ATM over E1 Framing Formats on IMA Interfaces

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Introduction

E1 is part of the international digital hierarchy of bit rates greater than 1 Mbps. E1 lines are used throughout the world, particularly in Europe and Asia.

All digital bit rates follow a framing format. Framing is the defined structure of the digital ones and zeros that are transmitted on the physical wire as a particular voltage level or optical light level. A receiving interface needs to recognize where a new frame begins and know how to interpret these ones and zeros.

This document reviews E1 framing formats for E1 lines used with Cisco inverse multiplexing over ATM (IMA) interfaces.

Prerequisites

Requirements

There are no specific requirements for this document.

Components Used

This document is not restricted to specific software and hardware versions.

The information in this document was created from the devices in a specific lab environment. All of the devices used in this document started with a cleared (default) configuration. If your network is live, make sure that you understand the potential impact of any command.

Conventions

For more information on document conventions, refer to the Cisco Technical Tips Conventions.

E1 Multiframe Format

An E1 frame consists of 32 channels or time slots. Two of these time slots are reserved:

- Time slot 0 Carries framing information in a frame alignment signal as well as remote alarm notification, five national bits, and optional cyclic redundancy check (CRC) bits.
- Time slot 16 Carries signaling information out of band. Every time slot in an E1 is a clear channel, and no bits are robbed from a data time slot for signaling.

The full E1 bit rate is 2.048 Mbps. You calculate this bit rate by multiplying the 32−octet E1 frame by 8000 frames per second. Subtracting time slots 0 and 16, you can see that E1 lines offer 30 time slots to carry user data: a payload−carrying capacity of 1.920 Mbps.

Sixteen E1 frames create an E1 multiframe. The purpose of the multiframe is to have sufficient overhead bits to support two key functions in time slot 16, which carries signaling information when an E1 is transmitting digital voice streams.

Frame 0	Frame 1	Frame 2	...	Frame 14	Frame 15

- Frame 0 Synchronizes the receiver to the signaling channel and establishes multiframe alignment.
- Frames 1 to 15 Transmit voice signaling bits for channel associated signaling.

```
30 data channels × 4 signaling (ABCD) bits per channel = 15 bytes
```

These are the important International Telecommunications Union Telecommunication Standardization Sector (ITU−T) standards that define E1 interfaces:

- G.703 Defines electrical and physical properties of an E1 interface. Electrical properties are specifications such as pulse shape, impedance, and peak voltage. Cisco IMA interfaces support G.703 as the basic electrical specification with **crc4adm** and **pcm30adm** framing.
- G.704 Defines the framing format of an E1 interface as well as other bit rates, such as 1.544 Mbps (T1) and 44.736 Mbps (DS−3).
- G.804 Defines how to map ATM cells into E1 frames in the 30 time slots that are available for user data and are not reserved.

  Note: The ATM Forum defines how to map ATM cells into E1 frames in the af−phy−0064.000 specification.

ATM Direct Mapping

It is important to understand the difference in framing between non−ATM E1 interfaces and IMA or ATM E1 interfaces. Non−ATM interfaces specify a different set of framing formats because you do not need to specify how to map the ATM cells into the E1 frame. On non−ATM Cisco router interfaces such as the PA−MC−2E1 specify E1 framing by issuing the **framing {crc4 | no−crc4}** configuration subcommand, as in this example:

```
router(config-controller)# framing crc4
```

When transmitting ATM cells over a digital interface like E1, you map the cells into the physical−layer frame. In the case of an E1 interface, you map the cells directly into the frame. ITU−T Recommendation G.804 and ATM Forum specification af−phy−0064.000 define this ATM direct mapping (ADM) process. ADM uses

the header error check (HEC) field in the cell header to identify the first bit of a cell in an E1 frame. A receiving E1 IMA interface examines the incoming bit stream and checks if a set of eight bits comprises a valid CRC for the preceding 32 bits.

The next table lists the E1 IMA framing formats. Note that two formats incorporate **adm** in their name.

Name of Format	Cisco IOS® Software Name	Description
CCS−CRC	**crc4adm**	Specifies CRC4 framing for the E1 IMA interface.
Basic Frame	**pcm30adm**	Specifies CRC4−disabled or Multiframe−no−CRC4 framing for the E1 IMA interface. (This is the default for a PA−A3−8E1IMA.)
Clear E1	**clear e1**	Specifies clear−e1 framing for the E1 IMA interface.

The alternative to ADM is the physical layer convergence protocol (PLCP). PLCP uses special overhead bytes to delineate the start and end of the ATM cells inside the E1 frame and thus reduces the effective payload rate. Because PLCP adds overhead, ADM replaces PLCP.

Now consider the cell mapping function in more detail. Recall that an E1 frame is exactly 32 octets. Thus, E1 IMA interfaces map ATM cells into bits 9 through 128 and bits 137 through 256 (the 30 payload time slots). Because the payload is not an even multiple of 53 bytes, ATM cells cross E1 frame boundaries. Idle cells fill bit positions left unused by user cells.

CRC4 Framing

Time slot 0 provides important functions for E1 interfaces. A 16−frame multiframe breaks down into two eight−frame semiframes. Within each semiframe, time slot 0 follows one of two formats:

- Frame alignment signal Frames with an even number, such as 0, 2, or 4.

