DATA SHEET

CIRCUIT EMULATION OVER IP NETWORK MODULES

Figure 1. Four-Port T1/E1 Circuit Emulation Network Module (NM-CEM-4TE1)

Figure 2. Four-Port Serial Circuit Emulation Network Module (NM-CEM-4SER)

The *Circuit Emulation over IP (CEoIP)* network modules (product numbers NM-CEM-4TE1 and NM-CEM-4SER) for the Cisco® 2600XM, 2691, 2811, 2821, 2851, 3660, 3700 and 3800 routers provide a new CEoIP service offering. These network modules provide bit-transparent data transport that is completely protocol-independent.

For the first time, this allows network administrators to take advantage of their existing IP network to provide leased-line emulation services, or to carry data streams or protocols that do not meet the format requirements of other multiservice platform interfaces.

APPLICATIONS

These two new network modules are the first Cisco router interfaces designed to meet the emerging standards for CEoIP.

All previous Cisco router interfaces require that data be presented in the form of:

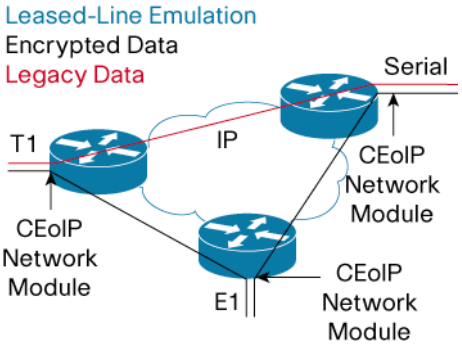
- Native IP frames
- Frame Relay frames
- High-Level Data Link Control (HDLC) frames
- ATM cells
- Channelized pulse-code-modulation (PCM) voice
- Asynchronous (“start/stop”) data

These new network modules do not assume that data has *any* predefined format or structure. They simply regard the data as an arbitrary bit stream. All data bits are simply transported to a defined destination encapsulated in IP packets.

This transparency, for the first time, allows an IP network to carry the variety of data applications and protocols that do not meet the requirements of other router interfaces. Such applications, shown in Figure 3, might include:

- Pre-encrypted data for government, defense, or other high-security applications
- Proprietary synchronous or asynchronous data protocols used in transportation, utilities, and other industries
- Leased-line emulation service offerings in metropolitan (metro) ethernet or wide-area network service provider environments

Figure 3. CEoIP Application Examples



FEATURES AT A GLANCE

- Emerging standards-based CEoIP based on Vainshtein draft with enhancements
- Configurable using Cisco IOS® software
- Four T1/E1 ports per T1/E1 network module
- Four synchronous serial ports per serial network module
- Interworking between the T1/E1 and serial network modules
- Bit-transparent data transport
- Protocol-independent data transport
- IP transport using Real-Time Transport Protocol (RTP) and UserDatagram Protocol (UDP) protocol stack
- IP quality of Service (QoS) using differentiated services code point (DSCP) or type of service (ToS) and IP Precedence
- Configurable payload size
- Optional payload compression
- Optional data protection
- Adaptive clock synthesis
- Configurable egress de-jitter buffers up to 500 milliseconds
- Configurable idle pattern
- Online insertion and removal (OIR) supported on Cisco 3660 and Cisco 3745 platforms
- Overall network module status LEDs
- Per-port status LEDs

Additional Features of the NM-CEM-4TE1

- Unframed (unstructured) T1/E1 transport
- N x 64 kbps and N x 56 kbps framed T1 transport
- N x 64 kbps framed E1 transport
- Grooming of up to 24 (T1) or 31 (E1) separate data streams, each able to terminate on a separate network destination

- Optional channel associated signaling (CAS) transport
- Configurable clock source for each port
- T1/E1 line diagnostic loopbacks (local line, local payload, and network payload)

