platform supports fifteen different feature sets. These feature sets along with other characteristics of the 7500 series platform are found in Appendix B.

   1. Cisco 7505 Series

      The 7505 series is the smallest platform of the 7500 line. It supports four interface processors and one RSP board. Figure 2.11 depicts the platform format for the 7505. The 7505 comes with a single CyBus for attaching the interface boards to the RSP. The 7505 series supports RSP1 and RSP4. The single power supply offered on this platform makes the 7505 series a choice for locations with low availability requirements but with high throughput requirements and the need for varied interface support.

   2. Cisco 7507 Series

      The Cisco 7507 series router platform from Cisco expands the interface combination possibilities by providing five slots for interface processors as shown in Figure 2.12. The 7507 series provides a higher reliability through the use of a second power supply and dual RSP boards. The redundant configuration for the 7507 series enables it to reliably serve as a core or distribution router. The 7507 series uses either an RSP2 or RSP4. The RSPs used in a dual RSP configuration (HSA) should however be the same RSP platform. Added to the higher availability architecture of the 7507 is the use of a dual CyBus architecture. This architecture not only enables recovery should a bus fail, the architecture allows both buses to be used simultaneously allowing higher throughput than on the 7505 series.

   3. Cisco 7513 Series

      The Cisco 7513 is the high capacity 7500 series router platform from Cisco. This series provides two RSP slots for HSA and eleven interface processor slots, ash shown in Figure 2.13, to support any combination of network interface

requirements. The 7513 series also supports the dual CyBus architecture and allows for two power supplies. Both RSP2 and RSP4 processors are supported on the platform. The 7513's high capacity for interfaces makes it a useful platform for multiple LAN segment interfaces in a large environment along with using the interface combination possibilities to serve as a core, distribution or access router.

4. Usage

   The 7500 series is quite versatile and provides the functionality of core, distribution and access layers. Figure 2.14 illustrates the various functions and configurations found in a typical network infrastructure. The 7505 is used as a low availability access router servicing a casual end user site supporting multiple LAN interfaces. A site of this nature is usually autonomous with processing done locally for the majority of the time.

   The 7507 series servicing the remotes performs the functions of the distribution and access layers. The 7507 features are useful in access locations where there are many different types of interface requirements, many LAN segments and supports high volume of data from the site to the WAN. As a WAN distribution router, the 7507 connects many of the remote access locations without going to the core routers. The 7513, as indicated earlier, is suitable for all the three layers of the router networking architecture. In Figure 2.14, the 7513 is illustrated as a core routing platform. In this example topology, the 7513 connects the core routers using an ATM backbone, the distribution routers with frame relay. Also note that the 7513 may feed other locations within its own building using FDDI and Ethernet.

5. System Processors

   The Route Switch Processor (RSP) platform used on the 7500 series router is a combination of the router processor (RP) and switch processor (SP) originally used on the Cisco 7000 series router platform. Combining the functionality of the RP and SP into one board enables the RSP to switch and process packets faster and allows each platform to gain an extra slot for an interface processor. There are three types of RSP platforms. The base platform of each RSP type comes with 32MB of DRAM and 8MB of Flash SIMM memory. The 7500 series uses the Flash SIMM for storing and loading the Cisco IOS BOOT images necessary for the RSP to activate prior to executing any other functions. The DRAM is upgradeable from 32- to 64- to 128MB of DRAM with Flash memory upgrades using PCMCIA cards in up to two slots totaling 40MB. Each RSP comes with 128KB of Non-Volatile RAM (NVRAM) to store the IOS system running and startup configuration files.

   RSP1

   The RSP1 is the default RSP on the 7505 series router. It is only available on the 7505 router. The RSP1 stores the Cisco IOS image in Flash memory on the RSP or on up to two Intel Series 2+ Flash memory PCMCIA cards. The RSP1 has an external clock speed (bus speed) of 50MHz and internal clock speed (CPU speed) of 100 MHz.

   RSP2

   The RSP2 is the base RSP board supplied for the 7507 and 7513 series routers.

The RSP2 operates at an external clock speed (bus speed) of to 50MHz and an internal clock speed (CPU speed) of 100 MHz. The RSP2 platform of the RSP system processors supports the High System Availability (HSA) features. Using two RSP2 system processors, the 7507 and 7513 provide for RSP failure recovery as the slave takes over for the master if the master should experience an outage. The default for identifying the system master is the RSP2 occupying slot2 on the 7507 and slot6 on the 7513 router. The order is configurable but it is highly recommended that the defaults be taken when using HSA. A caveat to using HSA is Cisco IOS Release 11.1(5) or higher and ROM monitor version 11.1(2) or higher. Each RSP2 must have the same version of ROM monitor installed for HSA to function properly.

RSP4

The RSP4 platform of the RSP system processors is available for the three 7500 series platforms. Its external clocking speed (bus speed) is 100 MHz and supports an internal clocking speed (CPU speed) of 200 MHz. The RSP4 uses DIMM chip sets for DRM memory. As such, the RSP4 DRAM configuration is 32-, 64-, 128- or 256MB. AN enhancement to the RSP4 over the RSP1 and RSP2 is the use of static RAM (SRAM) for packet buffering and a secondary cache memory for CPU functions. The RSP4 supports any type of PCMCIA flash memory card for flash memory. PCMCIA card formats come in three types. PCMCIA Type 1 and 2 and usable in slot 0 and slot 1. Type 3 PCMCIA flash memory cards are only supported in slot 1 of the PCMCIA slots for the RSP4. Like the RSP2, the nRSP4 supports HAS. Support for HAS on the RSP4 is dependent to the level of Cisco IOS and ROM monitor. HAS is fully supported on the RSP4 using Cisco IOS release 11.1(8)CA1 and ROM monitor version 11.1(8)CA1 and higher.

6. Memory

Memory on the RSP and any interface processor is paramount to efficiently running the routers. The more the better. It does not hurt to order the highest amount of memory available for any platform as an inexpensive insurance policy against poor design or "memory leaks" from the IOS or microcode software. That aside, the 7500 series platform comes with DRAM memory size recommendations based on the number of IP routes in a network. Cisco categorizes network sizes into the following:

- Small networks – less than 2,000 IP routes
- Medium networks – between 2,000 and 10,000 IP routes
- Large networks – greater than 10,000 IP routes

The for the RSP1, RSP2 and RSP4 system processors on each on the 7505, 7507 and 7513 router platform the DRAM memory requirements are recommended to be:

- Small networks – 32MB
- Medium networks – 32MB
- Large networks – 64MB

Cisco highly recommends that even if some networks are much smaller than the 2,000 IP routes a minimum of 32MB of DRAM is beneficial for router performance.

The Flash memory PCMCIA cards available for insertion into slot 0 and slot 1 of the RSP boards are available in different memory sizes. The default card comes with 8MB of memory and has a default IOS software image stored. If a spare is ordered or purchased it must first be formatted before use. PCMCIA cards used on RP boards from a 7000 series router must be reformatted for use on the 7500

series router due to a difference in formatting of memory on the different system processors.

1. 7200 Series

   The Cisco 7200 series router is a change in the routing platform architecture for Cisco. The architecture of the interface slots is based on the technology conceived with the Versatile Interface Processor 2 (VIP2) boards from the 7x00 series. Instead of using slots the 7200 series uses port adapters. Figure 2.15 illustrates the adapter layout for the 7200 series router.

   The 7200 series platform is available in two formats. The 7204 supports up to four port adapters while the 7206 supports up to six port adapters. Each platform requires a network processing engine (NPE) and an Input/Output (I/O) Controller processor. The I/O Controller has two slots for PCMCIA flash memory cards and can be optionally configured with a Fast Ethernet interface using an MII connector. Each port adapter supports the OIR function allowing non-interruption of port upgrades or replacements. As found in the 7x00 series the replacement of like-adapters are automatically configured up on insertion.

   The 7200 series uses a peripheral component interconnect (PCI) bus architecture in support of the various network interfaces available using the port adapters. This bus architecture is built on two primary PCI buses and a secondary PCI bus providing a high-speed mid-plane rate of 600Mbps. A second power supply is available for added redundancy enhancing high availability.

   1. Usage

      The 7200 is positioned as a low volume core router or medium distribution router. Network Layer 3 switching support directly supported by the 7200 series makes it an excellent candidate as a distribution router for a large office complex or as a access router for many LAN segments with in the office complex as Figure 2.16 illustrates.

   2. Network Processing Engine

      Maintenance and execution of system management functions are supported by the network processing engine (NPE) on the 7200 series platform. The NPE works with the I/O Controller to monitor environmentals and share in system memory management. There are two versions of the NPE. The NPE-100 maintains an internal clock speed of 100MHz and an external clock speed of 50Mhz. The higher performance NPE-150 uses an internal clock speed of 150MHz and an external clock speed of 75Mhz. In addition the NPE-150 includes 1MB of packet SRAM for storing packets used in fast switching. The NPE requires Cisco IOS software verison 11.1(5) or later for the 7206 and 11.1(6) or later for the 7204.

