CHAPTER 29

TDM/DSx

This chapter describes the level of support that Cisco ANA provides for time-division multiplexing (TDM), Digital Signal (DSx) Hierarchy, and related physical technologies, as follows:

Technology Description

TDM

Time-Division Multiplexing (TDM) is a type of digital multiplexing in which two or more signals or bit streams are transferred apparently as subchannels in one communication channel. The transmission of these streams appears to be simultaneous, but they are actually taking turns on the channel. This is done by dividing the transmission time domain into several recurrent slots of fixed length, one for each subchannel. A sample byte or data block of subchannel 1 is transmitted during timeslot 1, subchannel 2 during timeslot 2, and so on. One TDM frame consists of one timeslot per subchannel. After the last subchannel, the cycle starts again with a new frame, starting with the second sample, byte or data block from subchannel 1, and so on.

DSx

Digital Signal (DSx) Hierarchy refers to the rate and format of digital telecommunication circuits, as part of the North American Digital Hierarchy. DSx is related to the T-carrier designations. However, DS refers to multiplexing techniques, while the T designations refer to the underlying equipment and signaling. There are various DS levels, the most common being:

- DS0/Fractional T1 (64 Kb/s), which represents a single voice telephone call.
- DS1/T1 (1.544 Mb/s), with 24 user channels.
- DS2/T2 (6.312 Mb/s), with 96 user channels.
- DS3/T3 (44.736 Mb/s), with 672 user channels.

T3/E3

T-carrier telecommunications is a generic name for several digitally multiplexed telecommunications carrier systems used in North America, Japan, and Korea. The basic unit of the T-carrier system is the Fractional T1, which corresponds to the Digital Signal Hierarchy's DS0, and is commonly used for one voice circuit.

The E-carrier system (the "E" stands for "European") is incompatible with the T-carrier system (though cross-compliant cards exist). It is in common use everywhere outside of North America, Japan, and Korea. It typically uses the E1 (2.048 Mb/s) and E (334.368 Mb/s) line rates.

Channelized T3, OC3, DS3 Interface

Channelization, coupled with native edge-aggregation services such as MPLS and QoS, allows service providers and large enterprises to save dramatically on power, floor space, local-loop charges, and equipment costs, by permitting receipt and transmission of multiplexed T3, OC3 and DS 3 circuits over high-bandwidth physical media.

Circuit Emulation over MPLS

In CEM, TDM bitstream connections (T1, E1, T3, E3) are encapsulated as pseudowires over the MPLS backbone. Both structured and structure-agnostic TDM bitstreams are supported.

1588 Clocking

TDM 1588 is known as Precision Time Protocol (PTP). The PTP standard specifies a clock synchronization protocol applicable to distributed systems consisting of one or more nodes communicating over a network. Nodes are modeled as containing a real-time clock that may be used by applications within the node for various purposes, such as generating time stamps for data or ordering events managed by the node. The protocol provides a mechanism for synchronizing the clocks of participating nodes to a high degree of accuracy and precision.

SyncE Clocking

One of the fundamental requirements placed on next-generation networks is to provide the ability to distribute precision frequency or timing synchronization around the network. Frequency synchronization is provided by SONET/SDH equipment. used in conjunction with external timing technology, such as Cesium oscillators and GPS.

As SONET/SDH equipment is replaced by Ethernet equipment, this frequency synchronization ability is required over Ethernet ports. Synchronous Ethernet (SyncE) provides SONET/SDH physical layer (POS-PHY) frequency distribution of known, common precision frequency references.

To maintain SyncE links, a set of operations messages is required. These messages provide information about the quality of the timing source being used to clock the SyncE link, ensuring that each node is always deriving timing from the most reliable source. In SONET/SDH networks, these messages are known as Synchronization Status Messages (SSM). Each timing source has a Quality Level (QL) associated with it, which gives the accuracy of the clock. This QL information is transmitted across the network via SSMs over the Ethernet Synchronization Messaging Channel (ESMC), or via SSMs contained in the SONET/SDH frames, so that devices can know the best available source with which to synchronize. To define a preferred network synchronization flow and help prevent timing loops, users can assign priority values to particular timing sources on each router. The combination of QL information and user-assigned priority levels allows each router to choose a timing source to clock its SyncE and SONET/SDH interfaces.

Note Cisco ANA supports these technologies only in conjunction with data link layer technologies, such as ATM or PoS.