Additional Features of the NM-CEM-4SER

- Serial data rates from 200 bps to 2048 kbps
- Optional serial control lead transport
- Optional extended serial control lead support
- Configurable serial control lead sampling
- Serial control lead programming
- Optional data strobe configuration
- Configurable clock mode for each port
- Configurable clock source for each port
- Serial port loopbacks (local and network)
- Asynchronous data support with over-sampling
- Support of RFC 1406 MIB for T1/E1 performance monitoring

FEATURE DETAILS

Protocol-Independent Data Transport

These network modules provide completely bit-transparent, bidirectional, point-to-point data transport. Every bit presented to an ingress port is transported unchanged to the corresponding egress port by encapsulating the data bits into an IP packet for transport across an IP network. The data ports do not care about the structure or content of the data stream. Consequently, these network modules are ideally suited to transport data streams that are not suited to be carried using other platform interfaces. Such data streams might include:

- Leased-line emulation services
- Encrypted data
- Data protocols that cannot easily be migrated to native IP, ATM, Frame Relay, HDLC, etc.

Data Integrity

Because these network modules do not consider the content of any circuit emulation data stream, it is important to engineer the transport network in such a way as to minimize the risk of losing any data packets. To that end, these network modules support a variety of QoS mechanisms, including IP DSCP, IP ToS, and IP Precedence.

To ensure that a data stream is delivered, without gaps, to the destination customer premises equipment (CPE), data packets are held in a de-jitter buffer at the destination port to eliminate any delay variation (that is, jitter) experienced by successive packets traveling through the network. The de-jitter buffer is user-configurable up to 500 milliseconds (± 250 milliseconds).

For a measure of added safety, the network modules support a data protection feature based on RFC 2198. This feature guarantees that no data is lost in the event of any nonconsecutive packet(s) being dropped (or excessively delayed) in the IP network.

Flexibility in Delay vs. Overhead

Each packet created by these network modules carries a 44-byte header that includes:

- A 20-byte IP header
- An 8-byte UDP header
- A 12-byte RTP header
- A 4-byte circuit emulation header

However, these network modules support a wide variety of payload sizes from 1 byte (for very low-speed data streams) to 1312 bytes. This provides the user the ability to control the overall efficiency as well as the end-to-end delay of the system by controlling the packetizing delay. Naturally, large packets introduce more packetizing delay but generate fewer packets per second with correspondingly lower packet overhead.

Payload Compression and cRTP to Increase Efficiency

In networks where bandwidth optimization is of premium importance, these network modules support both payload and header compression, independently of each other. Both compression algorithms are optional.

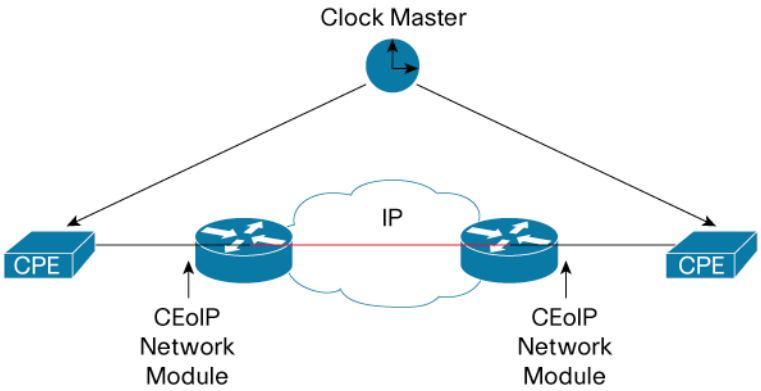
The payload compression is implemented on the network modules using the Lempel-Zif-Stac (LZS) algorithm. Naturally, the overall compression efficiency is a function of the data in the transmitted data stream.

The header compression is implemented on the host platform using compressed RTP (cRTP) to compress the 44-byte header to 6 or 8bytes.

Clocking Flexibility

In order to achieve bit-transparent circuit emulation without bit errors, it is imperative that both endpoints of the circuit use the same bit clock frequency.