   3. Memory

   Memory requirements on the 7200 series are dependent on the varied adapter configurations possible with each platform. Appendix C details the memory configuration requirements for the 7200 series platforms. The NPE come standard with 32MB of DRAM. This memory is incremental in 8-, 16- or 32MB SIMMs totaling 128MB. Both the NPE-100 and NPE-150 have a unified cache memory of 512KB as a secondary cache for the Orion R4700 RISC processor.

The I/O Controller for the 7200 series provides NVRAM for the storage of system configurations and logging environmental monitor results. The two PCMCIA slots found on the I/O Controller support the Intel Series 2+ Flash Memory PCMCIA formats. These PCMCIA cards have 8-, 16- or 20MB of flash memory on board. The total available for the two slots combined is 40MB.

2. 7000 Series

The Cisco 7000 series was the original "big" router platform introduced. It was the replacement for the Cisco AGS and AGS+ router platforms. The 7000 platform itself has since been replaced by the 7500 platforms. The Cisco 7000 comes in two platforms as Figure 2.17 depicts. These are the 7000 and the 7010 series. The 7000 has a total of seven slots. Five of these slots are used for interface processors and two for system processors. The 7010 series is smaller and offers a total of five slots. Three of the slots on the 7010 are used of interface processors and the remaining two slots provide support for system processors.

OIR was originally introduced with this platform along with a backplane called the Cisco extended bus (CxBus). The CxBus architecture provided a data bus throughput of 533Mbps on the 7000 series. The 7000 series supports up to two power supplies to enhance availability. However, the series itself does not support the high system availability feature found on the 7500 series platforms.

1. Usage

The 7000 platforms were initially developed primarily as a core router. However, the need for higher port densities and faster processing have moved the 7000 series out of the core and into the role of a small to medium distribution. As shown in Figure 2.18, the 7000 or 7010 is used as a distribution router servicing a minimal amount of access locations.

2. System Processors

On introduction of the 7000 platform Cisco used a Motorola 68040 CPU clocked at 25Mhz.. While this was considered fast for the time it has since been antiquated. The CPU is found on the Router Processor (RP) board. The RP is installed in slot 6 of the 7000 series and slot 4 of the 7010 series. In concert with the RP, the 7000 platform utilized three models of a Switch Processor (SP). These are the Switch Processor (SP) Silicon Switch Processor (SSP) and Silicon Switch Processor–2MB (SSP-2MB). The SP offloaded the responsibility of managing the CxBus from the CPU on the RP board. Thus, allowing the RP to efficiently manage system functions. Further enhancements using a Silicon Switch Engine (SSE) on the SP allowed the SP to examine incoming packet data link and network link header information making an intelligent decision on whether the packet should be bridged or routed and forward the packet to the corresponding interface. The speed of the decision process was enabled by using a silicon-switching cache which kept track of packet information through the router. The SSE is encoded in the SP hardware and in this configuration is called a Silicon Switch Processor (SSP). The SSP performs switching decisions independently of the RP thereby increasing the throughput and efficiency of system resources. The base SSP includes an extra 512KB of memory for handling switching decisions while the SSP-2MB provides an extra 2MB of memory. On the 7000 series the SP, SSP or SSP-2MB is installed in slot 5 and on the 7010 series the SP, SSP or SSP-2MB is installed in slot 3. The configuration for this installation is shown in Figure 2.19.

Extending the life of the 7000 platform was made possible by the introduction of the Route Switch Processor 7000 (RSP7000) and the 7000 Chassis Interface (7000CI) processors. These two boards together give the 7000 platform the enhancements and ability to use the IOS software made for the

7500 router platform. The IOS software must be at IOS version 10.3(9), 11.0(6) 11.1(1) or later to support the RSP7000 processor and the 7000CI processor. The RSP7000 increases the performance of the 7000 platform by using a MIPS Reduced Instruction Set Code (RISC) CPU at 100MHz and a bus speed clocking (external clock) of 50Mhz. Use of the RSP7000 on the 7000 and 7010 series routers enables these platforms to use the Versatile Interface Processor (VIP) technology supported under the 7500 IOS software platform. The 7000CI monitors chassis specific functions relieving the RSP7000 from the following duties:

- ☐ Report backplane and arbiter type
- ☐ Monitor power supply status
- ☐ Monitor fan/blower status
- ☐ Monitor temperature sensors on the RSP7000
- ☐ Provide router power up/down control
- ☐ Provide power supply power-down control

The RSP7000 is installed in slot 5 of the 7000 series and slot 4 of the 7010 series. The 7000CI is installed in slot 6 of the 7000 series and slot3 of the 7010 series. Figure 2.20 diagrams the installation of the RSP7000 and 7000CI on both the 7000 and 7010 series routers.

1. Memory

While both the RP and RSP7000 use the Intel Series 2+ Flash Memory cards, they must be reformatted if used between the two processors. The RP supports one slot for flash memory and the RSP7000 supports two flash memory slots. The RP flash memory PCMCIA card is either 8MB or 16MB. The RSP7000 is available in either 8-, 16- or 20MB formats with a total of 40MB of flash memory.

The RP processor comes standard with 16MB of RAM and is upgradeable to 64MB. The RSP7000 comes standard with 32MB of RAM with expansion to a total of 128MB. Appendix D highlights the various DRAM requirements along with the feature sets available for the 7000 series routers.

1. Cisco 7x00 Series Interface Processors

   The strength of the Cisco router product line is the ability to support the many different LAN/WAN physical interface standards available. The Cisco 7x00 family of routers has a very versatile offering supporting these standards without restricting the combinations possible by mixing and matching the interface processor boards on the chassis. The Cisco 7x00 router platform can actively support any combination of Ethernet, Fast Ethernet, Gigabit Ethernet, Token Ring, FDDI, serial, channelized T3, Multichannel E1/T1, IBM mainframe channel attachment, ATM, Packet OC-3, ISDN, and HSSI interfaces. These interfaces are provided on interface processors that connect physical networks to the high-speed bus of the Cisco 7x00 router. The interface processors are specific to the 7000 and 7500 router platforms. The 7200 router platform uses port adapters which are akin to the port adapters of the Versatile Interface Processor (VIP) available on the 7000 and 7500 router platforms. The VIP and the port adapters supported are discussed in the following section.

   The interface processors are modular circuit boards measuring 11 x 14 inches with network interface connectors. The interface processors all support OIR and are loaded with mircocode images bundled with the Cisco IOS software. The exception to this bundling of microcode is the CIP which is unbundled as of IOS version 11.1(7) and higher. For the most part, each interface processor is self contained on a single motherboard. However, some interface processors require a companion board attached to the motherboard. For example, the AIP board uses a physical layer interface module

(PLIM) which is installed at the factory based on the AIP order.

1. ATM Interface Processor (AIP)

The AIP board supports fiber optic connectivity and coaxial connectivity in support of Asynchronous Transfer Mode (ATM) networking environments. The board also supports single mode and multimode fiber-optic connections. Figure 2.21 illustrates the AIP board with a fiber-optic PLIM. The following lists the media types supported by the AIP board:

- Transparent Asynchronous Transmitter/Receiver Interface (TAXI) multimode fiber-optic
- Synchronous Optical Network (SONET) multimode fiber-optic
- SONET single-mode fiber-optic
- E3 coaxial
- DS3 coaxial

The AIP board can now support up to OC-12 SONET connectivity for high bandwidth and throughput requirements. Each of the media type supported requires a specific cable connection. Appendix E lists all the cable specifications for all the router platforms and their interfaces.

1. Channel Interface Processor 2 (CIP2)

The Cisco Channel Interface Processor 2 (CIP2) is the second generation of IBM mainframe channel connectivity boards offered in support of connecting router networks directly to the mainframe. The CIP2 is a direct competitor to IBM's 3172 Interconnect Controller and the IBM 2216 channel attached router. The CIP2 has memory and processing advantages over the first generation CIP. The CIP2 supports both IBM's parallel bus-and-tag channel and ESCON fiber channel architectures. The CIP2 ships with a default of 32 MB of memory with memory configuration of 64- and 128-MB allocations.

The CIP2 is compatible with the Cisco 7000 series router using Cisco IOS release 10.2(13) or later, 10.3(12) or later, 11.0(10) or later and all versions at 11.1(5) or later. The 7500 series router requires the Cisco IOS release level be at 10.3(13) or later, 11.0(10) or later, and all versions at 11.1(5) or later.

The CIP2 microcode is unbundled from the IOS software as of release 11.1(7) and must be ordered separately from the IOS when installing a CIP2. The microcode supports the following mainframe connectivity features:

- TCP/IP Datagram
- TCP/IP Offload
- CIP Systems Network Architecture (CSNA) connectivity using External Communications Adapter (XCA) communications to VTAM
- TN3270 Server
- Native Client Interchange Architecture (NCIA) Server
- Advanced Peer to Peer Network (APPN)

The CIP2 supports different combinations of channel connectivity to the mainframe. These combinations are configured at the factory and must be ordered appropriately. Figure 2.22 diagrams a CIP2 board with a single parallel channel and single ESCON interface configuration. The valid combinations for the CIP2 interfaces are:

- Single parallel channel
- Dual parallel channel
- Single ESCON channel

- Dual ESCON channel
- Single ESCON channel and single parallel channel

When ordering a CIP2 board it is advisable to determine the number of TCP/IP and SNA connections planned for use by the CIP2. The number of connections directly related to CIP2 performance and memory requirements. While Cisco has memory recommendations and formulas to calculate memory requirements it is advisable to order the CIP2 with the maximum amount of memory, 128 MB, to allow for growth and performance without compromising availability and reliability. Appendix E details the CIP2 memory formulas and minimum requirements.