Information Model Objects (IMOs)

This section describes the following IMOs:

- DS0 Bundle Interface (IDS0Bundle)
- DS1 Physical (IDS1Pdh)
- DS3 Physical (IDS3Pdh)
- CEM Interface (ICEMEncap)
- CEM Group (ICEMGroup)
- Clock Service (IClockService)
- Clock Source (IClockSource)
- PTP Service (IPtpService)
- PTP Interface (IPtpInterface)
- ACR Service (IACRService)
- Recovered Clock (IRecoveredClock)
- SyncE Service (ISyncE)
- SyncE Interface (ISyncEInterface)

DS0 Bundle Interface

The data link layer DS0 Bundle Interface object is bound by its Containing Termination Points attribute to either DS1 Physical or DS3 Physical Layer objects. It is accessed primarily by the data link layer object, such as the ATM Interface and the Frame Relay Interface, bound by its Contained Connection Termination Points attribute.

Table 29-1 DS0 Bundle Interface (IDS0Bundle)

Attribute Name	Attribute Description	Scheme	Polling Interval
Bundled Time Slots	Bundled time slots (DS1 channels).	Product	Configuration
Bundle Location	Bundle location/index.	Product	Configuration
AdminStatus	The administrative status of the interface (*Down*, *Testing*, *Up*).	IPCore	Configuration
OperStatus	The operational status of the interface (*Down*, *Testing*, *Up*).	IPCore	Configuration
IANA Type	Internet Assigned Numbers Authority (IANA) type of the sublayer.	N/A	N/A
Containing Termination Points	Underlying termination points (connection or physical).	Product	N/A
Contained Connection Termination Points	Bound connection termination points.	Product	N/A

DS1 Physical

The physical layer DS1 Physical and DS3 Physical objects are bound by their Containing Termination Points attribute to a Port Connector object. Each of these objects is accessed primarily by the data link layer object (such as an ATM Interface, Frame Relay Interface, or DS0 Bundle Interface) bound by its Contained Connection Termination Points attribute.

Table 29-2 DS1 Physical (IDS1Pdh)

Attribute Name	Attribute Description	Scheme	Polling Interval
Framing Type	Framing type (*Null, OTHER, ESF, ANSI ESFf, D4, E1, E1 CRC, E1 MF, E1 CRC MF, UNFRAMED, E1 UNFRAMED, DS2 M12, E2, E1 Q50, E1 Q50 CRC, ANSI SF, E1 CAS CRC4, E1 CAS No CRC4, E1 No CAS CRC4, E1 No CAS No CRC4, E1 Unstructured, T1 Unstructured, CLEAR CHANNEL*).	Product	Configuration
Cell Mapping Type	Cell mapping type (*Null, PLCP, HEC, HCS, Direct, ADM*).	Product	Configuration
Loop Back Type	Loopback type (*Null, Cell, Payload, Diag, Line, None, Other, Path, Metalic, Non Metalic, Serial, Parallel, Local, Internal, Network, Inward, Dual, Remote, Inbound Local, No Loop*).	Product	Configuration
Scrambling Mode	Scrambling mode (*Null, On, Off*).	Product	Configuration
Port Description	Port description.	Product	Configuration
International Bit	Indicates whether the E3 international bit is set.	Product	Configuration
Line Code	Line-code type for T1 or E1 lines (*ami, b8zs, hdb3*).	Product	Configuration
Cable Length	Set cable length.	Product	Configuration
Recovered Clocking ID	Recovered clocking ID.	Product	Configuration

Table 29-2 DS1 Physical (IDS1Pdh) (continued)

Attribute Name	Attribute Description	Scheme	Polling Interval
Clocking	Clocking type (*stratum1*, and so on).	Product	Configuration
Loopback	Transponder loopback setting (*none*, *internal*, *line*).	Product	Configuration
All additional attributes are the same as Physical Layer (IPhysicalLayer)			

DS3 Physical

Table 29-3 DS3 Physical (IDS3Pdh)

