Multi-Service Business Routers (MSBR)

Access, Data, Voice & Security

Session Border Controller (SBC)

Configuration Guide

Configuring MSBR for LAN & WAN Access using CLI

HD VoIP Sounds Better

Version 6.8

AudioCodes

Table of Contents

Notice

Information contained in this document is believed to be accurate and reliable at the time of printing. However, due to ongoing product improvements and revisions, AudioCodes cannot guarantee accuracy of printed material after the Date Published nor can it accept responsibility for errors or omissions. Before consulting this document, check the corresponding Release Notes regarding feature preconditions and/or specific support in this release. In cases where there are discrepancies between this document and the Release Notes, the information in the Release Notes supersedes that in this document. Updates to this document and other documents as well as software files can be downloaded by registered customers at http://www.audiocodes.com/downloads.

Date Published: July-06-2017

WEEE EU Directive

Pursuant to the WEEE EU Directive, electronic and electrical waste must not be disposed of with unsorted waste. Please contact your local recycling authority for disposal of this product.

Customer Support

Customer technical support and services are provided by AudioCodes or by an authorized AudioCodes Service Partner. For more information on how to buy technical support for AudioCodes products and for contact information, please visit our Web site at www.audiocodes.com/support.

Abbreviations and Terminology

Each abbreviation, unless widely used, is spelled out in full when first used.

Document Revision Record

LTRT	Description
31660	Initial document release for Version 6.8.
31661	New chapter added for A/VDSL recovery.
31664	New chapters added for Ethernet OAM, Ethernet CFM Verification, Y.1731 and EFM OAM. Removed support for interface termination CO mode.
31666	Updated section for ADSL/VDSL.

Documentation Feedback

AudioCodes continually strives to produce high quality documentation. If you have any comments (suggestions or errors) regarding this document, please fill out the Documentation Feedback form on our Web site at http://www.audiocodes.com/downloads.

1 Introduction

This document describes the different types of LAN and WAN access interfaces and protocols supported by the MSBR. It provides a description of the commands necessary to configure the type of access as well as typical configuration examples.

This page is intentionally left blank.

2 Cellular Interfaces (3G vs. 4G)

3G is the third generation of mobile telecommunications technology. This is based on a set of standards used for mobile devices and mobile telecommunication services. 3G telecommunication networks support services that provide an information transfer rate of at least 200 Kbit/s. The 3G versions 3.5G and 3.75G also provide mobile broadband access of several Mbit/s to smartphones and mobile modems in laptop computers.

4G is the fourth generation of mobile telecommunications technology succeeding 3G. A 4G system, in addition to usual voice and other services of 3G system, provides mobile ultra-broadband Internet access, for example to laptops with USB wireless modems, to smartphones, and to other mobile devices.

Two 4G candidate systems are commercially deployed: the Mobile WiMAX standard and the first-release Long Term Evolution (LTE) standard. 4G technologies enable IP-based voice, data and streaming multimedia at higher speeds and offer at least 100 Mbit/s with high mobility and up to 1 GBit/s with low mobility.

Command	Description
`# configure data`	`Enter data configuration menu.`
`(config-data)# interface Cellular slot/port`	Enter the cellular interface configuration commands. Type `interface cellular ?` to display slot/port location on MSBR.
`(conf-cellular)# pin [pin number]`	Personal identification number. This is a numeric password shared between a user and a system for authentication. The command `pin` grants access only when the number is correct.
`(conf-cellular)# ppp [user] pass/obscured-pass [password]`	Cellular interface can be configured to use PPP authentication protocol when required.
`(conf-cellular)# apn [AccessPoint_Name]`	Configures the name of the Gateway between 3G/4G mobile network and another computer network (internet). A mobile device making a data connection must be configured with an APN to present to the carrier. The carrier then examines this identifier to determine what type of network connection should be created, for example: what IP addresses should be assigned to the wireless device, what security methods should be used, and how or if, it should be connected to some private customer network.
`(conf-cellular)# initstr [AT-Style]`	The command set consists of a series of short text strings which combine together to produce complete commands for operations such as dialing, hanging up, and changing the parameters of the connection.

2.1 Examples

When you attach the cellular modem to MSBR, the MSBR immediately installs drivers.

Figure 2-1: Cellular Interface Example


```
Looking for target devices ...
 No devices in target mode or class found
Looking for default devices ...
 Found devices in default mode or class (1)
Accessing device 005 on bus 001 ...[4361336.011000] usb 1-1.2:
usbfs: process 7445 (usb_modeswitch) did not claim interface 0
before use

Getting the current device configuration ...
 OK, got current device configuration (1)
Using endpoints 0x01 (out) and 0x81 (in)
Using endpoints 0x01 (out) and 0x81 (in)
Inquiring device details; driver will be detached ...
Looking for active driver ...
 OK, driver found ("usb-storage")
 OK, driver "usb-storage" detached

SCSI inquiry data (for identification)
-------------------------
  Vendor String: HUAWEI
   Model String: Mass Storage
Revision String: 2.31
-------------------------

USB description data (for identification)
-------------------------
Manufacturer: Huawei Technologies
     Product: HUAWEI Mobile
  Serial No.: not provided
-------------------------
Setting up communication with interface 0 ...
Using endpoint 0x01 for message sending ...
Trying to send message 1 to endpoint 0x01 ...
 OK, message successfully sent
Resetting response endpoint 0x81
Resetting message endpoint 0x01

Checking for mode switch (max. 20 times, once per second) ...
```

```
 Waiting for original device to vanish ...
 Original device can't be accessed anymore. Good.
 Searching for target devices ...
 Searching for target devices ...
 Searching for target devices ...
 Searching for target devices ...
 Searching for target devices ...

Found target device, now opening
 Found correct target device

Mode switch succeeded. Bye.
```

After MSBR successfully installs the driver, it configures the cellular interface (but not completely):

```
#configure data
(config-data)# interface Cellular 0/0
```

- Configured automatically:

```
(conf-cellular)# ip dns server auto
(conf-cellular)# initstr AT&F (means Restore factory settings)
(conf-cellular)# apn uinternet
(conf-cellular)# phone *99#
(conf-cellular)# firewall enable
(conf-cellular)# napt
(conf-cellular)# mtu auto
(conf-cellular)# ip address auto
```

- Configured manually:

```
(conf-cellular)# ppp user orange pass PASSWORD
(conf-cellular)# no shutdown
(conf-cellular)# pin 1111 (without this command there will be
no connection to the internet)
(conf-cellular)# exit

# Add Default route to traffic through Cellular interface:
(config-data)# ip route 0.0.0.0 0.0.0.0 Cellular 0/0
```