1. Channelized T3 Interface Processor (CT3IP)

   The CT3IP is based on the VIP2 interface processor architecture. It is a fixed-configuration, meaning that it is not reconfigurable after ordering or installation. The CT3IP supports four T1 connections and a single DS-3 connection as shown in Figure 2.23. The T1 connections use a DB-15 connector and the DS-3 uses a transmit (TX) and receive (RX) female BNC connection pair. The DS-3 connection provides up to 28 T1 channels with each channel viewed as a serial interface to the system. Each channel may then be configured individually. The CT3IP board is supported on the Cisco 7500 series and Cisco 7000 series with the RSP7000 and 7000CI boards only.

2. Ethernet Interface Processor (EIP)

   The EIP supports 10 Mbps Ethernet LAN connectivity. There are three variations of the EIP board supporting either two, four or six 10 Mbps Ethernet 802.3 interface ports. Figure 2.24 diagrams a six port EIP board. Attachment of the EIP interfaces may require a transceiver that converts to 802.3 and attachment user interface (AUI) cable to RJ-45 cable connectivity to a LAN hub or switch.

3. Fast Ethernet Interface Processor (FEIP) and FEIP2

   The interface processor forms support fast Ethernet connectivity at 100 Mbps. The media supported is twisted-pair or fiber-optic cable. The format of the board uses the port adapter architecture found with VIP2 boards, but, the FEIP and FEIP2 port adapters are not interchangeable for use on the VIP2 board or Cisco 7200 series routers. Figure 2.25 illustrates the FEIP and FEIP2 boards. Note that the main difference on the boards is the inclusion f a CPU on the FEIP2. The CPU on the FEIP2 offloads the RSP of switching, filtering and other previously RSP based functions thereby increasing performance on the FEIP2 and the RSP in general.

   Both the FEIP and FEIP2 have configurations that support one or two port adapters. Each port adapter supports a RJ-45 and MII connector. The MII connector in concert with a transceiver supports fiber-optic connectivity. Only one of the interfaces may be active on each port adapter. The RJ-45 supports Category 5 UTP 100BaseTX connectivity. The FEIP supports full- and half-duplex operations on all interfaces in any combination. The FEIP2 only allows half-duplex operations on the 100BaseTX RJ-45 connection. The FEIP2 may operate both 100BaseFX interfaces using either half-duple or full-duplex modes. However, in a configuration where both MII interfaces attach 100BaseFX LANs, only one interface may operate in full-duplex mode. In addition to the use of a CPU on the motherboard, the FEIP2 includes 1 MB of SRAM and 8 MB of DRAM.

The Cisco 7000 series supports the FEIP using 100BaseTX with Cisco IOS release 10.3(5) or later. The Cisco 7500 series supports FEIP 100BaseTX using Cisco IOS software release 10.3(6) or later. Support for 100BaseFX connectivity on the Cisco 7000 and 7500 series using Cisco IOS Release 10.3(13) or later, 11.0 (10) or later and Release 11.1(5) or later.

The FEIP2 board and interface support for 100BaseTX and 100BaseFX connections is found in Cisco IOS Release 11.1(10)CA or later for both the Cisco 7000 and 7500 series routers.

4. FDDI Interface Processor (FIP)

The FIP enables the Cisco 7000 and 7500 router platform to support single mode and multimode FDDI connections at 100 Mbps. Figure 2.26 diagrams the four FIP board configurations. These configurations support:

- ☐ Multimode to multimode with optical bypass
- ☐ Multimode to single-mode
- ☐ Single-mode to multimode
- ☐ Single-mode to single-mode with optical bypass

1. Fast Serial Interface Processor (FSIP)

   The FSIP, as shown in Figure 2.27, uses dual-port port adapters. Each port adapter supports two serial interfaces. Each interface can support up to 6.132 Mbps. The 6.132 Mbps bandwidth is the total allowed for the entire FSIP board. If one or more ports totals a bandwidth of 6.132 Mbps, the remaining ports are not available for use.

   The FSIP supports two configurations. A four interface serial port adapter and an eight interface serial port adapter. The first ports are numbered 0 – 3 and the second are numbered 4 – 7.

2. High Speed Serial Interface(HSSI) Interface Processor (HIP)

   The HIP is capable of supporting up to 52 Mbps bandwidth. The HIP, diagrammed in Figure 2.28, enables data rates up to 45 Mbps (DS-3) or 34 Mbps (E3) for connecting ATM, SMDS, Frame Relay or private lines. The HIP uses a special cable and must be ordered from Cisco for supporting this high speed configuration.

3. Multichannel Interface Processor (MIP)

The MIP, shown in Figure 2.29, is a multichannel multiplexer allowing the router to emulate an Nx64 or Nx56 backbone multiplexer on a 1.536 Mbps (T1) or 2.048 Mbps (E1) line. The MIP supports seven different types of configurations:

- ☐ One E1/PRI port at 75-ohm unbalanced
- ☐ Two E1/PRI ports at 75-ohm unbalanced
- ☐ One E1/PRI port at 120-ohm balanced
- ☐ Two E1/PRI ports at 120-ohm balanced
- ☐ One channelized E1 75-ohm unbalanced or 120-ohm balanced
- ☐ One T1/PRI port
- ☐ Two T1/PRI ports

These configuration allow the MIP to provide varied answers to connectivity requirements. The dual port MIP can act as a dial-on-demand ISDN PRI for high volume locations or be configured through software enabling one port to act as an ISDN PRI line while the other operates as a multichannel multiplexer feeding remote locations.

1. Packet OC-3 Interface Processor (POSIP)

The POSIP board, shown in Figure 2.30, complies with RFC 1619, "PPP over SONET/SDH" and RFC 1662, "PPP in HDLC-like Framing". Using these standards, the POSIP encapsulates packet data using Point-to-Point Protocol (PPP) which is then mapped into an STS-3c/STM-1 frame reducing the transport overhead by approximately fifty percent as compared to using ATM adaptation Layer 5 (AAL5) and line card control (LCC) Subnetwork Access Protocol (SNAP) encapsulations over SONET OC-3 media.

The POSIP interface supports one 155 Mbps port using either single-mode or multimode optical-fiber on Cisco 7000 and 7500 series routers. The Cisco 7000 must have the RSP7000 system processor installed to support the POSIP board. The POSIP has support for the following features:

- ☐ SONET/SDH compliant interface; SONET/STS-3c and SDH/STM-1 framing and signaling overhead
- ☐ Full-duplex operation at OC-3 155 Mbps
- ☐ Intermediate reach optical interface with single-mode fiber
- ☐ Optical interface with multimode fiber
- ☐ OIR

The POSIP board connects the OC-3 optical-fiber network to the CxBus on the 7000 series or the CyBus on the 7500 series routers. The POSIP installs on any available interface processor slot. The POSIP board may be configured with 16 or 32 MB of DRAM and 1 or 2 MB of SRAM. The memory requirements may be upgraded at a later date.

1. Service Provider MIP (SMIP)

Internet Service Providers require speed in delivering packets between the end user community and the Internet. The SMIP functions similarly to the MIP. However, the SMIP does not support multiprotocol routing. Using Cisco IOS Release 10.2(6) or later is requried to support the following SMIP functions:

- ☐ IP routing with PPP or High-Level Data Link Control (HDLC)
- ☐ ISDN PRI connectivity

The SMIP, shown in Figure 2.31, supports three different types of configurations. These are:

- ☐ Two T1 ports
- ☐ Two E1 ports with 75-ohm
- ☐ Two E1 ports with 120-ohm

Note that the SMIP is only optioned with two ports. One port may be used to channelize Nx64 or Nx56 supporting 24 channels on a T1 or 30 channels on an E1. Each channel is configured as its own serial interface. The second port may be used as an ISDN PRI port for ISDN BRI dial connections to the router.

1. Standard Serial Interface Processor (SSIP)

   The SSIP is only optioned with eight high-speed serial ports. The total aggregate

bandwidth supported by the SSIP is 8 Mbps. The dual-port port adapters used on the SSIP are compatible with the FSIP. They are not interchangeable with the VIP2 or 7200 series port adapters. Each port diagrammed in Figure 2.32, when using Cisco IOS Release 10.3(6) or later, supports up to T1 or E1 speeds when using IP routing encapsulated in PPP or HDLC. If multiprotocol routing is required the serial port uses PPP or HDLC encapsulation with speeds at 64 Kbps or less.