Attribute Name	Attribute Description	Scheme	Polling Interval
Framing Type	Framing type (*Null, Other, M23, SYNTRAN, CBIT, Clear Channel, E3 Other, E3 Framed, Unframed, E3 Unframed, ITU-T G.804, ITU-T G.832, M13*).	Product	Configuration
Cell Mapping Type	Cell mapping type (*Null, PLCP, HEC, HCS, Direct, ADM*).	Product	Configuration
Loop Back Type	Loopback type (*Null, Cell, Payload, Diag, Line, None, Other, Path, Metalic, Non Metalic, Serial, Parallel, Local, Internal, Network, Inward, Dual, Remote, Inbound Local, No Loop*).	Product	Configuration
Scrambling Mode	Scrambling mode (*Null, On, Off*).	Product	Configuration
Port Description	Port description.	Product	Configuration
International Bit	Indicates whether the E3 international bit is set.	Product	Configuration
Line Code	Line-code type for T1 or E1 lines (*ami, b8zs, hdb3*).	Product	Configuration
Cable Length	Set cable length.	Product	Configuration
Recovered Clocking ID	Recovered clocking ID.	Product	Configuration
Clocking	Clocking type (*stratum1*, and so on).	Product	Configuration
Loopback	Transponder loopback setting (*none*, *internal*, *line*).	Product	Configuration
All additional attributes are the same as Physical Layer (IPhysicalLayer)			

CEM Interface

The CEM Interface object represents a CEM-encapsulated E1/T1 circuit interface.

Table 29-4 CEM Interface (ICEMEncap)

Attribute Name	Attribute Description	Scheme	Polling Interval
cemIfName	The interface name (for example, *CEM8/0/0* or *Virtual-cem8/0/24*).	IPCore	Configuration

CEM Group

The CEM Group object represents a CEM Group configured on a physical or virtual CEM Interface.

Table 29-5 CEM Group (ICEMGroup)

Attribute Name	Attribute Description	Scheme	Polling Interval
ID	The DS0 bundle CEM group identifier.	IPCore	Configuration
IdlePattern	The 8-bit hexadecimal number that is transmitted on a T1 or E1 line when missing packets are detected on the PW circuit.	IPCore	Configuration
IdleCAS	When channel associated signaling (CAS) is used, the 8-bit hexadecimal signal that is sent when the CEM interface is identified as idle.	IPCore	Configuration
DeJitter	The size of the dejitter buffer in milliseconds (ms) (in the range *4-500*, *4* is the default).	IPCore	Configuration
PayloadSize	The size of the payload (in bytes) for packets on the CEM interface (in the range *32-1312*).	IPCore	Configuration
RTP	Indicates whether RTP compression is *enabled* or *disabled*.	IPCore	Configuration
RTPHeader	Indicates whether RTP header compression is *enabled* or *disabled*.	IPCore	Configuration
TimeSlots	The range of timeslots (DS0 channels) allotted to the CEM interface. Empty if the Structure-Agnostic TDM over Packet (SAToP) method is used.	IPCore	Configuration
Pseudowire	The name of the pseudowire configured on the CEM interface.	IPCore	Configuration
AdminStatus	The administrative status of the CEM interface (*Down*, *Testing*, *Unknown*, *Up*).	IPCore	Configuration
OperStatus	The operational status of the CEM interface (*Dormant*, *Down*, *Not Present*, *Testing*, *Unknown*, *Up*).	IPCore	Configuration

Clock Service

The Clock Service object models the generic clocking configuration and clocking features of a network element, independent of any particular timing scheme, such as PTP or Anonymous Call Rejection (ACR).

Table 29-6 Clock Service (IClockService)

Attribute Name	Attribute Description	Scheme	Polling Interval
ActiveClockSource	The current active clock source used by the network element.	Any	Configuration
NcsMode	The network clock selection mode (*revert*, *nonrevert*, *unknown*). NCS is used in case of master device failure.	Any	Configuration
HoldTimeout	The network clock selection hold timeout in seconds (in the range *0-86400*, *-1* for no timeout).	Any	Configuration
UseStratum4	Indicates whether the Stratum4 clock is used (*true*) or not (*false*). The default is *false*, which means the Stratum3 clock is used.	Any	Configuration
Mode	The network element clocking mode (*unknown*, *slave*, *master*, *hybrid*).	Any	Configuration
NcsPriorityList	The network clock selection priority list.	Any	Configuration

Table 29-6 Clock Service (IClockService) (continued)

Attribute Name	Attribute Description	Scheme	Polling Interval
Pseudowire Clock Recovery	An array of zero or more instances of ACR Service (IACRService).	Any	Configuration
PtpService	An array of zero or more instances of PTP Service (IPtpService).	Any	Configuration

Clock Source

The Clock Source object represents the network clock source defined in an instance of the Clock Service object.