The following show command displays the current status of the interface:

```
# show data interfaces cellular 0/0

Cellular 0/0 is Connected.
  Description: 3G Cellular PPP connection
  IP address negotiated using PPP is 10.170.120.150
  State Time:   0:01:19
  Time since creation:   0:02:25
  Time since last counters clear :   0:01:19
  mtu auto
  napt
  network wan
  DNS is configured dynamic
  DNS primary IP address is 82.102.139.10
  DNS secondary IP address is 82.102.139.20
```

```
  IPv6 is disabled
  rx_packets 13    rx_bytes 594    rx_dropped 0       rx_errors 0
  tx_packets 13    tx_bytes 416    tx_dropped 0       tx_errors 0
  15-seconds input rate:   22 bits/sec, 0 packets/sec
  15-seconds output rate:  16 bits/sec, 0 packets/sec

  Tunnel destination server is (none)
  Remote server IP: 10.64.64.64
  ppp configuration:
  username: orange, password: (not shown)
  enabled authentication methods: chap ms-chap ms-chap-v2 pap
  lcp echo parameters: interval 6, fails
```

The following show command displays all the cellular interface status:

```
# show data cellular status
Cellular interface status:
        Modem status:       UP
        PPP status:         UP
        KB sent:            708
        KB received:        631
        Packets sent:       42503
        Packets received:   42831
```

Verify that the cellular installation has completed successfully, using the following command:

```
# show system assembly
Board Assembly Info:
| Slot No.            | Ports      | Module Type              |
| 0/0                 | 1          | WAN-Copper               |
| 0/1                 | 1          | WAN-Fiber                |
| 0/2                 | 1          | WAN-A/VDSL               |
| 1                   | 1-4        | LAN-GE                   |
| 2                   | 1-4        | FXS                      |
USB Port 1:  Manufacturer - ZTE,Incorporated, Product - ZTE WCDMA
Technologies MSM, Product Id - 0124, Vendor Id - 19d2, Type -
Cellular
USB Port 2: Empty
```

You can also use the cellular interface for WAN backup, as described in Section 15 on page 57.

3 PPP and PPPoE

Point-to-Point Protocol (PPP) and Point-to-Point Protocol over Ethernet (PPPoE) are network protocols that allow data communication between two network hosts or points. PPPoE is encapsulated in Ethernet frames. Both protocols exist at the network access layer (also known as the data link layer). PPP can be encapsulated in a number of data link layer protocols such as Ethernet (PPPoE).

PPP supports three types of user authentication protocols that provide varying levels of security (CHAP/PAP/EAP).

PPPoE expands the original capability of PPP by allowing a virtual point-to-point connection over a multipoint Ethernet network architecture, PPPoE is configured as a point-to-point connection between two Ethernet ports. As a tunneling protocol, PPPoE is used as an effective foundation for the transport of IP packets at the network layer.

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# interface pppoe [0-7 interface number]`	Enter the PPPoE interface commands.
`(conf-pppoe-[number])# underlying [interface slot/port]`	Configures the interface with which the PPPoE interface commands are associated.
`(conf-pppoe-[number])# ppp user[user name] obscured-pass [pass]`	Configures the user and password authentication by using PPP on that interface.
`(conf-pppoe-[number])# ppp authentication [chap/pap/ms-chap/ms-chap-v2]`	Enables PPP authentication. No limit is placed on which and how many authentication is used (all four can be activated on the same interface). ▪ pap: Password Authentication Protocol – normal login when a connection has been made the host sends a username and password. ▪ chap: Challenge Handshake Authentication Protocol – CHAP does not have these deficiencies. With CHAP, the authenticator (i.e. the server) sends a randomly generated ``challenge'' string to the client, along with its hostname. The client uses the hostname to look up the appropriate secret, combines it with the challenge, and encrypts the string using a one-way hashing function. The result is returned to the server along with the client's hostname. ▪ ms-chap: Microsoft version of CHAP authentication.
`(conf-pppoe-[number])# ppp lcp-echo [interval_sec_number] [fails number]`	PPP Link Control Protocol (LCP) negotiates the link and PPP parameters to dynamically configure the data link layer of a PPP connection. ▪ Interval option: determines how often Echo-Request messages are sent on idle links to check the viability and integrity of the link. ▪ Fails option: determines how many echo-reply missed before announcing that the link has been broken.

3.1 Examples

This example shows how to use PPP authentication after plugging in the cellular modem device. You need to enter a username and encrypted password to make the cellular modem authenticate with the server.

Figure 3-1: PPP and PPPoE Example


```
# configure data
MSBR(config-data)# int cellular 0/0
MSBR(conf-cellular)# ppp user user pass 012@pass
```

Another example is after a VDSL connection has been established, an EFM interface is automatically configured, but you need to configure the PPPoE interface:

```
#configure data
(config-data)# interface EFM 0/2
(conf-if-efm 0/2)# ip address 10.3.90.26 255.255.0.0
(conf-if-efm 0/2)# desc "VDSL"
(conf-if-efm 0/2)# no shutdown
(conf-if-efm 0/2)# exit
(config-data)#int pppoe 0
(conf-pppoe-0)# ppp user user@ISP pass PASSWORD
(conf-pppoe-0)# ppp authentication chap
(conf-pppoe-0)# ppp authentication ms-chap
(conf-pppoe-0)# ppp authentication ms-chap-v2
(conf-pppoe-0)# ppp authentication pap
(conf-pppoe-0)# ppp lcp-echo 6 5
(conf-pppoe-0)# underlying EFM 0/2
(conf-pppoe-0)# no shutdown
(conf-pppoe-0)# exit
(config-data)# ip route 0.0.0.0 0.0.0.0 EFM 0/2
```

4 ADSL/VDSL

Asymmetric Digital Subscriber Line (ADSL) is a technology used for transmitting digital information at a high bandwidth on existing phone lines to homes and businesses. ADSL is asymmetric in that it uses most of the channel to transmit downstream to the user and only a small part to receive information from the user.

ADSL is generally offered at downstream data rates from 512 Kbps to approximately 6 Mbps. It uses standard telephone lines to upload and download data on a digital frequency, which separates these data streams from the analog signals that are used by telephones and fax machines. The telephone can be used at the same time when surfing the Web with a DSL service because the signal operates on a different frequency.

Very-high-bit-rate digital subscriber line (VDSL or VHDSL) is a digital subscriber line (DSL) technology providing data transmission faster than ADSL over a single flat untwisted or twisted pair of copper wires (up to 52 Mbit/s downstream and 12 Mbit/s upstream), using the frequency band from 25 kHz to 12 MHz. These rates imply that VDSL is capable of supporting applications such as high-definition television, as well as telephone services (voice over IP) and general Internet access over a single connection.

The MSBR will set the modem to use ADSL or VDSL automatically by sensing the signals on the wire. It is not possible and not required to configure ADSL or VDSL manually.

To configure ADSL mode use the commands shown in the table below:

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# interface dsl slot/port`	Enter the physical DSL port.
`(conf-if-dsl slot/port)# no shutdown`	Shutdown is default configuration for this kind of port; use it to enable the DSL interface.
`# show data interfaces dsl slot/port`	Displays DSL interface information such as: current configuration, downstream and upstream bandwidth and status (connected, disconnected).