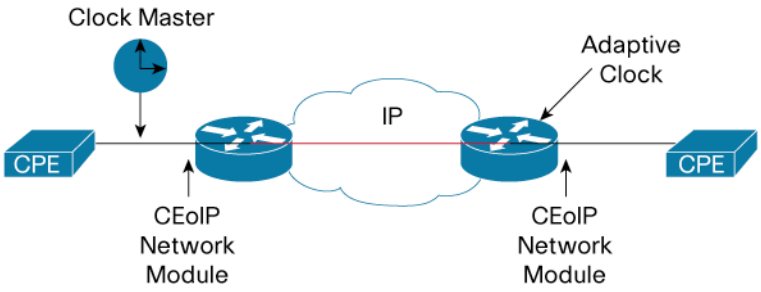
Figure 4. Synchronization with a Common Clock



One way to accomplish this is to externally synchronize both end devices with a common clock source, as shown in Figure 4.

An alternative is to use an “adaptive clock” at the slave end of the circuit, as shown if Figure 5.

Figure 5. Synchronization With Adaptive Clock



The “adaptive clock” is a locally synthesized clock frequency that is tuned to match the master clock (applied to either the source CPE or the source router). These network modules provide the option to generate an adaptive clock based on the average amount of data in the egress de-jitter buffer of the data stream.

FEATURES OF THE NM-CEM-4TE1

The same hardware supports either four T1 ports or four E1 ports.

Unframed vs. Framed Mode

Each T1/E1 port can be independently configured to operate either in unframed or framed mode.

In *unframed* mode, a T1 or E1 port encapsulates the entire T1 stream (1544000 bits/second) or E1 stream (2048000 bits/second) for transport across the IP network.

In *framed* mode, a T1/E1 port supports both unchannelized and channelized operation. In unchannelized operation, a T1 or E1 port encapsulates the entire T1 payload (1536000 bits/second) or E1 payload (1984000 bits/second) for transport across the IP network. In channelized operation, a T1 or E1 port may be configured with up to N separate data streams (N = 24 for a T1 port and N = 31 for an E1 port). Each data stream may include any combination of time slots, either contiguous or not. Of course, each time slot may be included in only one data stream.

T1/E1 Clock Sources Supported

On a T1/E1 port, each device must provide the clock used to send data bits to the other device. Depending on the clock configuration of the attached CPE, the T1/E1 port supports any of three clock modes.

If *internal* clock is specified, the internal oscillator of the router or the network module is used to derive the clock used to send data to the attached CPE.

If *line* clock is specified, the port phase-locks to the clock provided by the CPE and uses that clock to send data to the attached CPE.

If *adaptive* clock is specified, the network module provides a clock that is locally synthesized, based on the level of data bits in the egress de-jitter buffer of one of the data streams terminating on the port, to match the clock used at the source data port.

Channel Associated Signaling

If the network module is used to transport N x 64 kbps data streams that carry voice with CAS, the signaling transport feature may be enabled to ensure proper signaling bit extraction, transport, and insertion across the IP network.

FEATURES OF THE NM-CEM-4SER

This network module provides four independent synchronous serial interfaces. Each serial port is equipped with a “smart serial” connector widely used on previous serial interfaces from Cisco Systems®.

Port Types Supported

Depending on the cable plugged into the “smart serial” connector, the port may be:

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

Similarly, depending on the cable plugged into the “smart serial” connector, the port may be either a data communications equipment (DCE) or a data terminal equipment (DTE).

Table 1 and Table 2 below give the Cisco part numbers for each type of available cable.

Serial Data Rates Supported

Each serial data port may be configured to support any of the following data rates, specified in bits per second.