Table 29-7 Clock Source (IClockSource)

Attribute Name	Attribute Description	Scheme	Polling Interval
Priority	The priority of the defined clock source.	Any	Configuration
Source	The clock source.	Any	Configuration
Status	Indicates that the clock source status is valid (*true*) or non existent/non functional (*false*).	Any	Configuration
Type	The clock source type (*BITS*, *packet-timing*, *sync*, *E1/T1*).	Any	Configuration

PTP Service

The PTP Service object represents PTP (IEEE-1588) configurations on a network element at the device level.

Table 29-8 PTP Service (IPtpService)

Attribute Name	Attribute Description	Scheme	Polling Interval
Mode	The PTP operating mode (*unknown*, *ordinary*, *boundary*, *e2etransparent*, *p2ptransparent*). On the Cisco MWR-2941, only *ordinary* is supported.	Any	Configuration
ClockId	The PTP clock ID.	Any	Configuration
Domain	The PTP domain ID (in the range *0* to *127*).	Any	Configuration
Priority1	PTP clock selection priority-1 (in the range *0* to *255*).	Any	Configuration
Priority2	PTP clock selection priority-2 (in the range *0* to *255*).	Any	Configuration
PtpEnabled	Indicates whether PTP is enabled (*true*) or disabled (*false*).	Any	Configuration
PtpInterfaceList	An array of one or more instances of PTP Interface (IPtpInterface)	Any	Configuration

PTP Interface

The PTP Interface object represents PTP (IEEE-1588) configurations on a network element at the interface level.

Table 29-9 PTP Interface (IPtpInterface)

Attribute Name	Attribute Description	Scheme	Polling Interval
Version	The PTP version (default is *2*).	Any	Configuration
AnnounceInterval	The PTP interface announce interval (in the range *0* to *4*)	Any	Configuration
AnnounceTimeout	The PTP interface announce timeout (in the range *2* to *10*).	Any	Configuration
DestinationAddress	The clock destination IP address (can be *null*, set only when in Master mode).	Any	Configuration
SourceAddress	The clock source IP address (can be *null*, set only when in Slave mode).	Any	Configuration
DelayReq	The PTP interface delay request message interval.	Any	Configuration
MasterMode	The PTP communication mode in Master mode (*notset*, *multicast*, *unicast*, *unicastnegotiation*).	Any	Configuration
SlaveMode	The PTP communication mode in Slave mode (*notset*, *multicast*, *unicast*, *unicastnegotiation*).	Any	Configuration
SyncInterval	The PTP interface sync interval.	Any	Configuration
SyncLimit	The PTP interface maximum offset (in the range *1000* to *50000*).	Any	Configuration
InterfaceXid	The XID of the associated interface.	Any	Configuration

ACR Service

The ACR Service object represents the pseudowire clock recovery.

Table 29-10 ACR Service (IACRService)

Attribute Name	Attribute Description	Scheme	Polling Interval
RecoveredClockSource	The interface (slot or subslot) on which the clock recovery will occur.	Any	Configuration
RecoveredClockMode	The recovered clock mode.	Any	Configuration
CemInterface	The corresponding CEM or Virtual CEM interface instance ID.	Any	Configuration
RecoveredClockList	An array of one or more instances of Recovered Clock (IRecoveredClock).	Any	Configuration

Recovered Clock

The Recovered Clock object represents the clock information derived from the RNC or from other n-PE, P, or u-PE devices.

Table 29-11 Recovered Clock (IRecoveredClock)

Attribute Name	Attribute Description	Scheme	Polling Interval
ClockId	The clock ID.	Any	Configuration
RecoveredClockMode	The recovered clock mode.	Any	Configuration
Port	The port number.	Any	Configuration
Cem	The CEM Group.	Any	Configuration
Status	The priority.	Any	Configuration
FrequencyOffset	The value of the frequency offset.	Any	Configuration

SyncE Service

The SyncE Service object represents the global Synchronous Ethernet configuration for a network element.