4.1 ADSL Examples

In this example, MSBR connects to the Internet Service Provider using ADSL mode.

Figure 4-1: ADSL Example


```
# configure data
(config-data)# interface dsl 0/0
(conf-if-dsl 0/0)# no shutdown
```

Once the DSL port senses that it is connected to ADSL, the ADSL mode is automatically selected and the show command displays the status of the interface:

```
# show data interfaces dsl 0/2
Hardware is ADSL/VDSL-WAN mezzanine, rev 1 on slot 0/2
Capabilities: CPE termination. ADSL Annex A/J, VDSL2
Framer XWAY VRX268 Firmware ver 1.5
  DSL Link Info
         Configuration: mode adsl,  no shutdown
         Line Termination: CPE, Annex: A
 DSL mode: ADSL2+ (ITU-T G.992.5)
         Status: Connected
   Downstream info
         Data rate (bps): Maximum Attainable 26488000/ Actual 26488000
         Power   10.2, Line Attenuation   0.0, SNR Margin  10.6
   Upstream info
         Data rate (bps): Maximum Attainable  1239000/ Actual  1236000
         Power   12.4, Line Attenuation   0.0, SNR Margin   6.0
   Performance Monitoring
         Current 15-min interval statistics (Assessed seconds: 67):
                 NearEnd - UAS: [ 39], ES: [  0], SES: [  0], LOSS: [  0], LOFS: [  0],
CRC: [    0], FEC: [    0], HEC: [    0]
                 FarEnd  - UAS: [ 39], ES: [  0], SES: [  0], LOSS: [  0], LOFS: [  0],
CRC: [    0], FEC: [    0], HEC: [    0]
                 ATM Rx  37401 cells    181 data cells
         Last 24-hour interval statistics: (Assessed seconds: 67)
                 NearEnd - UAS: [ 39], ES: [  0], SES: [  0], LOSS: [  0], LOFS: [  0],
CRC: [    0], FEC: [    0], HEC: [    0]
                 FarEnd  - UAS: [ 39], ES: [  0], SES: [  0], LOSS: [  0], LOFS: [  0],
CRC: [    0], FEC: [    0], HEC: [    0]
                 ATM Rx  37401 cells    181 data cells
         Last showtime statistics: (Assessed seconds: 13)
                 NearEnd - UAS: [  0], ES: [  0], SES: [  0], LOSS: [  0], LOFS: [  0],
CRC: [    0], FEC: [    0], HEC: [    0]
                 FarEnd  - UAS: [ 39], ES: [  0], SES: [  0], LOSS: [  0], LOFS: [  0],
CRC: [    0], FEC: [    0], HEC: [    0]
                 ATM Rx  37401 cells    181 data cells

   DSL. Current bandplan table
   Band Format: (Index, Direction,(First Tone Idx, Last Tone Idx),(First Tone MHz, Last
Tone MHz))
( 0, DOWNSTREAM, (   32,  511), (  0.138,  2.204))
( 1,   UPSTREAM, (    6,   31), (  0.026,  0.134))
```

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# interface dsl slot/port`	Enter the physical DSL port.
`(conf-if-dsl slot/port)# no shutdown`	Shutdown is default configuration for this kind of port; use it to enable the DSL interface.
`# show data interfaces dsl slot/port`	Displays DSL interface information, such as: current configuration, downstream and upstream bandwidth and status (connected, disconnect).

4.2 Examples

In this example, MSBR is connected to the Service Provider and is configured to VDSL mode.

Figure 4-2: VDSL Example


```
# configure data
(config-data)# interface dsl 0/0
(conf-if-dsl 0/0)# no shutdown
```

After you have configured the DSL port connection, use the following command to display the status of the interface:

```
# show data interfaces dsl
Hardware is ADSL/VDSL-WAN mezzanine, rev 1 on slot 0/0
Capabilities: CPE termination. ADSL Annex A/J, VDSL2
Framer XWAY VRX268 Firmware ver 1.5
  DSL Link Info
        Configuration: mode vdsl,  no shutdown
        Line Termination: CPE, Annex: A
  DSL mode: VDSL2 (ITU-T G.993.1), VDSL Profile DSL_PROFILE_17A
        Status: Connected
   Downstream info
        Data rate (bps): Maximum Attainable 141622672/ Actual 119992000
        Power    6.6, Line Attenuation   0.4, SNR Margin  12.5
   Upstream info
        Data rate (bps): Maximum Attainable 60740000/ Actual 50008000
        Power   10.7, Line Attenuation   0.0, SNR Margin  13.7
   Performance Monitoring
        Current 15-min interval statistics (Assessed seconds: 90):
                NearEnd - UAS: [ 35], ES: [  0], SES: [  0], LOSS: [  0], LOFS:
[0], CRC: [    0], FEC: [    0], HEC: [    0]
                FarEnd  - UAS: [ 35], ES: [  0], SES: [  0], LOSS: [  0], LOFS:
[0], CRC: [    0], FEC: [    0], HEC: [    0]
        Last 24-hour interval statistics: (Assessed seconds: 90)
                NearEnd - UAS: [ 35], ES: [  0], SES: [  0], LOSS: [  0], LOFS:
[0], CRC: [    0], FEC: [    0], HEC: [    0]
```

```
                  FarEnd  - UAS: [ 35], ES: [  0], SES: [  0], LOSS: [  0], LOFS:
[0], CRC: [    0], FEC: [    0], HEC: [    0]
         Last showtime statistics: (Assessed seconds: 39)
                  NearEnd - UAS: [  0], ES: [  0], SES: [  0], LOSS: [  0], LOFS:
[0], CRC: [    0], FEC: [    0], HEC: [    0]
                  FarEnd  - UAS: [ 35], ES: [  0], SES: [  0], LOSS: [  0], LOFS:
[0], CRC: [    0], FEC: [    0], HEC: [    0]

   DSL. Current bandplan table
   Band Format: (Index, Direction,(First Tone Idx, Last Tone Idx),(First Tone MHz,
Last Tone MHz))
( 0, DOWNSTREAM, (  161,  857), (  0.694,  3.696))
( 1, DOWNSTREAM, ( 1218, 1959), (  5.253,  8.448))
( 2, DOWNSTREAM, ( 2795, 4083), ( 12.053, 17.608))
( 3,   UPSTREAM, (  882, 1193), (  3.804,  5.145))
( 4,   UPSTREAM, ( 1984, 2770), (  8.556, 11.946))
```

5 ATM-based Interfaces and Encapsulation

Asynchronous Transfer Mode (ATM) is a high-speed networking standard designed to support both voice and data communications. ATM is normally utilized by Internet service providers on their private long-distance networks. ATM operates at the data link layer (Layer 2 in the OSI model) over either fiber or twisted-pair cable.