200	3600	12800	32000	76800	168000	384000	1024000
200	3600	12800	32000	76800	168000	384000	1024000
800	6400	16000	48000	96000	224000	512000	1344000
1200	7200	16800	56000	112000	230400	672000	1536000
1800	8000	19200	57600	115200	25600	768000	1544000
2400	9600	24000	64000	128000	288000	772000	2048000
3200	12000	28800	72000	144000	336000	896000	

Serial Clock Modes Supported

Each serial port may be configured in one of two clock modes to specify whether the DCE or the DTE provides each of the required transmit and receive data clocks.

In *normal* clock mode, the DCE provides both the receive clock and the transmit clock to the DTE.

In *split* clock mode, the DCE provides the receive clock to the DTE and the DTE provides the transmit clock to the DCE.

Serial Clock Sources Supported

In any mode where a serial data port provides a clock (or both clocks) to the attached CPE, the source of that clock may be specified.

If *internal* clock is specified, the internal oscillator of the router or the network module is used to derive the clock(s) provided to the CPE.

If *looped* clock is specified, the transmit or receive clock provided by the CPE is used as the receive or transmit clock provided to the CPE. Of course, this is supported only in split clock mode.

If *adaptive* clock is specified, the network module provides a clock that is locally synthesized, based on the level of data bits in the egress de-jitter buffer, to match the clock used at the source data port.

Control Signal Support

The network module provides the option to monitor, transport, and deliver changes in the serial port control signals across the network.

Depending on the cable plugged into the “smart serial” connector, the port may support either the “basic” set of serial control signals or the “extended” set of serial control signals.

The “basic” set of control signals supported follows:

- Data Terminal Ready (DTR)
- Data Set Ready (DSR)
- Request to Send (RTS)
- Clear to Send (CTS)
- Data Carrier Detect (DCD)
- Local Loop (LL)

The “extended” set of control signals supported follows:

- Remote Loop (RL)
- Test Mode (TM)
- Ring Indicator (RI)

Note: The set of control signals supported on each port, and the standards-based name for each signal, depends on the interface type. Each control signal listed may not be supported on every interface type. Also, the control signal names shown are simply the most commonly used names, familiar to most users.

Table 1. Smart Serial Cables with Basic Control Leads

	DCE	DTE
V.35	• CAB-SS-V35FC • CAB-SS-V35MT	• CAB-SS-V35MC • CAB-SS-V35FC
X.21	CAB-SS-X21FC	CAB-SS-X21MT
EIA-530	Not available	CAB-SS-530MT
EIA-530A	Not available	CAB-SS-530AMT
EIA/TIA-449	CAB-SS-449FC	CAB-SS-449MT
EIA/TIA-232	CAB-SS-232FC	CAB-SS-232MT

Table 2. Smart Serial Cables with Extended Control Leads

	DCE	DTE
V.35	• CAB-SS-V35FC-EXT • CAB-SS-V35MT-EXT	• CAB-SS-V35MC-EXT • CAB-SS-V35FC-EXT
EIA-530	CAB-SS-530FC-EXT	CAB-SS-530MT-EXT
EIA-530A	CAB-SS-530AFC-EXT	CAB-SS-530AMT-EXT

	DCE	DTE
EIA/TIA-449	CAB-SS-449FC-EXT	CAB-SS-449MT-EXT
EIA/TIA-232	CAB-SS-232FC-EXT	CAB-SS-232MT-EXT

Bandwidth Preservation

The network module has the intelligence to detect the failure of the attached CPE and to stop building and sending packets across the IP network when that occurs.

This feature works by detecting that an input clock is missing (assuming the CPE is supposed to provide such a clock) or, optionally, by monitoring the state of any specified serial control signal (known as a “data strobe”). If the clock or the specified control signal becomes inactive, no packets are built until the clock and control signal return to their normal states.

When data packets are not received at the destination port (because of a missing ingress clock, de-activation of the data strobe, or drops in the IP network), the “vacant” data bit times are replaced with a user-configurable idle pattern.