2. Token-Ring Interface Processor (TRIP)

   The TRIP connects the Cisco CxBus or CyBus to a token ring network at 4 or 16 Mbps. Each port is connected to a token ring multistation access unit (MAU) suing a DB-9 connector. The TRIP is configurable with either two or four token ring ports. Figure 2.33 illustrates the TRIP board.

3. Versatile Interface Processor 2 (VIP2)

The VIP2, shown in Figure 2.34, is a new generation interface processor board with a high speed RISC MIPS 4700 processor with an internal speed of 100 MHz and a system bus interface speed of 50 MHz. This CPU enables the VIP2 to process all functions on the VIP2 rather than requesting functions from the RSP system processor. This function is available with Cisco IOS Release 11.1 (472) or later, enabling the VIP2 to run the Cisco IOS kernel directly on its own CPU. The 7000 and 7010 series routers must have the RSP7000 and 7000CI system boards installed in order to use the VIP2 features.

The VIP2 is comprised of a motherboard and up to two port adapters or service adapters. Any combination of port or service adapters may be installed on the VIP2 in support of LAN and WAN interfaces and services. Appendix E details the VIP2 models of VIP2 required in support of various port adapter and service adapter configurations.

1. Cisco 7x00 Series Port and Service Adapters

The port and service adapters for the 7x00 series routers are compatible between the VIP2 and the 7200 series router. The 7000 and 7010 series routers must have the RSP7000 and 7000CI system boards installed prior to using the VIP2 board supporting the port adapter and service adapters. The following media and interface types are supported on the entire 7x00 series product line:

- ☐ ATM
- ☐ 100VG-AnyLAN
- ☐ Ethernet 10BaseT
- ☐ 10BaseFL
- ☐ Fast Ethernet 100BaseTX
- ☐ 100BaseFX
- ☐ Token Ring
- ☐ Fiber Distributed Data Interface (FDDI)
- ☐ High-Speed Serial Interface (HSSI)
- ☐ Synchronous serial media
- ☐ Channelized T1/ISDN PRI

The Cisco 7200 series supports all of the above media and interface types along with support for ATM-Circuit Emulation Services (ATM-CES) and ISDN PRI and BRI connections.

1. ATM OC-3

The ATM OC-3 comes in two models as shown in Figure 2.35. The port adapter uses a single-port SC duplex connector to the OC-3c ATM network. It is supported on the full 7x00 series line when used with Cisco IOS Release 11.1(9) CA. The fiber run from the router to the switch may be up to 15 km in length.

2. ATM-Circuit Emulation Services (ATM-CES)

   The ATM-CES is supported only on the 7200 series routers. It supports four T1 CES interfaces and a single ATM trunk for servicing data, voice and video traffic over an ATM WAN using Cisco IOS Release 11.1(11)CA or later. As shown in Figure 2.36, the ATM-CES can support either structured Nx64 Kbps or unstructured 1.544 Mbps circuits. The ATM-CES is optioned with either an OC-3 (155 Mbps) single-mode intermediate reach ATM trunk interface or a DS-3 (45 Mbps) ATM trunk interface.

3. 100VG-AnyLAN

   The 100VG-AnyLAN standard was developed and published by Hewlett-Packard (HP). Its intention is to provide voice, video and data transport over 100 Mbps using Ethernet. The 100VG-AnyLAN port adapter uses a single interface port supporting the IEEE 802.12 specification of running 802.3 Ethernet packets at 100 Mbps over Category 3 or Category 5 UTP cable with RJ-45 terminations. The 100VG-AnyLAN port adapter operates at 120 Mbps using the 5B/6B coding scheme to provide the 100 Mbps data rate at half-duplex. Figure 2.37 depicts the 100VG-AnyLAN port adapter.

4. ISDN Basic Rate Interface (BRI)

   The ISDN BRI port adapter is available only on the 7200 series router. Using an NT1 device, the 7200 ISDNBRI port adapter connects using either one or both of the two B channels (64 Kbps) in full-duplex mode observing an aggregate rate of 128 Kbps. The single D channel on the BRI is also available at a full-duplex data rate of 16 Kbps. Figure 2.38 illustrates the two models available for the 7200 series router. The port adapters are available in either 4 or 8 ISDN BRI ports. The 4 port ISDN BRI port adapter connect switch a U interface while the 8 ISDN BRI port adapter uses an S/T interface to the NT1 device.

5. Channelized T1/E1 ISDN PRI

   The channelized port adapters from Cisco support T1 (1.544 Mbps) and E1 (2.048 Mbps) line speeds with the ability to connect using ISDN PRI standards. Each port adapter is available with one or two interfaces. The channelized E1/ISDN PRI port adapter is available with unbalanced 75-ohm or balanced 120-ohm connections. Figure 2.39 illustrates the channelized T1/E1 ISDN PRI port adapter.

6. Ethernet 10BaseT

   The IEEE 802.3 Ethernet 10BaseT standard is supported using wither four or eight interfaces. Each interface runs at wire speed of 10 Mbps thereby providing an aggregate bandwidth of 40 Mbps for the four port and 80 Mbps for the eight port. The Ethernet 10BaseT port adapter, depicted in Figure 2.40, is available on the entire Cisco 7x00 router platform.

7. Ethernet 10BaseFL

Support for 10 Mbps Ethernet over fiber-optic media is provided by using the 10BaseFL port adapter. The port adapter has up to five interfaces using the IEEE 802.3 Ethernet 10BaseFL standard running at 10 Mbps each in half-duplex mode with an aggregate bandwidth rate of 50 Mbps. The interfaces, as shown in Figure 2.41, uses a pair of multimode S/T receptacles one for receive (RX) and one for transmit (TX) both at wire speed. The Ethernet 10BaseFL is supported across the Cisco 7x00 router platform.

8. Fast Ethernet

   The Cisco Fast Ethernet port adapters support full- and half-duplex operation at 100 Mbps. This port adapter is available on all the Cisco 7x00 router platforms and comes in two models.

   In support of twisted pair media, the Fast Ethernet port adapter provides a single 100BaseTX port for connection to Category 5 UTP media using an RJ-45 connection. The 100BaseTX port adapter, shown in Figure 2.42, may also connect to Category 3, 4, and 5 UTP or STP for 100BaseT4 media using the MII interface. Additionally the 100BaseTX Fast Ethernet model may connect to multimode fiber for 100BaseFX media using the MII interface through external transceivers.

   Connectivity to fiber-optic media is also available using the 100BaseFX Fast Ethernet port adapter. The 100BaseFX port adapter, shown in Figure 2.43, connects to fiber-optic media in one of two ways. The 100BaseFX may use SC fiber-optic connectors or use external transceivers to multimode fiber through the MII interface. Additionally, the 100BaseFX Fast Ethernet port adapter allows connectivity to 100BaseT4 networks through the MII interface over Category 3, 4, and 5 UTP or STP media.

9. Synchronous Serial

The synchronous serial port adapter comes with four interfaces. Each interface must be alike and supports the following electric standards:

- ☐ EIA/TIA-232
- ☐ EIA/TIA-449
- ☐ EIA-530 X.21
- ☐ V.35

The interfaces support either DCE or DTE terminations depending on the type of cable connected to the interface. The synchronous serial port adapter depicted in Figure 2.44 is available on the Cisco 7500, 7000 and 7200 series routers.

1. Single Port Molex 200-pin receptacle

   The Molex 200-pin receptacle supports a wide variety of synchronous serial interfaces. Each Molex receptacle interface provides up to eight synchronous serial interfaces using a special cable designed for supporting the desired electrical interface specification. The Molex runs full-duplex mode supporting either 1.544 Mbps (T1) or 2.048 Mbps (E1) speeds for V.35 and X.21 interfaces. Support for EIA/TIA-232 interfaces allows up to eight ports operating full-duplex mode at 64 Kbps. Figure 2.45 illustrates the 200-pin Molex receptacle. These port adapters are available on the 7x00 family of routers.

2. Synchronous Serial E1-G.703/G.704

   The E1-G.703/G.704 serial interface is an International Telecommunication Union Telecommunication (ITU-T) standard for serial line speeds of 2.048 Mbps on E1 lease lines. The port adapter supports up to four synchronous serial interfaces framed and unframed service. The interfaces are ordered with eight unbalanced 75-ohm or balanced 120-ohm. Figure 2.46 diagrams the Synchronous Serial E1-G.703/G.704 port adapter.

3. Token Ring

   The Token Ring port adapter provides up to four IEEE 802.5 token ring interfaces at either 4 or 16 Mbps. The port adapter is available on the 7x00 family of routers and comes in two models. A half-duplex and full-duplex model. The full-duplex model realizes an aggregate speed of 32 Mbps. Figure 2.47 illustrates the token ring port adapter.

4. FDDI

   The FDDI port adapter comes in two flavors: half-duplex and full-duplex. Each of these flavors is available with two multimode or single-mode interfaces at a maximum bandwidth of 100 Mbps per port. Each port adapter supports the optical bypass switching capability. Figure 2.48 diagrams the single and multimode FDDI port adapters. The full-duplex option enables the FDDI port adapter to realize and aggregate speed of 200 Mbps per port. The FDDI port adapters are available for all the Cisco 7x00 family of routers.