ATM differs from more common data link technologies such as Ethernet in several ways:

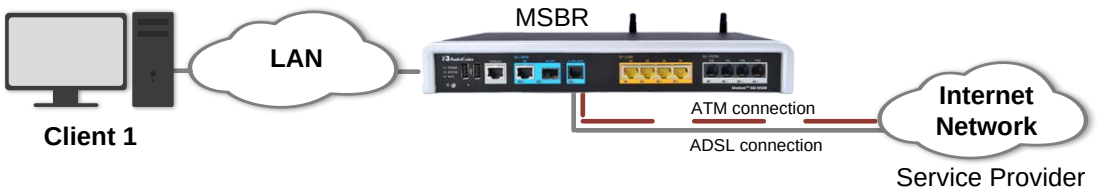
- ATM utilizes no routing. Hardware devices known as ATM switches establish point-to-point connections between endpoints and data flows directly from source to destination.
- Instead of using variable-length packets as Ethernet does, ATM utilizes fixed-sized cells. ATM cells are 53 bytes in length that includes 48 bytes of data and 5 bytes of header information.
- ATM technology is designed to improve utilization and quality of service (QoS) on high-traffic networks. Without routing and with fixed-size cells, networks can much more easily manage bandwidth under ATM than under Ethernet.

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# interface atm slot/port`	Create a logical ATM port that "rides" on the DSL physical port.
`(conf-atm slot/port)# pvc slot/number_pvc`	Establishes a permanent virtual circuit (PVC) connection. Specify the PVC number as well.
`(conf-atm slot/port)# ubr`	Unspecified bit rate, a traffic contract used to guarantee QoS for ATM networks.
`(conf-atm slot/port)# ip address [IP Address] [Subnet Mask]`	Configure an IP Version 4 address for the ATM interface.
`(conf-atm slot/port)# encapsulation [ethoa-mux ,ethoa-snap, ipoa-mux ,ipoa-snap ,pppoa-mux , pppoa-snap,pppoe , pppoe-mux]`	Configure the protocol type: ▪ ipoa: IP over ATM ▪ ethoa: Ethernet over ATM ▪ pppoe: PPP over Ethernet ▪ pppoa: PPP over ATM Configure the encapsulation: ▪ snap: SubNetwork Attachment Point (SNAP). This is an encapsulation called LLC. LLC encapsulation is needed when more than one protocol might be carried over the same VC (Virtual Circuit) and the snap header uniquely identifies a routed or bridged protocol. For example, value 0x00-00-00 indicates that an EtherType is in use. ▪ mux: Multiplexing. In the "VC Multiplexing" method, each ATM VC carries PDUs of exactly one protocol type. When multiple protocols need to be transported, there is a separate VC for each.
`(conf-atm slot/port)# ppp [user] [password]`	For PPP authentication (if required). Type the username and password (encrypted or not).

5.1 Examples

In this example below, the MSBR is connected to the Service Provider and the ATM logical interface also needs to be configured.

Figure 5-1: ATM Example



Configuration:

1. Configure the physical DSL port:

```
# configure data
(config-data)# interface dsl 0/0
(conf-if-dsl 0/0)# no shutdown
(conf-if-dsl 0/0)# mode adsl
```

2. Configure the logical layer ATM:

```
(config-data)# interface ATM 0/0
(conf-atm0/0)# encapsulation ethoa-snap
(conf-atm0/0)# pvc 0/35
(conf-atm0/0)# ubr
(conf-atm0/0)# ip address 10.3.90.30 255.255.0.0
(conf-atm0/0)# exit
```

3. Route traffic to the Internet network:

```
(config-data)# ip route 0.0.0.0 0.0.0.0 ATM 0/0
```

To view the interface status, use the following command:

```
# show data interfaces atm 0/0

ATM 0/0 is Connected.
  Description: ATM 0/0
  Hardware address is 00:90:8f:4b:bd:c6
  IP address is 10.3.90.30
  netmask is 255.255.0.0
  State Time:   0:11:51
  Time since creation:  18:24:50
  Time since last counters clear :   0:12:55
  mtu auto
  napt
  IPv6 is disabled
  rx_packets 14520   rx_bytes 762001        rx_dropped 0      rx_errors 0
  tx_packets 9       tx_bytes 680           tx_dropped 0      tx_errors 0
  15-seconds input rate:   30.8 Kbps, 78 packets/sec
  15-seconds output rate:  27 bits/sec, 0 packets/sec
  5-minutes input rate:  13.1 Kbps, 31 packets/sec
  5-minutes output rate: 10 bits/sec, 0 packets/sec
```

The following example shows the use of the PPP protocol and the different encapsulation on the ATM interface:

```
(config-data)# interface ATM 0/0
(conf-atm0/0)# encapsulation pppoe
(conf-atm0/0)# ppp user user@ISP pass Encrypt_pass
(conf-atm0/0)# pvc 8/48
(conf-atm0/0)# ubr
(conf-atm0/0)# exit
(config-data)# ip route 0.0.0.0 0.0.0.0 ATM 0/0
```

This page is intentionally left blank.

6 EFM Interfaces

Ethernet in the First Mile (EFM) is a technology that utilizes symmetric dedicated leased lines to offer bandwidth speeds of up to 35 Mbps. It provides a point-to-point solution that utilizes multiple copper-pairs for enhanced connectivity and resilience. Whereas standard ADSL and SDSL offer just one line, a copper EFM connection can use several of them in parallel - meaning that if one individual line fails, connection can still be maintained, albeit at a lower throughput.

EFM is used in traditional copper circuits. 'EFM over copper' works by sending electrical signals over copper wires to deliver fast speeds and fix faults reliably. Its main selling point is the multiple lines, which provide increased bandwidth. Network operators will provide at least 2 and up to as many as 8 'copper-pairs', which work to improve bandwidth speeds, productivity, and efficiency.

EFM capabilities:

- EFM leased lines offer consistently high speeds and a symmetrical connection (upstream is similar to downstream).
- EFM connections have much lower latency (delay between when the data is sent and when it is received), so the shorter the delay the better.

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# interface efm slot/port`	This interface is automatically configured when VDSL mode is active. The `efm slot/port` is displayed with the command, `show running data`.
`(conf-if-dsl slot/port)# no shut`	Enables the interface.

6.1 Examples

In this example, EFM is required after the VDSL connection has been established.