PLATFORM SUPPORT, SOFTWARE, AND MEMORY REQUIREMENTS

Memory Requirements

Memory requirements depend on the selected platform, software feature set, and other installed modules and features. For information about memory planning, refer to the software release notes or the Cisco IOS Software Upgrade Planner, or ask your local Cisco representative.

Platforms Supported

Table 3 shows which platforms support these network modules, and the minimum Ciso IOS Software release for eac p

Table 3. Supported Platforms and Minimum Software Requirements

Platform	Cisco IOS Software Release Required
Cisco 2610XM—2651XM	12.3(7)T and later
Cisco 2691	12.3(7)T and later
Cisco 2811, 2821, 2851	12.3(8)T and later
Cisco 3660	12.3(7)T and later
Cisco 3725 , 3745	12.3(7)T and later
Cisco 3825, 3845	12.3(11)T and later

Cisco IOS Software Feature Set Requirements

These network modules are supported in the following Cisco IOS Software feature sets for the platforms and releases listed in Table 3.

- SP Services and above (Cisco 2600XM, 2691, 2811, 2821, 2851, 3700 and 3800)
  - SP Services
  - Advanced IP Services
  - Enterprise Services
  - Advanced Enterprise Services
- IP Plus and above (Cisco 3660 only)

The network modules also are supported in a selection of special purpose feature sets. For more details of the feature sets supporting these network modules, refer to the Feature Navigator at http://www.cisco.com/go/fn or contact your local Cisco representative.

Maximum Number of Circuit Emulation Network Modules per Platform

Table 4 shows the maximum number of network modules, including circuit emulation network modules, that are supported in each platform.
Maximum Number of Network Modules Supported

Table 4. Maximum Number of Network Modules Supported

Network Module	Cisco 2600XM	Cisco 2691	Cisco 2811, 2821, 2851	Cisco 3660	Cisco 3725	Cisco 3745	Cisco 3825	Cisco 3845
Total Number of Network Modules Supported	1	1	1	6	2	4	2	4

HARDWARE SPECIFICATIONS

Table 5 shows the environmental specifications for these network modules.

Table 5. Environmental Specifications

Specification	Description
Dimensions (H x W x D)	• 1.55 x 7.1 x. 7.2 inches • 39 x 180 x 183 millimeters
Operating Temperature	• 32°to 104℉ • 0°to 40℃
Non-operating Temperature	• -40°to 185℉ • -40°to 85℃
Relative Humidity	5 to 95 percent non-condensing

Table 6 shows the hardware specifications for the T1/E1 network module.

Table 6. Hardware Specifications for the NM-CEM-4TE1

Ports	4 Ports (all T1 or all E1 according to software selection)
Nominal Bit Rate per Port	• T1: 1544000 bits/second • E1: 2048000 bits/second
Line Coding	• T1: binary 8-zero substitution (B8ZS) • E1: high-density bipolar with three zeroes (HDB3)
Line Framing	• T1: superframe (SF), extended superframe (ESF), or unframed • E1: G.704 with 4-bit cyclic redundancy check (CRC4), G.704 without CRC4, or unframed

Table 7 shows the hardware specifications for the serial network module.