Cx	0	0	1	1	0	1	1	

  - Cx Transmits cyclic redundancy check 4 (CRC4) bits (designated C_1, C_2, C_3, and C_4) in each eight−frame semiframe.
  - Remaining bits Frame alignment signal with specific bit pattern.
- No frame alignment signal Frames with an odd number, such as 1, 3, or 5.

CI	1	A	N	N	N	N	N	

  - Ci Either transmits one of six CRC4 multiframe alignment signal bits or transmits one of two CRC4 error indication bits.
  - 1 Always set to one.

- A Yellow (remote) alarm signal that communicates a loss of signal or an out of frame to the far end.
- N National bits reserved for country−specific control information.

ITU−T specifications G.704 and G.706 define the CRC4 cyclic redundancy check for enhanced error monitoring on the E1 line.

Note: The current 4−bit CRC is calculated from the previous semimultiframe.

Verifying Framing on an IMA E1 Interface

The IMA network module for Cisco 2600 and 3600 series routers supports Multiframe−CRC4 only. This sample output from a Cisco 3640 router shows that you can not enter controller configuration mode to change the framing format:

```
3640−2.2(config)# controller ?

   % Unrecognized command
```

Section 4.1.1.1 of the af−phy−0064.000 standard on the ATM Forum recommends Multiframe−CRC4, which is the correct name, officially.

```
3600# show controller atm0/2

Interface ATM0/2 is administratively down
  Hardware is ATM E1
LANE client MAC address is 0050.0f0c.1482
  hwidb=0x617BEE9C, ds=0x617D498C
  slot 0, unit 2, subunit 2
  rs8234 base 0x3C000000, slave base 0x3C000000
  rs8234 ds 0x617D498C
  SBDs − avail 2048, guaranteed 2, unguaranteed 2046, starved 0

!−−− Output suppressed.

Part of IMA group 3
Link 2 IMA Info:
   group index is 1
   Tx link id is 2, Tx link state is unusableNoGivenReason
   Rx link id is 99, Rx link state is unusableFault
    Rx link failure status is fault,
    0 tx failures, 3 rx failures
Link 2 Framer Info:
    framing is Multiframe−CRC4, line code is HDB3, impedance is 120 ohm
    clock src is line, payload−scrambling is enabled, no loopback
    line status is 0x1064; or Tx RAI, Rx LOF, Rx LOS, Rx LCD.
    port is active, link is unavailable
    0 idle rx, 0 correctable hec rx, 0 uncorrectable hec rx
    0 cells rx, 599708004 cells tx, 0 rx fifo overrun
```

On the IMA port adapter for Cisco 7x00 series routers, the Multiframe−CRC4 format is specified at the router command line as **crc4adm**. The IMA port adapter also supports the **pcm30adm** and **clear e1** framing formats. Issue the framing controller configuration command to select the frame type for an IMA E1 data line.

```
router(config)# controller e1 1/0

router(config−controller)# framing {crc4adm | pcm30adm | clear e1}
```

For more information on this subject, refer to the Framing section of Multiport T1/E1 ATM Port Adapters

with Inverse Multiplexing over ATM.

Caution: Cisco supports the **clear e1** framing format but cautions against using it. This format provides only a 2048 kbps line without framing and, importantly, without support for sending remote alarms; it does allow you to use time slot 16 for transmitting user payload.

Issue the **show controller atm** command on your E1 IMA interface to verify the current setting of your E1 framing format.

```
7200# show controller atm 1/0

Interface ATM1/0 is up
Hardware is IMA PA − E1 (2Mbps)
Lane client mac address is 0090.b1f8.e454
Framer is PMC PM7344, SAR is LSI ATMIZER II
Firmware rev:DG01, ATMIZER II rev:3
  idb=0x61C03C58, ds=0x61C0B480, vc=0x61C2C860, pa=0x61BF9880
  slot 3, unit 1, subunit 0, fci_type 0x00BB, ticks 658
  400 rx buffers:size=512, encap=64, trailer=28, magic=4
linecode is HDB3
E1 Framing Mode: crc.4 adM format
LBO (Cablelength) is long gain43 120db
Facility Alarms:
        No Alarm
```

Configuring Cell Rates on IMA PVCs

On a variable bit rate, non−real time (VBR−NRT) permanent virtual connection (PVC), the maximum kbps value for the peak cell rate parameter is 2000 kbps (2 Mbps). All platforms currently use this same value.

```
3640−2.2(config−if−atm−vc)# vbr−nrt ?

<64−2000>  Peak Cell Rate(PCR) in Kbps
```

As of Cisco IOS Software Release 12.2 (refer to Cisco Bug ID CSCdt57977 (registered customers only)), the bandwidth displayed on ATM IMA T1 and E1 interfaces is 1536 kbps and 1920 kbps, respectively.

Related Information

- **Multiport T1/E1 ATM Port Adapters with Inverse Multiplexing over ATM**
- **Inverse Multiplexing for ATM (IMA) Frequently Asked Questions**
- **IMA (Inverse Multiplexing for ATM) Support Pages**
- **ATM (Asynchronous Transfer Mode) Support Pages**
- **Technical Support − Cisco Systems**

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