Figure 6-1: EFM Example


```
# configure data
(config-data)# interface dsl 0/0
(conf-if-dsl 0/0)# no shutdown
(conf-if-dsl 0/0)# mode vdsl
(conf-if-dsl 0/0)# exit
(config-data)# interface EFM 0/2
(conf-if-efm 0/2)# ip address 10.3.90.26 255.255.0.0
(conf-if-efm 0/2)# desc "VDSL"
(conf-if-efm 0/2)# no shutdown
(conf-if-efm 0/2)# exit
(config-data)# ip route 0.0.0.0 0.0.0.0 EFM 0/2
```

Another example (based on the previous example) is to use PPP authentication with a PPPoE interface to secure connection:

```
(config-data)# int pppoe 0
(conf-pppoe-0)# ppp user audco121@012 pass cgEaQUMYFg4e
(conf-pppoe-0)# ppp authentication chap
(conf-pppoe-0)# ppp authentication ms-chap
(conf-pppoe-0)# ppp authentication ms-chap-v2
(conf-pppoe-0)# ppp authentication pap
(conf-pppoe-0)# ppp lcp-echo 6 5
(conf-pppoe-0)# underlying EFM 0/2
(conf-pppoe-0)# no shutdown
(conf-pppoe-0)# exit
```

To view the EFM interface status, use the following command:

```
# show data interfaces efm 0/2

EFM 0/2 is Enabled - connection in process
  Description: VDSL
  Hardware address is 00:90:8f:4b:bd:c6
  IP address is 10.3.90.26
  netmask is 255.255.0.0
  State Time:   0:00:52
  Time since creation:  18:04:40
  mtu is 1568 bytes
  IPv6 is disabled
  rx_packets 13578  rx_bytes 944361    rx_dropped 0    rx_errors 0
  tx_packets 12     tx_bytes 824       tx_dropped 0    tx_errors 0
  15-seconds input rate:   0 bits/sec, 0 packets/sec
  15-seconds output rate:  0 bits/sec, 0 packets/sec
  5-minutes input rate:  13.6 Kbps, 24 packets/sec
  5-minutes output rate: 25 bits/sec, 0 packets/sec
```

7 SHDSL - EFM/ATM

Symmetrical high-speed digital subscriber line (SHDSL) is a form of DSL, a data communications technology that enables faster data transmission over copper telephone lines than a conventional voice-band modem can provide.

Compared to ADSL, SHDSL employs modulation and frequencies that include those used by analog plain old telephone service (POTS) to provide equal transmit and receive (i.e. symmetric) data rates. As such, a frequency splitter, or DSL filter, cannot be used to allow a telephone line to be shared by both an SHDSL service and a POTS service at the same time.

SHDSL features symmetrical data rates in both the upstream and downstream directions, from 192 to 2,312 kbit/s of payload in 8-kbit/s increments for one pair and 384 to 4,624 kbit/s in 16-kbit/s increments for two pairs of wires, The two pair feature may alternatively be used for increased reach applications by keeping the data rate low. Halving the data rate per pair provides similar speeds to single pair lines while increasing the error/noise tolerance.

Generally, it is capable of transferring T1, E1, ATM, IP, and ISDN signals at a high-speed data rate that ranges between 192 kbit/s and 2.3 Mbit/s, and covers distances from 1.8 to 4.6 miles (about 3 to 7.5 km) per second.

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# interface shdsl slot/port`	SHDSL port configuration mode.
`(conf-if-shdsl slot/port)# mode atm/efm`	Configures the technology to use for the SHDSL interface.
`(conf-if-shdsl slot/port)# group [group number – 0-7]`	Up to 8 groups can be configured, where each group can be configured differently (annex, pairs, termination and mode).
`(conf-if-shdsl slot/port)# annex A/B/F/G`	▪ Annex A: Describes the specifications that are unique to SHDSL systems operating under conditions such as those typically encountered within the North American network. ▪ Annex B: Describes the specifications that are unique to SHDSL systems operating under conditions such as those typically encountered within European networks. The clauses in this annex provide the additions and modifications to the corresponding clauses in the main body and Annex A for payload data rates up to 5696 kbps. The clauses in this annex provide the additions and modifications to the corresponding clauses in the main body and Annex B for payload data rates up to 5696 kbps.
`(conf-if-shdsl slot/port)# pairs [RJ11_pin pairs]`	Configures which pairs would wire.
`(conf-if-shdsl slot/port)# termination cpe`	Determines the interface termination used for connecting to SHDSL DSLAM lines (with CPE mode).

Command	Description
`(conf-if-shdsl slot/port)# linerate auto`	Configures the rate on the SHDSL interface.

7.1 Examples

In this example, the SHDSL connection needs to be configured for MSBR and a DSLAM DSL line. The MSBR acts like a CPE, and the CO is the DSLAM (MSBR is the client side.)

Figure 7-1: SHDSL Example

1. Configure the SHDSL interface (ATM or EFM mode):

```
# configure data
(config-data)# interface shdsl 0/1
(conf-if-shdsl 0/1)# mode atm|efm
(conf-if-shdsl 0/1)# no group 1
(conf-if-shdsl 0/1)# no group 2
(conf-if-shdsl 0/1)# no group 3
(conf-if-shdsl 0/1)# group 0
(conf-if-shdsl-0)# termination cpe
(conf-if-shdsl-0)# linerate auto
(conf-if-shdsl-0)# annex A
(conf-if-shdsl-0)# caplist-style new
(conf-if-shdsl-0)# pairs 0,1,2,3
(conf-if-shdsl-0)# exit
(conf-if-shdsl 0/1)# exit
```

- **If ATM mode:**

  1. Configure the ATM interface:

```
# configure data
(config-data)# interface atm 0/0
(conf-atm0/0)# encapsulation ethoa-snap
(conf-atm0/0)# pvc 0/36
(conf-atm0/0)# ubr
(conf-atm0/0)# ip address dhcp
(conf-atm0/0)# ip dns server auto
(conf-atm0/0)# mtu auto
```

  2. Configure routing:

```
(config-data)# ip route 0.0.0.0 0.0.0.0 ATM 0/0
```

- **If EFM mode:**

  1. Configure the EFM interface:

```
# configure data
(config-data)# interface EFM 0/2
(conf-if-EFM 0/2)# ip address dhcp
(conf-if-EFM 0/2)# ip dns server auto
(conf-if-EFM 0/2)# no shutdown
(conf-if-EFM 0/2)# exit
```