Table 29-12 SyncE Service (ISyncE)

Attribute Name	Attribute Description	Scheme	Polling Interval
synchronousMode	Enable automatic synchronization selection process.	Any	Configuration
equipmentClock	Indicates the currently selected Ethernet Equipment Clock option (EEC-Option I, EEC-Option II).	Any	Configuration
clockMode	Indicates whether Quality Level is enabled (*QL-Disable*, *QL-Enable*).	Any	Configuration
ssmOption	Indicates which of the Synchronization Status Messages (SSM) options is currently in use on the NE (*ITU-T Option I*, *ITU-T Option II generation 1*, *ITU-T Option II generation 2*).	Any	Configuration
esmcMode	Indicates whether Ethernet Synchronization Messaging Channel is enabled on the NE (*true*) or not (*false*).	Any	Configuration
holdOffTimer	The amount of time (in milliseconds) the NE waits before removing a source that has gone down (values in the range *0* to *50000*, default is *300).*	Any	Configuration
waitToRestore	The amount of time (in milliseconds) the NE waits before adding a source that has just come up (values in the range *0* to *86400).*	Any	Configuration
Revertive	Indicates whether Revertive mode is enabled (*true*) or disabled (*false*) on the NE.	Any	Configuration

SyncE Interface

The SyncE Interface object represents the Synchronous Ethernet configuation for a single interface on an NE.

Table 29-13 SyncE Interface (ISyncEInterface)

Attribute Name	Attribute Description	Scheme	Polling Interval
selectionInput	Assign the interface as a timing source to be passed to the selection algorithm.	Any	Configuration
ingressESMCMode	Indicates whether Ethernet Synchronization Messaging Channel is enabled (*true*) or disabled (*false*) for incoming QL information on the interface.	Any	Configuration
egressESMCMode	Indicates whether Ethernet Synchronization Messaging Channel is enabled (*true*) or disabled (*false*) for outgoing QL information on the interface.	Any	Configuration
ingressQLMode	Indicates whether incoming quality level information is enabled (*true*) or disabled (*false*) on the interface.	Any	Configuration
ingressQuality	Indicates the type of incoming quality level information, depending on the globally configured SSM option. For *ITU-T Option I*, available values are *QL-PRC*, *QL-SSU-A*, *QL-SSU-B*, *QL-SEC*, and *QL-DNU*. For *ITU-T Option II generation 1*, available values are *QL-PRS*, *QL-STU*, *QL-ST2*, *QL-SMC*, *QL-ST4*, *QL-DUS*. For *ITU-T Option II generation 2*, available values are *QL-PRS*, *QL-STU*, *QL-ST2*, *QL-TNC*, *QL-ST3*, *QL-SMC*, *QL-ST4*, *QL-DUS*.	Any	Configuration
egressQLMode	Indicates whether incoming quality level information is enabled (*true*) or disabled (*false*) on the interface.	Any	Configuration
egressQuality	Indicates the type of outgoing quality level information, depending on the globally configured SSM option. For *ITU-T Option I*, available values are *QL-PRC*, *QL-SSU-A*, *QL-SSU-B*, *QL-SEC*, and *QL-DNU*. For *ITU-T Option II generation 1*, available values are *QL-PRS*, *QL-STU*, *QL-ST2*, *QL-SMC*, *QL-ST4*, *QL-DUS*. For *ITU-T Option II generation 2*, available values are *QL-PRS*, *QL-STU*, *QL-ST2*, *QL-TNC*, *QL-ST3*, *QL-SMC*, *QL-ST4*, *QL-DUS*.	Any	Configuration
waitToRestore	The amount of time (in milliseconds) the interface waits before adding a source that has just come up (values in the range *0* to *86400*).	Any	Configuration
holdOffTimer	The amount of time (in milliseconds) the interface waits before removing a source that has gone down (values in the range *0* to *50000*, default is *300).*	Any	Configuration

Vendor-Specific Inventory and IMOs

There are no vendor-specific inventory or IMOs for this technology.

Network Topology

Cisco ANA does not support discovery of physical layer topology. This topology is manually (statically) configured by the system administrator. However, it is used in conjunction with the data link layer above it, such as ATM, for discovering its physical topology, while further verifying it by matching the traffic signature of these ports using Cisco's confidential scheme, which requires a substantial amount of traffic in order to function correctly.

Service Alarms

The following alarms are supported for this technology:

- Discard Input Packets/Normal Discard Input Packets
- Dropped Output Packets/Normal Dropped Output Packets
- Link Down/Link Up
- Port Down/Port Up
- Receive Utilization/Receive Utilization Normal
- Transmit Utilization/Transmit Utilization Normal
- DS0 Bundle Admin Down
- DS0 Bundle Oper Down
- DS0 Bundle Up

For detailed information about alarms and correlation, see the *Cisco Active Network Abstraction 3.7 User Guide*.