5. HSSI

   HSSI port adapters are configurable with either one or two HSSI interfaces. Each interface uses the EIA/TIA 612/613 high speed standard to provide T3 (45 Mbps), E3 (34 Mbps) and SONET STS-1 (51.82 Mbps) data rates. Figure 2.49 illustrates the HSSI port adapter which is available on all Cisco 7x00 routers.

6. Compression Service Adapter

Bandwidth for many installation is a valuable asset. Compressing data prior to transmission enables routers to transmit fore information than would be allowed without compression. The Compression Service adapters off-load compression and decompression functions from the host processor for inbound and outbound traffic over channelized E1/ISDN PRI, channelized T1/ISDN PRI, BRI ISDN and synchronous serial port adapters. Figure 2.50 diagrams the two models for the compression service adapters.

The first model has 786 KB of memory enabling it to handle compression/decompression for up to 64 WAN links. The second model is configured with 3 MB of memory in support of 256 WAN links. Both models of the compression service adapter are available on the entire Cisco 7x00 family of routers.

1. 4000 Series

The Cisco 4x00 router platform is based on the use of network processor modules (NPM). Using the NPMs a 4x00 router can combine many different types of interface connections in support of various networking requirements. The 4x00 series router platform is available in three models. Each model looks identical as depicted in Figure 2.51, with different interface support and processing power. The

models 4000-M, 4500-M and 4700-M can mix and match the NPMs using the three available slots. The low-end 4000-M model supports the following NPMs:

- Ethernet
- Token Ring
- FDDI
- Serial
- ISDN BRI
- Channelized E1/T1 ISDN PRI

The higher-end 4500-M and 4700-M routers support the following network interfaces in any combination using the three available slots:

- Ethernet
- Token Ring
- FDDI
- HSSI
- High-density serial
- ISDN BRI
- Channelized E1/T1 ISDN PRI
- ATM OC-3c
- ATM DS-3
- ATM E3

The NPMs available for each router platform come in various port configurations. Though some have multiple ports the 4000 series platform supports full wire speed on each port. Each NPM has the following port configurations:

- 1-, 2-, or 6-port Ethernet
- 1-port Fast Ethernet
- 1 or 2-port Token Ring
- 1-port multimode FDDI (both single [SAS] and dual attachment station [DAS])
- 1-port single-mode FDDI (DAS)
- 2 or 4-port synchronous serial
- 2-port high-speed serial and 16-port low-speed serial
- 4 or 8-port ISDN BRI
- 1-port channelized T1/ISDN PRI
- 1-port channelized E1/ISDN PRI (balanced or unbalanced)
- 4-port serial G.703 and G.704 (balanced or unbalanced)
- 1-port HSSI
- 1-port ATM (single-mode or multimode) OC-3c
- 1-port ATM DS-3
- 1-port ATM E3

Due to the processing of the high-speed NPMs there is a maximum of two high-speed interface available on the Cisco 4500-M and Cisco 4700-M platforms. This means only two of the following NPMs may be installed and operable using the Fast Ethernet, FDDI, ATM-OC3 or DS-3 NPMs. The exception to this is that there can only be one ATM-OC3 NPM configured and operable on the 4500-M or 4700-M routers. Therefore combinations with the ATM-OC3 NPM are either one Fast Ethernet, one FDDI, one ATM-DS3 or E3, and one HSSI. The 4500 or 4700 routers can however be configured with two Fast Ethernet, two FDDI, two HSSI, or one Fast Ethernet and one FDDI, or one Fast Ethernet and one HSSI, or one FDDI and one HSSI. In these types of configuration the remaining slot may be used by the other NPMs as noted. For complete detail of NPM configurations and combinations see Appendix F.

1. Usage

   The 4000 series routers were initially developed as access routers in the Cisco routing architecture. However, as depicted in Figure 2.52, the 4700-M router using the high-speed NPMs may perform the duties of a distribution router as well as an access router.

2. Processors

   The processor vary on each platform. The 4000-M series uses a Motorola 40-MHz 68030 processor while the 4500-M and the 4700-M uses and IDT Orion RISC processor. The Cisco 4500-M router uses a 100 MHz IDT Orion RISC processor while the high end 4700-M platform uses a 133 MHz IDT Orion RISC processor.

3. Memory

Each 4000 series router comes standard with 128 KB of NVRAM which is used to store and recall the router configuration. Main memory on the router is used for executing the Cisco IOS and process routing tables. Shared memory is used to move packets between interfaces and flash memory is used to store router configurations and Cisco IOS code. Since the 4000 series is actually designed for the access layer of the Cisco routing architecture it comes with low base memory.

The 4000-M platform comes with a base of 4 MB of Flash memory expandable to either 8 MB or 16 MB. Main memory on the 4000-M starts with 8 MB and may be expanded to 16 or 32 MB of memory. Shared memory on the 4000-M in earlier models were shipped with 1 MB of shared memory. The newer models are shipped with 4 MB of shared memory. If the 4000-M being used is an earlier model the shared memory must be upgraded to a minimum of 4 MB to support FDDI or have more the five physical or virtual interfaces defined. Shared memory is expandable to 16MB.

The Flash memory support on the 4500-M platform is the same as that found on the 4000-M router. Main memory comes standard at 16 MB and with an upgrade to 32 MB of main memory. The 4500-M router comes standard with 4 MB of shared memory with the option to expand to 8 or 16 MB.

The 4700-M platform also comes standard with 4 MB of flash memory with upgrades to either 8 or 16 MB. Being the high end of the 4000 series platform the 4700-M comes standard with 16 MB of main memory with expansion to either 32 or 64MB of memory to handle large routing tables. Shared memory on the 4700-M is the same as that found on the 4500-M router.

1. 3600 Series

The 3600 series routers is one of the newer modular platforms form Cisco. This router comes in two models the 3640 and the 3620. The 3600 series provides for increased dial-up port density with newer WAN technologies like ATM. One special feature available on the 3600 series is the ability for the operator console and auxiliary console to connect to a local or remote PC at 115.2 Kbps and support for Xmodem or Ymodem protocol for loading the router IOS software directly through these ports versus having to have a network connection.

The 3640 has more port capacity than the 3620 as shown in Figure 2.53. The 3640 is available with four network module slots while the 3620 has two network module slots available. The module slots are used to connect external media to the bus backplane of the router with network module interface cards that mix LAN and WAN media types along with asynchronous and synchronous serial connections and support for ISDN PRI and BRI interfaces.

In support of ISDN PRI connectivity the 3640 installed with a mixed media module and three 2-port

ISDN PRIN network module interface can connect up to 138 T1 or 180 (E1) B channels. This enables the 3640 as a cost effective solutions for corporate telecommuting. Using three 8-port ISDN BRI network interface modules the Cisco 3640 connects up to 48 B channels with local LAN and WAN routing capability.

The port density on the network interface cards enables the 3640 to support up to 24 asynchronous or synchronous serial interfaces for multiple 56 Kbps connections. The 3600 series routers support the following network interfaces:

- 1 and 4 port Ethernet network modules
- 1 port Fast Ethernet network module
- 1 port Ethernet and 1 port Token Ring network module
- 4 and 8 port Asynchronous/Synchronous network module
- 4 port serial network module
- ISDN BRI (ST and U interfaces)
- Channelized T1/ISDN PRI (with and without CSU)
- Channelized E1/ISDN PRI (balanced and unbalanced)

The 3600 series of Cisco routers require Cisco IOS software Release 11.1(7)AA and later or Release 11.2(5)P and later.

The network modules are the cards that slide into the slots of the 3600 series routers as shown in Figure 2.54. The network modules themselves provide various interfaces for connecting external networks to the router bus backplane. Of these network modules one of the more versatile is the mixed-media network module.

The mixed-media network module supports up to two fixed LAN interfaces and two user installable WAN interfaces. The LAN interfaces are a part of the network module itself and cannot be removed. The LAN interface support as illustrated in Figure 2.55 is one of the following:

- 1 Ethernet port
- 2 Ethernet ports
- 1 Ethernet and 1 token ring port

The Ethernet connections support both 10BaseT and AUI interfaces at 10 Mbps. The Token Ring port is either 4 or 16 Mbps using either STP or UTP wiring. The WAN expansion slots on the mixed-media network module supports the following WAN interface cards:

- 1-port ISDN BRI WAN interface card
- 1-port ISDN BRI with NT1 WAN interface card
- 1-port serial WAN interface card
- 1-port 4-wire 56 Kbps DSU/CSU WAN interface card

Each of the WAN network interface cards are shown in Figure 2.56. The Cisco 1600 series routers also supports the Cisco 3600 ISDN BRI, ISDN with NT1 and serial interface cards. The 3600 series router requires Cisco IOS Release 11.2(4)XA, 11.2(5)P or later to properly operate the WAN interface cards ISDN BRI, ISDN with NT1, 1-port 4-wire 56 Kbps DSU/CSU interface cards.