  2. Configure routing:

```
(config-data)# ip route 0.0.0.0 0.0.0.0 EFM 0/2
```

To view the SHDSL status, use the following command:

```
# show data interface shdsl
Hardware is SHDSL-WAN mezzanine, rev 1 on slot 0/1
Capabilities: M-pair, 2/4 wire, Annex A, B, F & G, CPE termination
Framer SOC-4e version 1.2 IDC FW version 1.7.5

  Group (0) Info:
         Type: M-pair over g.shdsl, Status: UP
         Master Pair: 0 ,slave pairs: 1,2,3
         Line Termination: CPE, Line Mode: M-Pair, ANNEX_A_F, PMMS
Disabled
         Operation Mode: ATM
         Line Coding: N/A, Configured line rate/ Actual payload
rate: 22784/0 kbps
         Connection state: DOWN_NOT_READY, Condition: 0, Reason: 0
         Power back off: 0 dB, FarEnd power back off: 0 dB
         Loop attenuation: 0 dB, SNR margin: 0 dB, Link Losses: 0

         Current interval (15 minutes) statistics:
                 ES: 0, SES: 0, CRC: 0, LOSWS: 0, UAS: 321
         Previous interval (15 minutes) statistics:
                 ES: 0, SES: 0, CRC: 0, LOSWS: 0, UAS: 900
         Current 24 hours statistics:
                 ES: 0, SES: 0, CRC: 0, LOSWS: 0, UAS: 1934838
         Previous 24 hours statistics:
                 ES: 0, SES: 0, CRC: 0, LOSWS: 0, UAS: 0

         ATM-TC Tx: data cells: 0, Idle cells: 4673976
         ATM-TC Rx: data cells: 0, Uncorrected HEC cells: 0
         ATM-TC Rx: OCD starts: 0, LCD starts: 0, LCD stops: 0

  Group (1) is not configured

  Group (2) is not configured

  Group (3) is not configured

# show data shdsl status
SHDSL status:
   SHDSL group 0: Connected
```

```
   SHDSL group 1: Disabled
   SHDSL group 2: Disabled
   SHDSL group 3: Disabled
   SHDSL group 5: Disabled
   SHDSL group 6: Disabled
   SHDSL group 7: Disabled
```

8 Ethernet OAM

8.1 What is Ethernet OAM

Operations, Administration, and Maintenance (OAM) is a general term that refers to a toolset for fault detection and isolation, and for performance measurement in the network.

In particular, Ethernet operations, administration and maintenance (EOAM) is a group of protocols for installing, monitoring and troubleshooting Ethernet Metropolitan area network (MANs) and Ethernet WANs.

This group includes the following three protocols:

- CFM OAM (IEEE 802.1ag)
- Y.1731
- EFM OAM (IEEE 802.3ah)

8.2 Ethernet CFM (CFM OAM)

8.2.1 Description

Ethernet CFM (Connectivity Fault Management) is a computer networking protocol designated to provide end-to-end Ethernet layer proactive connectivity monitoring, fault verification and fault isolation for large Metro-Ethernet networks.

CFM was originally published as IEEE 802.1ag; however, is now incorporated in the 802.1 standard.

This protocol's extensions, among others, include Y.1731 which provides additional signaling, measuring, and functionality for the CFM operation.

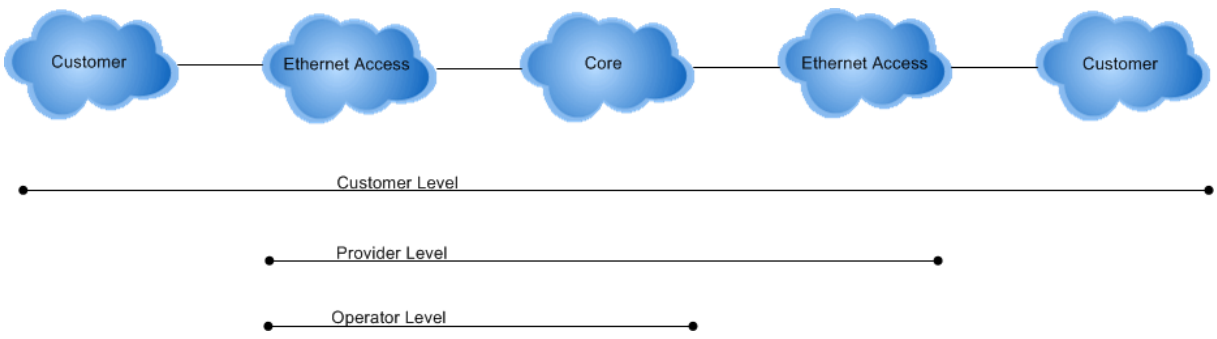
8.2.1.1 Acronyms & Terms

- **Maintenance Domain (MD):** Management space on a network, typically owned and operated by a single entity. MDs are configured with Names and Levels, where the eight levels range from 0 to 7.

  A hierarchical relationship exists between domains based on levels. The larger the domain, the higher the level value. The recommended values of levels are as follows:

  - Customer Domain: Largest (e.g., 7)
  - Provider Domain: In between (e.g., 3)
  - Operator Domain: Smallest (e.g., 1)

Figure 8-1: Maintenance Domains



- **Maintenance Association (MA):** A set of MEPs, all of which are configured with the same MAID (Maintenance Association Identifier) and MD level, each of which is configured with a MEPID unique within this MAID and MD level, and all of which are configured with the complete list of MEPIDs.

- **Maintenance association End Point (MEP):** Points at the edge of the domain which define the boundary for the domain. A MEP sends and receives CFM frames through the relay function, dropping all CFM frames of its level or lower that are received from the wire side.
- **Maintenance domain Intermediate Point (MIP):** Points internally to a domain (not at the boundary). CFM frames received from MEPs and other MIPs are cataloged and forwarded; all CFM frames at a lower level are stopped and dropped. MIPs are passive points that respond only when triggered by CFM trace route and loopback messages.

8.2.1.2 CFM Sub-Protocols

IEEE 802.1ag Ethernet CFM (Connectivity Fault Management) protocols comprise three protocols that work together to help administrators debug Ethernet networks. These are as follows:

- **Continuity Check Protocol (CCP):** "Heartbeating" messages for CFM. The Continuity Check Message (CCM) provides a means of detecting connectivity failures in an MA. CCMs are multicast messages that are confined to a domain (MD). These messages are unidirectional and do not solicit a response. Each MEP transmits a periodic multicast Continuity Check Message inward towards the other MEPs.
- **Link Trace (LT):** Link Trace messages otherwise known as Mac Trace Route are Multicast frames that a MEP transmits to track the path (hop-by-hop) to a destination MEP. This is similar in concept to User Datagram Protocol (UDP) Trace Route. Each receiving MEP sends a Trace Route Reply directly to the Originating MEP and regenerates the Trace Route Message.
- **Loop-back (LB):** Loopback messages otherwise known as MAC ping are Unicast frames that an MEP transmits. These messages are similar in concept to an Internet Control Message Protocol (ICMP) Echo (Ping) message, where sending a Loopback message to successive MIPs can determine the location of a fault. Sending a high volume of Loopback Messages can test bandwidth, reliability, or jitter of a service, which is similar to a flood ping. A MEP can send a Loopback message to any MEP or MIP in the service. Unlike CCMs, Loopback messages are administratively initiated and stopped.

8.2.2 CFM MPID Configuration

The table below describes the CFM MPID commands.