Table 7. Hardware Specifications for the NM-CEM-4SER

Feature	Description					
Ports	4 synchronous serial ports					
Port Interface Type	Depends on cable attached; refer to Table 1 and Table 2 for cable options. • ITU-T V.35 • ITU-T X.21 • EIA-530 • EIA-530A • EIA/TIA-449 • EIA/TIA-232					
Port Interface Polarity	DCE or DTE, depending on cable attached; refer to Table 1 and Table 2 for cable options.					
Nominal Bit Rate per Port (bits/second)	Software-configurable to any of the following:					
	200	8000	38400	144000	672000	
	400	9600	56000	168000	768000	
	800	12000	57600	192000	772000	
	1200	12800	64000	224000	896000	
	1800	14400	72000	230400	1024000	
	2400	16000	76800	256000	1152000	
	3200	16800	84000	288000	1344000	
	3600	19200	96000	336000	1536000	
	4800	24000	112000	384000	1544000	
	6400	28800	115200	448000	2048000	
	7200	32000	128000	512000		
Clock Modes per Port	• Normal: DCE provides Receive Clock and Transmit Clock • Split: DCE provides Receive Clock and DTE provides Transmit Clock					
Clock Sources per Port	• Internal (uses platform time-division multiplexing (TDM) bus phase-lock loop (PLL) clock or on-board oscillator) • Looped (uses clock provided by CPE) • Adaptive (uses synthesized clock based on arriving data rate)					
Control signals supported per port with standard 12-in-1 "Smart Serial" cables as described in Table 1	The subset of the following control signals that are defined on each interface type are supported (note that some interface types may use different names for these control signals):					
	DTR	DS	RTS	CTS	DCD	LL
Control signals supported per port with extended 12-in-1 "Smart Serial" cables as described in Table 2	The subset of the following control signals that are defined on each interface type are supported (note that some interface types may use different names for these control signals):					
	RL	TM	RI			
Control Signal Sampling Rate	0 to 20 samples per second					

REGULATORY COMPLIANCE, SAFETY, EMISSIONS, EMC, AND IMMUNITY

Table 8 shows a partial listing of regulatory compliance and safety data.

Table 8. Regulatory Compliance and Safety (Partial Listing[1])

Telecommunication Interface Industry Standards		
NM-CEM-4TE1 Configured in T1 Mode	• TIA-968-A (U.S. requirement, formerly known as FCC Part 68) • G.703 • G.704 • G.824 (except not compliant with clock wander requirements in adaptive clock mode) • CS-03 (Canada) • T1.403 • GR-499	
NM-CEM-4TE1 Configured in E1 Mode	• G.703 • G.704 • G.706 • G.823 (except not compliant with clock wander requirements in adaptive clockmode) • TBR 4, 12, and 13 (Europe) • ACA S016 (Australia)	
NM-CEM-4SER	TBR 1 and 2 (Europe)	
Safety	• US (UL 60950) • Canada (CSA-C22.2 No. 60950) • UK (EN 60950) • Germany (EN 60950) • France (EN 6095) • Australia and New Zealand (TS001, AS/NZS 60950) • Other countries (IEC 60950)	
NEBS	• GR-63 • GR-78 • NM-CEM-4TE1 is designed for compliance with GR-1089-Core Type 1/3 • NM-CEM-4SER is designed for compliance with GR-1089-Core Type 2/4	
EMC Emissions and Immunity	• EN300386: 2001 • EN50082-1: 1997 • EN55022: 1998 • CISPR22: 1997 • EN61000-3-2:2000 • EN61000-3-3: 1995 • EN55024: 1998 • EN55082-1: 1992 • AS/NZS3548: 1995 (including Amendments I and II) • VCCI:V-3/2000.04	• CFR 47 Part 15: 2002 • CFR 47 Part 15 Subpart B • EN61000-4-6: 1996 (including Amendment 1) • EN61000-4-3: 1996 (including Amendments 1 and 2) • EN61000-4-2: 1995 (including Amendments 1 and 2) • EN61000-4-4: 1995 • EN61000-4-5: 1995 • EN61000-4-11: 1994 (including Amendment 1) • EN61000-4-5: 1995 • EN300386-2: 1997

Telecommunication Interface Industry Standards		
	• CNS13438: 199 • CISPR24: 1997 • ITU-T K.22: 1995	• CISPR22: 1997 • EN55022: 1998

1 For more information, visit the Cisco Compliance home page (listed later in this document under Country Support) or contact your local Cisco representative for further details.

POWER AND ENVIRONMENTAL REQUIREMENTS

These network modules, when installed in Cisco routers, do not change the power or environmental requirements and standards of the router platform itself. Refer to the platform-specific data sheets for more information.

Country Support

Contact your local Cisco representative for country-specific approval information.

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