The network modules supporting channelized T1/E1 and ISDN PRI lines are available with a built-in CSU with one or two ports. Figure 2.57 illustrates the various channelized T1/ISDN-PRI and E1/ISDN-PRI network modules available for the 3600 series routers. Using a T1/ISDN-PRI CSU the network module connects directly to the providers network connection. Without the internal CSU the T1/ISDN PRI network module connects to an external CSU which then connects to the provides network connection. The T1 module channelizes the T1 up to 24 virtual channels per T1 port. The

E1/ISDN PRI network module provides one or two E1 ports at 2.048 Mbps second in full duplex transmission. They are configured as either balanced or unbalanced and provide up to 30 virtual channels per E1 port. If the T1/E! modules are configured for using ISDN PRI they are not compatible with the 4 or 8-port ISDN BRI modules. However, when used as a "multiplexer" the ISDN BRI modules are compatible.

The ISDN BRI network modules have four different models. The use of 4 or 8 ISDN BRI ports along with S/T or on board NT1 service for each port define the four different model types as shown in Figure 2.58. The ISDN BRI network modules use local SRAM for buffer descriptor, input queues and configuration storage to increase performance. The performance of the ISND BRI 8-port model is 5,760 packet-per-second (pps) running full-duplex continuous data of 144 Kbps using 50-byte packets. The aggregate full duplex rate of the 8-port ISDN BTI network module is 2.3 Mbps. The ISDN BRI network modules include features to query the network module, SNMP traps for monitoring the network module, manageability with Ciscoworks or CiscoView and support for the ISDN MIB standard.

For more traditional low-speed network connections the 4 and 8-port Asynchronous/Synchronous network modules are available. Figure 2.59 illustrates the two module formats. These network modules support 128 Kbps synchronous connections or 115.2 Kbps asynchronous connections per port. The ports use the DB-60 interface standard for connecting to the router.

In support of Ethernet the 3600 series network modules are available with 1 and 4-port Ethernet connections. As shown in Figure 2.60, the 1-port Ethernet network module comes with one AUI DB-15 and one 10BaseT RJ-45 interface connections. Only one of these ports may be active at any time for this network module. The 4-port Ethernet adds to the 1-port Ethernet network module format three 10BaseT RJ-45 connections on the left side of the network module. The restriction of either the AUI or RJ-45 port be active on the right side of the 4-port Ethernet module still holds true. Cisco IOS Release level 11.2(4)XA and 11.2(5)P or later are required for operation.

The advancement of Ethernet has dictated that the network modules keeping with the new Ethernet standards. Currently, the 3600 series routers support a 1-port Fast Ethernet network module using an RJ-45 connector or a 40-pin media-independent interface (MII).. Again, there is a restriction that only one of these interfaces may be active at any given time. The RJ-45 connects two pair Category 5 UTP wiring using the 100BaseTX standard. Using the MII an external transceiver is required to connect to a multimode optical fiber using 100BaseFX standard or it can use the 100BaseT4 standard over four-pair of Category3, 4 or 5 UTP or STP wiring. Figure 2.61 diagrams the 1-port Fast Ethernet network module for the 3600 series router which requires Cisco IOS Release 11.2(6)P or higher for operation.

The Cisco 3640 supports a maximum of two 1-port Fast Ethernet network modules with no other network modules installed. If using the 1-port Fast Ethernet with a 4-port Ethernet network module the 3640 router may be configured for a maximum of 1 Fast Ethernet and two 4-port Ethernet network modules along with other network modules.

Using the high-density DB-60 interface standard the 4-port serial network module can support various data rates. If only port 0 is use then the interface can realize a data rate of 8 Mbps. Using ports 0 and 2 the data rate is halved to 4 Mbps per port and using all four ports the data rate is halved again to maximum of 2 Mbps per port.

1. Usage

   The 3600 series routers are designed for the access layer of the Cisco router architecture. As shown in Figure 2.62, the 3640 is ideal for use by ISPs to have many points-of-presence (POPs) or for telecommuting to a corporate

environment. The 3620 provides for small office connectivity and local LAN and WAN connections using mixed media network modules.

2. Processors and Memory

The two models of the Cisco 3600 series use different processors. The Cisco 3640: uses the 100-MHz IDT R4700 RISC processor and the Cisco 3620 uses the 80-MHz IDT R4600 RISC processor. The 3600 series uses a single DRAM pool which is partitioned main and shared memory areas. This partitioning of DRAM makes memory calculation difficult when configuring the 3600 router platforms. Appendix F identifies some guidelines on how to configure the proper amount of DRAM for the 3600 routers. The 3600 series also uses flash memory. Both the DRAM and flash using the SIMM chips for memory allowing field upgrades and replacements. The standard flash memory is 4 MB. However, the flash memory can be upgraded to a maximum of 48 MB for both the 3620 and 3640 routers. Each routers comes with a base of 16 MB of DRAM which is expandable on the 3620 to 64 MB and on the 3640 to 128 MB. In addition to on board flash memory the 3600 series has PCMCIA two slots available in support of 4MB to 128 MB of flash using two 64 MB PCMCIA flash cards.

1. 2600 Series

The Cisco 2600 series router platform extends the modular format of the 3600 series into the smaller remote branch office. The modularity of the 2600 series enables these small offices to deploy voice/fax/video along with data in a single versatile network appliance. The Cisco 2600 shares many of the same network module interfaces with the 3600 and 1600 router platforms. The 2600 series supports one network module slot, two WAN Interface Card slots and a new interface slot dubbed Advanced Integration Module (AIM). Cisco maximizes uptime on the 2600series through the use of an external Redundant Power Supply (RPS) and Cisco IOS dial-on demand routing features for the restoration of both data an voice connections automatically should the primary link failure occur.

The 2600 series comes in two flavors: a single Ethernet (2610) or a dual Ethernet interface (2611). The WAN interface card slots support:

- Serial
- ISDN BRI
- Built in CSU/DSU functions

The network modules add needed support for:

- Multiservcie voice/data/fax integration
- Deparmental dial concentraion
- High-density serial concentration

The AIM slot supports added features for optimization through hardware assisted data compression and encryption.

An auxiliary port with the ability for use as a 115 Kbps Dial ON Demand Routing interface for WAN back-up connectivity is standard on both the 2610 and 2611 models. Figure 2.63 shows the rear panel of the 2600 models.

The Cisco 2600 shares many of the data network modules with the 3600 series routers. These shared data network modules are:

- 16-port high density async network module - NM-16A
- 32-port high density async network module - NM-32A

- 4-port low speed (128 Kbps max) async/sync serial network module1-NM-4A/S1
- 8-port low speed (128 Kbps max) async/sync serial network module - NM-8A/S

The following Voice/fax network modules and interface cards are shared with the 3600 series router:

- One-slot Voice/Fax Network Module - NM-1V
- Two-slot Voice/Fax Network Module - NM-2V
- Two-port FXS Voice /Fax Interface Card - VIC-2FXS
- Two-port FXO Voice /Fax Interface Card - VIC-2FXO
- Two-port E/M Voice /Fax Interface Card - VIC-2E/M

The 2600 series also shares WAN Interface Cards (WICs) with the 1600 and 3600 series routers. These cards are the:

- One-port serial WAN Interface Card - WIC-1T
- One-port 4-wire 56 Kbps DSU/CSU - WIC-1DSU-56K4
- One-port ISDN BRI - WIC-1B-S/T
- One-port ISDN BRI with NT1 -WIC-1B-U

WICs unique to the 2600 series support the following configuration:

- 2-Port Serial WAN Interface Card for Cisco 26002 - WIC-2T2
- 2-Port Async/Sync Serial WAN Interface Card for Cisco 26002 - WIC-2A/S2

1. Usage

   Based on its size and purpose we can see that the 2600 series falls into the access layer of the Cisco layered network topology. Multiservices have become quite desirable for reducing communications network infrastructure cost while at the same time enhancing application functionality. Using the QoS features built into the Cisco IOS software small branch offices and participate is voice-enabled desktop applications and desktop video.

   Using the modular features the 2600 can serve as a dial services concentrator for remote office and remote user access by supporting up to 36 high-speed asynchronous ports using PPP, SLIP, ARA and Xremote protocols. As shown in Figure 2.64, this enables casual connection for these remote locations to the corporate WAN through the WAN interface cards available on the two 2600 models.

   The various WAN modules and WAN Interface Card slot options enable the 2600 series routers to be a serial device concentrator. Through the power of the Cisco IOS and optional support of upto 12 synchronous serial interfaces the 2600 protects legacy sysetm investment for SDLC, bisynch and asynch devices. Ideally, this ability in combination with the Ethernet LAN interfaces and integrated CSU/DSU and ISDN BRI WAN interface cards allows a network designer to provide a solution for connecting retail, financial and sales branch offices.

2. Processor

   The 2600 series router has a Motorola MPC860 40 MHz CPU with a 20 MHz internal bus clock.