Command	Description
`# configure data`	Enter data configuration menu.
`# ethernet cfm mep domain [string] mpid [x]`	Creates a MPID Maintenance Point ID unit within a specific domain with a unique ID (MPID).
`#(conf-mep)# level x`	A unique maintenance level assigned to a Management Domain. Levels help to create a hierarchy between management domains. Generally, the larger the domain, the higher the level. Range: 0-7
`#(conf-mep)# domain-name-format string`	The Domain Name format that can be one of the following: • **None:** Do not include domain name as string • **String:** Include domain name as string

Command	Description
`#(conf-mep)# service string [string][number][vid]`	Maintenance Association (MA) short name that can be one of the following: • number • string • vid
`#(conf-mep)# link-state reflect`	Defines the CFM protocol to reflect the status of a LAN interface.
`#(conf-mep)# interface [name]`	WAN port that interfaces the maintenance domain and towards the other MEPs.
`#(conf-mep)# continuity-check interval [interval-string]`	“heartbeat” mechanism of the protocol, with adjustable interval. Possible values are: 100ms, 10m, 10ms, 10s,1m, 1s and 3ms
`#(conf-mep)# exit`	Returns to the data menu.

This page is intentionally left blank.

9 Ethernet CFM Verification

This chapter describes Ethernet CFM verification commands.

9.1.1 Show Data Ethernet CFM

This command displays CFM interface information for local and remote MFPs and checks the results.

```
Board_BS_5001# show data ethernet cfm

Local MEPs:
MPID  VLAN   RmtRDI MAC    Remote XCON
---------------------------------------
   17 OK     OK     Error  OK     OK

Remote MEPs:
MPID  Stat DomainName           MAC                Age    Intf
Port
-------------------------------------------------------------------
--
    7 UP   dima                 10:05:ca:2d:8d:89       2s Up
Down

Board_BS_500# show data ethernet cfm legend

Local MEPs:
MPID  VLAN   RmtRDI MAC    Remote XCON
---------------------------------------
   17 OK     OK     Error  OK     OK

Error legend:
VLAN  : The local logical interface is down.
RmtRDI: One of the remote MEPs is not receiving all CCMs.
MAC   : One of the remote MEPs has a blocked port status.
Remote: There are no known remote MEPs.
XCON  : The MEP is receiving CCMs from different domains or
services.

Remote MEPs:
MPID  Stat DomainName           MAC                Age    Intf
Port
-------------------------------------------------------------------
--
    7 UP   dima                 10:05:ca:2d:8d:89       6s Up
Down

Board_BS_500#
```

9.1.2 Ping Ethernet

This command sends layer two queries to a destination domain and displays the results.

```
Board_BS_500# ping ethernet mpid 7 domain dima
(1/1) Reply from 10:05:ca:2d:8d:89, seq 1
(2/2) Reply from 10:05:ca:2d:8d:89, seq 2
(3/3) Reply from 10:05:ca:2d:8d:89, seq 3
(4/4) Reply from 10:05:ca:2d:8d:89, seq 4
(5/5) Reply from 10:05:ca:2d:8d:89, seq 5
(6/6) Reply from 10:05:ca:2d:8d:89, seq 6
6 sent, 6 received.

Board_BS_500#
```

9.1.3 Traceroute Ethernet

This command traces the Ethernet route for a specific destination domain.

```
Board_BS_500# traceroute ethernet mpid 7 domain dima
Trace reply from 10:05:ca:2d:8d:89 TTL 63

Board_BS_500#
```

9.1.4 Show Remote Ethernet CFM Maintenance-points

This command displays the remote Ethernet CFM Maintenance points for the local MEP.

```
Aut_router#show ethernet cfm maintenance-points local
Local MEPs:
--------------------------------------------------------------------------------
MPID Domain Name                                    Lvl   MacAddress
Type  CC
Ofld Domain Id                                      Dir   Port
Id
     MA Name                                              SrvcInst
Source
     EVC name
--------------------------------------------------------------------------------
7    dima                                           7
1005.ca2d.8d89 Port  Y
No   dima                                           Down  Gi0/1
none
     test                                                 N/A
Static
     N/A

Total Local MEPs: 1

Local MIPs: None
Aut_router#show ethernet cfm maintenance-points remote
--------------------------------------------------------------------------------
```

```
MPID  Domain Name                                      MacAddress
IfSt  PtSt
 Lvl  Domain ID                                       Ingress
 RDI  MA Name                                         Type Id
SrvcInst
      EVC Name
Age
-------------------------------------------------------------------------
--------------
17    dima                                           0090.8f57.954f
Up    N/A
 7    dima                                           Gi0/1
 -    test                                           Port none
N/A
      N/A
8s

Total Remote MEPs: 1
Aut_router#
```

This page is intentionally left blank.

10 Y.1731: OAM Functions and Mechanisms for Ethernet based Networks

This chapter describes the implementation of Y.1731 recommendations for OAM Functions and Mechanisms for Ethernet based Networks.

10.1 Description

Y.1731 is used for user-plane OAM functionality in Ethernet networks (Operations, Administration, and Maintenance), point-to-point connections and multipoint connectivity in the ETH layer. Y.1731 includes the following mechanisms:

- Fault Management
- Performance Management

The IEEE 802.1ag is based in line with ITU-T recommendation Y.1731, which also addresses the following performance management issues:

- Ethernet alarm indication signal (ETH-AIS)
- Ethernet locked signal (ETH-LCK)
- Frame loss measurement (ETH-LM)
- Frame delay measurement (ETH-DM)

10.2 Functions for Fault Management

The source MAC address for all OAM frames is always a unicast MAC address. The destination MAC address may be either a unicast or a multicast address depending on the message type and application.

10.2.1 Alarm Indication Signal (AIS) Condition

AIS provides an indication of service interruption. AIS is signaled by remotely connected peer MEPs to indicate a network fault.

Command	Description
`# configure data`	Enters Data configuration menu.
`# ethernet cfm ais domain [name] level ]1-7]`	Configures to listen to the AIS signal in a specified domain and level.
`# ais-period interval [1,60] (Sec)`	Configures the time to wait until the AIS state is cleared.

10.2.1.1 Ethernet Locked - Signal ETH-LCK

LCK is signaled to indicate an administrative lock condition.

Command	Description
`# configure data`	Enters data configuration menu.
`# ethernet cfm lck level [1-7]`	Configures the LCK state for a specified level.
`# lck-period interval [1-60](Sec)`	Configures the time to wait until the sending of the LCK (fault) state is ceased.

Command	Description
`# configure data`	Enters data configuration menu.
`# ethernet cfm lck start level [1-7] period [1-60]`	Starts sending a LCK state for a specified level and period (sec).
`# ethernet cfm lck stop level [1-7] period [1-60]`	Stops sending and listening for changes in a LCK state.

An example CLI show output for the AIS and LCK state is displayed below:

```
Mediant 800 - MSBR# do show data ethernet cfm legend

Local MEPs:
MPID  VLAN   RmtRDI MAC    Remote XCON   RmtAIS   RmtLCK
-------------------------------------------------------
   18        OK     OK           OK     Error         OK        OK
OK
```

10.3 Functions for Performance Management (Y.1731)

Y.1731 Performance Monitoring (PM) provides a standard ethernet PM function that includes measurement of ethernet frame delay, frame delay variation, frame loss, and frame throughput measurements, All of these monitors are specified in the ITU-T Y-1731 standard and interpreted by the Metro Ethernet Forum.