3. Memory

The system memory (DRAM) comes in two DIMM slots. The default memory size is 16MB with expansion to a total of 64 MB. Flash memory is incorporated on the processor board using a single SIMM slot supporting a default of 4 MB with expansion to 16 MB. The DRAM on the 2600 uses pooled DRAM memory. The DRAM is partitioned between processor and packet memory areas. The default 16 MB of DRAM is partitioned into 12 MB for processor and 4 MB for packet memory.

Cisco IOS Release 11.3(2)XA and 11.3(3)T and higher. The Cisco IOS may be loaded into the router using the LAN interface and TFTP or using the auxiliary or console port using Ymodem or Xmodem protocols. This is valuable for remote dial-up restoration of a damaged IOS or for updating the stored configuration file.

1. 2500 Series

The 2500 series router platform from Cisco provides specific access layer functions for small offices or small business. The 2500 series comes in many different solution formats. These are:

- ☐ Single LAN routers
- ☐ Mission-Specific routers
- ☐ Router/hub combinations
- ☐ Dual LAN routers
- ☐ Modular routers

Additionally, the 2500 series comes in an access server offering for supporting remote dial-up access to enterprise networks The Cisco access servers are not discussed in this text. The console and auxiliary ports on the 2500 series use RJ-45 connectors. Any 2500 series model ordered comes with a cable kit to connect an RJ-45-to-RJ-45 using a roll-over console cable, an RJ-45-to-DB-25 male DCE adapter, an RJ-45-to-DB-25 female DTE adapter, and an RJ-45-to-DB-9 female DTE adapter for connecting PCs or modems to the these ports. The low-speed serial asynch-/synchronous ports on all the models support asynchronous connections up to 115.2 Kbps and synchronous connections up to 2 Mbps.

The single LAN routers come in eight models. Each model has a different combination of non-upgradeable or non-field modifiable interfaces. The 2501 shown in Figure 2.65 provides a single Ethernet 10 Mbps port and two synchronous serial interfaces. The Ethernet uses a DB-9 AUI port which may require an external transceiver to connect to an RJ-45 LAN hub interface. The two serial ports use DB-60 connectors and all data rates up to 2 Mbps.

The 2502 router pictured in Figure 2.65 has a token-ring LAN interface instead of an Ethernet AUI port. The token-ring interface uses DB-9 connection which may require a converter to an RJ-45 connector for connecting to a LAN hub. The token –ring interface is configurable as 4 or 16 Mbps data rates.

The addition of a single ISDN BRI port on the is shown on the 2503 and 2504 routers in Figure 2.65. Note that the 2503/2504 is the same as the 2501/2502 with the exception of the ISDN BRI ports. The ISDN BRI ports have an internal ISDN Terminal Adapter. These ports must connect to an ISDN NT1 device for switched ISDN connectivity.

Support for low-speed asynch-/synchronous serial lines is provided by the 2520/2521 platforms pictured in Figure 2.66. There are two low-speed connections with asynchronous data rates up to 115.2 Kbps and synchronous data rates up to 128 Kbps. Additionally, the LAN ports for Ethernet and Token-ring are also provided with an RJ-45 connection interface. Only one LAN interface is allowed to be configured and operative at any one time.

The 2520/2521 also provides a single ISDN BRI port. The 2520 Ethernet AUI or 10BaseT RJ-

45/UTP adapter supports 10 Mbps and the 2521 token-ring DB-9 or RJ-45/UTP adapter supports 4 or 16 Mbps data rates.

The last two models, pictured in Figure 2.67, in the single LAN category of the 2500 series routers provides for up to eight low-speed asynch-/synchronous and two high-speed communications interfaces, a single ISDN BRI and a single LAN interface. The 2522 provides for Ethernet at 10 Mbps using an AUI or a 10BaseT RJ-45 connection. The 2523 model supports the 4 or 16 Mbps token-ring speeds using either the DB-9 or RJ-45 UTP ports.

Mission specific entry level routers in the 2500 series come in twelve unique offerings. The mission specific router models are configured with less memory than the single LAN models and execute IOS software images specifically designed for the CFRAD (CF), LAN FRAD (LF) and ISDN requirements. The special IOS images disable/enable unused ports through software. These mission specific routers give the single LAN router platforms the ability to act as frame relay access devices for connecting the location to frame relay networks without having to connect through a separate frame relay access piece of equipment. The CF models allow the router to also act as a frame relay switch for delivering information through frame relay networks. These models are however upgradeable to full functionality through full function IOS software and added memory.

The mission-specific routers are the exact models of the single LAN routers however, through the software have limited functionality. The 2501CF/2502CF routers have their respective LAN ports disabled by the IOS software and only allows configuration of the two high speed serial interfaces. The 2501LF/2502LF have their LAN ports enabled along with the ability to send LAN traffic through frame relay networks directly.

The 2503I/2504I provide for Ethernet and Token-Ring LAN connectivity respectively through ISDN BRI connections. The high speed serial connections available on the router are software disabled.

The 2520CF, 2521CF, 2522CF and 2523CF routers all have their ISDN BRI ports disabled and their respective LAN interfaces also disabled. The low- and high-speed ports are enabled and functional.

The 2520LF, 2521LF, 2522LF and 2523LF have all their LAN and WAN ports enabled however their ISDN BRI ports are disabled by the software.

For locations where a single device to support both routing and LAN connectivity for workgroups and small offices the Cisco 2500 series router/hub combinations is available in six different formats. Each format supports only one LAN segment but has multiple ports available for connecting workstations or servers. The integrated hubs on these router platforms save the small business or small office equipment and software costs while providing a full LAN/WAN solution.

The 2505, 2507, 2516 and 2518 router/hub offerings, diagrammed in Figures 2.68 and 2.69, provide a single segment Ethernet LAN environment.

Caption; The 2505/2507 models of the Cisco 2500 series router.

The 2505 supports up to eight Ethernet connections, the 2507 supports sixteen, the 2516 supports fourteen and the 2518 supports twenty-three Ethernet LAN connections to the hub. The router card of the 2518 connects to port 24 of the Ethernet hub allowing the 2518 to route LAN traffic over the WAN. The AUI port on the 2518 allows the 2518 to connect to an external Ethernet hub expanding the reach of the LAN segment. Both the 2516 and the 2518 have the ability to expand to five hubs using Lanoptics hub expansion units. Each platform has two high-speed serial interfaces. Only the 2505/2507 do not provide for an ISDN BRI interfaces.

The 2517 and 2519 support toke-ring LAN segments. The 2517 model allows for eleven token-ring

LAN connections to the hub while the 2519 supports up to twenty-three token-ring LAN segments to the hub. The hub interfaces can either be 4 or 16 Mbps but all the ports must be using the same data rate. The 2519 contains a token-ring ring-in/ring-out ports for cascading token-ring hub equipment thereby increasing the size of the token-ring segment. Additionally, the ring ports 1-12 may be defined as a separate token-ring segment from ports 13-24. Both the 2517 and 2519 have router cards with token-ring RJ-45 connectors. The router cards attach to port 12 of the 2517 and port 24 of the 2519 routers. This enables the routers to transport LAN traffic over a WAN. The 2517 allows a single port on the 11 available ports to connect to another hub using an RJ-45 cross-over cable expanding the token-ring segment. On the 2519 the ring-in/ring-out ports allow for the expansion of the segment. An expansion unit is found on the top of the 2517 and 2519 to expand the hub to five hubs using Lanoptics supplied hubs. Both of these models have a single ISDN BRI port for switched backup use or bandwidth on demand use in conjunction with two high speed serial ports.

Small offices requiring more than one LAN are supported by the dual LAN router models. These are available in three different models. Figure 2.70 depicts the three dual LAN routers. All three models do not have ISDN BRI ports available. The 2513 supports one Ethernet 10 Mbps LAN segment and one toke-ring 4 or 16 Mbps LAN segments with two high-speed serial interfaces. The 2514 supports two Ethernet 10 Mbps LAN segments using AUI ports and the 2515 supports two Token-ring LAN segments at 4 or 16 Mbps using DB-9 connectors.

The modular routers in the 2500 series give the network engineer the ability to change and adapt the 2500 series routers unlike the previous models mentioned. There are two types of modular 2500 series routers. The two modular router models shown in Figure 2.71 differentiate themselves by the LAN support

. The 2524 connects Ethernet LANs while the 2525 provides Token Ring connections. Both allow up to three WAN modules configuring up to two synchronous serrial and one ISDN. The modules are available in the following configurations:

- 2-wire, switched, 56-kbps DSU/CSU
- 4-wire, 56/64-kbps DSU/CSU
- Fractional T1/T1 DSU/CSU
- Five-in-one synchronous serial
- ISDN BRI
- ISDN with integrated NT1 device

The three available slots shown in Figure 2.71 on the 2524 and 2525 are used for the WAN interfaces. The WAN slot on the right of the unit is keyed to allow only the ISDN BRI interface cards be installed. Likewise, the ISDN BRI cannot be installed in the first two WAN slots starting on the left of the router. The 2-wire, Switched 56 Kbps DSU/CSU WAN module allows for 56 Kbps dial up connections through the plain old telephone service (POTS) using an RJ-11 connection. The module connects directly form the RJ-11 port on the module to the RJ-11 port on the wall for connecting to the public telephone network.

The 4-wire 56/64 Kbps DSU/CSU WAN Module, Figure 2.71, for the 2524 and 2525 router provides dedicated leased line synchronous serial connections up to 64 Kbps using and RJ-48S connector directly to the wall plate connecting the line to the communications network.

The fractional T1/T1 DSU/CSU WAN module, shown in Figure 2.71, uses an RJ-48C connector to the network. This module supporting a 1.544 Mbps line provides either Nx56 or Nx64 channels up to a total of 24 individual channels at each speed. Each channel is defined as if it were its own unique interface.

The ISDN modules pictured in Figure 2.72 provide ISDN BRI connectivity using RJ-45 S/T

connections. The ISDN BRI supports two B channels and one D channel. The two B channels together allow for a switched connection of 128 Kbps. The ISDN BRI module contains its own Terminal adapter and must be connected to an external NT1 device. The second ISDN BRI module has an integrated NT1 device and connects directly to the ISDN BRI port installed by the network provider.

The five in one synchronous serial WAN module shown in Figure 2.73 enables the one interface to support the following electrical interface standards using the appropriate cables:

- EIA/TIA-232
- EIA/TIA-449
- V.35
- X.21
- EIA-530

The router side of the cable used has a DB-60 connector. The opposite end is headed with the appropriate interface required as specified by the line connection requirements.

1. Usage

   The 2500 series has many different uses and in some ways can provide both distributed an access layer functions. For example, in Figure 2.73 a 2525 is used to connect a location to a frame relay network with a 56 Kbps switched dial backup line to another 2525 at a different location. Meanwhile a 2519 at a third sight connects a token ring LAN to a corporate center using a 256 Kbps line to a multiplexer attached to a 2424 with a Fractional T1 WAN module servicing all three remote sights and connecting them to a core router in the larger corporate backbone.

2. Processor and Memory

All the 2500 series router platforms use the Motorola 20 MHz 68030 processor. Each system comes with a minimum of 8 MB of flash memory. The minimum system memory provided with the routers is 4 MB of DRAM partitioned between shared and primary DRAM memory. The total amount of DRAM available on the 2500 series graduates from 4 to 8 to 16 MB. All configurations of DRAM are partitioned into 2 MB of shared memory. The remaining DRAM is used for primary DRAM resulting in 2, 6 and 14 MB of primary DRAM respectively. For completeness consult Appendix G on 2500 series router memory requirements and IOS software feature support.

1. 1600 Series

   For small offices or offices with occasional connectivity requirements Cisco offers the 1600 series router platform. The 1600 series had four models. The 1601, 1602, 1603 and 1604. All the models come equipped with one Ethernet 10 Mbps port, a built-in WAN port and one WAN interface card expansion slot for added bandwidth and flexibility. The WAN ports support ISDN BRI, asynchronous serial up to 115.2 Kbps, synchronous serial connections up to 2.048 Mbps.

   The 1601 has a built-in serial WAN port for leased line connection rates up to 2.048 Mbps. The 1602 uses the built-in WAN port for a 56 Kbps 4-wire CSU/DSU interface thereby eliminating an external CSU/DSU device. The 1603 has a built in ISDN BRI S/T port with a Terminal Adapter requiring connectivity to an external NT1 device. The 1604 removes the external NT1 connection for the built in ISDN BRI port by including the NT1 device internally. IN addition, the n1604 includes an ISDN-S port which allows

the router to connect to an ISDN telephone or fax on the second B channel of the same ISDN line. Figure 2.75 illustrates the front of all the 1600 routers and the rear views of the four individual offerings. The expansion slot of the 1603 and 1604 is not available for a second ISDN port. However, the 1601 and 1602 can mix and match all the available WAN module for the expansion slot.

There are three WAN interface expansion modules available with the 1600 series routers. Figure 2.76 diagrams their interface plates. The serial WAN interface expansion module provides EIA/TIA-232, V.35, X.21, EIA/TIA-499, and EIA-530 standard interfaces with support for 115.2 Kbps asynchronous and up to 2.048 Mbps synchronous connections. The proper cable must be installed to support the various interface requirements for successful operation. The ISDN BRI S/T supports two B channels and one D Channel for data only. The ISDN BRI U with a built in NT1 allows connectivity to the a switched ISDN network without the use of an external NT1 device.

1. Usage

   The 1600 series routers are an ideal low cost solution for small remote sales offices or telecommuters with need for high-speed connectivity or casual connectivity to a single Ethernet LAN segment with IP/IPX or AppleTalk communication requirements. The 1600 series is the quintessential access layer router as shown in Figure 2.77.

2. Processor and Memory

The 1600 series uses the Motorola 68360 33 MHz processor. Each unit comes with a base of 4 MB of flash which is expandable to 12 MB. Flash expansion can go from 4 to 6MB or 4 to 8 MB or 4 to 12 MB. The DRAM comes with a bas e of 2 MB of memory expandable to a maximum of 18 MB.

2. 700M Family of Access Routers

The Cisco 700M family is an ISDN multiprotocol access router. The 700M family supports ISDN basic rate interface (BRI) of 56, 64 or 128 Kbps remote access connections. The Cisco 700M family of access routers comes in two series: the 760 and 770. The 760 series has one Ethernet 10Mbps LAN interface and an ISDN BRI port. The 770 series includes a built in 4-port 10 Mbps Ethernet hub, ISDN BRI along with a call connect/disconnect switch on the format of the router to allow the user to manually connect or disconnect the ISDN BRI data linen connection.

The 760/770 series is broken further down into four models. Their features and functions are:

- ☐ 761M/771M (h5906/ h8503)

Shown in Figure 2.78, these models require an external Network Termination 1 (NT1) device for connectivity. It is based on the Intel 25 MHz 386 processor and comes with 1.5MB expandable to 2 MB over DRAM. The on-board NVRAM is 16 KB with a 1 MB flash memory. It can support up ton 1500 users and is available worldwide.

- ☐ 762M/772M (h5905/h8504)

Shown in Figure 2.79, these models include an internal Network Termination 1 (NT1) device for connectivity. Additionally, these models have a second BRI port for external ISDN device connectivity or a second ISDN BRI line. It is based on the Intel 25 MHz 386 processor and comes with 1.5MB expandable to 2 MB over DRAM. The on-board NVRAM is 16 KB with a 1 MB flash memory. It can support up ton 1500 users and is available in North America only.

- ☐ 765M/775M (h5789/h8502)

Shown in Figure 2.80, these models require an external Network Termination 1 (NT1) device for

connectivity. It also includes two analog POTS RJ-11 ports for attaching phones, fax machines and modems to share the ISDN BRI simultaneously with data. This model also supports provider supplemental services over ISDN such as: call waiting, cancel call-waiting, call retrieve, call hold, 3-way call conferencing, and call transfer. It is based on the Intel 386 processor and comes with 1.5MB expandable to 2 MB over DRAM. The on-board NVRAM is 16 KB with a 1 MB flash memory. It can support up to 1500 users and is available worldwide.

- 766M/776M (h5788/h7861)

Shown in Figure 2.81, these models include an internal Network Termination 1 (NT1) device for connectivity. Additionally, these models have a second BRI port for external ISDN device connectivity or a second ISDN BRI line. It also includes two analog POTS RJ-11 ports for attaching phones, fax machines and modems to share the ISDN BRI simultaneously with data. This model also supports provider supplemental services over ISDN such as: call waiting, cancel call-waiting, call retrieve, call hold, 3-way call conferencing, and call transfer. It is based on the Intel 386 processor and comes with 1.5MB expandable to 2 MB over DRAM. The on-board NVRAM is 16 KB with a 1 MB flash memory. It can support up ton 1500 users and is available North America only.

The 700M family can act as the DHCP server for the LAN attached devices assigning the remote locations IP addresses to the attached workstations. The 700M family can also have its IP or IPX addresses assigned from the provider or central site network connection using Multilink Point-to-Point Protocol (MPPP). The ISDN BRI connection can dial-on demand dynamically when it senses "interesting" traffic as defined by the remote location network administrator. This feature is useful when one ISDN BRI B channel connects to one location and traffic is generated for a second location. The second B channel can be activated for the life of the interesting traffic and then terminated. Also useful is setting FTP traffic as interesting to the router when transferring large file to another location by bringing up the second B channel to increase bandwidth.

In typical configurations there are many LAN workstation requiring access to another remote location. In many instances the 700M is used as a connection to the Internet. Internet service providers (ISPs) typically provide only one Internet address for the location. The 700M uses a many-into-one feature called Port and Address Translation (PAT) to over come this single address restriction. PAT is also used as a firewall function allowing to protect unknown resources from accessing the remote locaiton and privileging internal devices to access the Internet. The access can include web browsing, e-mail or file transfer to devices on the remote LAN network.

As described the 700M family is an access router. It's typical use is for occasional connectivity requirements from a remote location to another location. The location may be another remote office, the Internet or a central office location.