10.3.1 Set Frame Delay Measurement (ETH-DM)

Frame delay measurement (ETH-DM) can be used for on-demand or proactive OAM to measure frame delay and frame delay variation. Frame delay and frame delay variation measurements are performed by sending periodic frames with ETH-DM information to the peer MEP and receiving frames with ETH-DM information from the peer MEP during a proactive measurement session and/or diagnostic interval. Each MEP may perform frame delay and frame delay variation measurements. When a MEP is enabled to generate frames with ETH-DM information, it periodically sends frames with ETH-DM information to its peer MEP in the same ME. When a MEP is enabled to generate frames with ETH-DM information, it also expects to receive frames with ETH-DM information from its peer MEP in the same ME.

10.3.1.1 1DM - One-way ETH-DM (using 1DM PDU)

1DM - MEP periodically transmits 1DM frames with the Transit Time Stamp value. The MEP uses a Data TLV when configured for measuring delay and delay variation for different frame sizes.

10.3.1.1.1 Reception

When configured for dual-ended ETH-DM, a MEP, upon receiving a valid 1DM frame, uses the following values to generate a one-way frame delay measurement. A 1DM frame with a valid MEG level and a destination MAC address equal to the receiving MEP's MAC address or multicast Class 1 MAC address is considered to be a valid 1DM frame. These values serve as input to the one-way frame delay variation measurement.

Command	Description
`# configure data`	Enters data configuration menu.
`# ethernet y1731 1dm domain [name] mpid [id] level [1-7]`	Starts sending 1DM frame for specified domain, MPID and level.

An example of the CLI show output for the 1DM results is displayed below:

```
# show data ethernet y1731 onedm
1DM Statistics:
MPID Delay(Nano Sec)
------------------------------
20       2678.000
```

10.3.1.2 DMM/DMR - Two-way ETH-DM (using DMM and DMR PDUs)

When configured for single-ended ETH-DM, a MEP periodically transmits DMM frames with the Transmit Time Stamp value. The MEP uses a Data TLV when configured for measuring delay and delay variation for different frame sizes.

10.3.1.3 DMM Reception and DMR Transmission

Whenever a valid DMM frame is received by a MEP, a DMR frame is generated and transmitted to the initiating MEP.

Note: A valid DMM packet has a MEG level and a destination MAC address that is the same as the MEP.

Command	Description
`# configure data`	Enters the Data configuration menu.
`# ethernet y1731 loss lmm domain [name] service [name] mpid [id] level [1-7] source mpid [id]`	Starts sending a DDM frame for specified Domain, MPID and Level.

An example CLI show output with DMM/DMR results is displayed below:

```
show data ethernet y1731 lmm

LMM LMR Statistics:
DstAddr                        SrcAddr                      Frame
Loss                                         Loss       Rate
---------------------------------------------------------------
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       5    0.000000001
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       2    0.222222222
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       2    0.200000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       2    0.181818182
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       2    0.166666667
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       1    0.000000000
00:90:8f:4f:5a:87        00:90:8f:5e:99:f3       2    0.153846154
```

```
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      1   0.000000000
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      1   0.000000000
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      1   0.000000000
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      1   0.000000000
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      1   0.000000000
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      1   0.000000000
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      1   0.000000000
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      1   0.000000000
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      1   0.000000000
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      1   0.000000000
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      2   0.000000001
00:90:8f:4f:5a:87       00:90:8f:5e:99:f3      1   0.000000000

Start time: Wed May 25 10:50:22 2016
End time:   Wed May 25 10:51:21 2016

Number of measurements initiated: 56
Number of measurements completed: 57
Forward
Number of Observations 57
Available indicators: 57
Unavailable indicators: 0
Tx frame count: 127
Rx frame count: 3
Min Avg Max - (FLR): 0 0.015940573 0.222222222
Cumulative -  (FLR): 0.924553240
Timestamps forward:
Min - Wed May 25 10:50:22 2016
Max - Wed May 25 10:51:21 2016

Backword
Number of Observations 57
Available indicators: 57
Unavailable indicators: 0
Tx frame count: 127
Rx frame count: 3
Min Avg Max - (FLR): 0 0.015940573 0.222222222
Cumulative -  (FLR): 0.924553240
Timestamps forward:
Min - Wed May 25 10:50:22 2016
Max - Wed May 25 10:51:21 2016
```

10.4 EFM OAM

10.4.1 Description

Ethernet in the first mile (EFM) refers to using one of the Ethernet family of computer network protocols between a telecommunications company and a customer's premises. From the customer's point of view, it is their "first" mile, although from the access network's point of view it is known as the "last mile". A working group of the Institute of Electrical and Electronics Engineers (IEEE) produced the standards known as IEEE 802.3ah-2004, which were later included in the overall standard IEEE 802.3-2008. Although it is often used for businesses, it can also be known as Ethernet to the Home (ETTH).

10.4.2 Features

The OAM features as defined by IEEE 802.3ah “Ethernet in the First Mile” which includes discovery, Link Monitoring, Remote Fault Detection, Remote Loopback, and Cisco Proprietary Extensions.

10.4.2.1 Discovery

Discovery is the first phase of the Ethernet OAM. This phase identifies the devices in the network and their OAM capabilities. Discovery uses information OAM PDUs. During the discovery phase, the following information is advertised within periodic information OAM PDUs:

- **OAM mode:** Conveyed to the remote OAM entity. This mode can be either active or passive and can be used to determine device functionality.

  Note: The MSBR is always in the passive mode.
- **OAM configuration (capabilities):** Advertises the capabilities of the local OAM entity. A peer can use this information to determine which functions are supported and accessible; for example, loopback capability.
- **OAM PDU configuration:** Includes the maximum OAM PDU size for receipt and delivery. This information along with the rate limit of 10 frames per second can be used to limit the bandwidth allocated to OAM traffic.
- **Platform identity:** A combination of an organization unique identifier (OUI) and 32-bits of vendor-specific information. OUI allocation, controlled by the IEEE, is typically the first three bytes of a MAC address.
- Discovery includes an optional phase in which the local station can accept or reject the configuration of the peer OAM entity. For example, a node may require that its partner support loopback capability to be accepted into the management network. These policy decisions may be implemented as vendor-specific extensions.

10.4.2.2 Link Monitoring

Link monitoring in Ethernet OAM detects and indicates link faults under a variety of conditions. Link monitoring uses the event notification OAM PDU and sends events to the remote OAM entity when problems are detected on the link. The error events include the following:

- **Error Symbol Period (error symbols per second):** The number of symbol errors that occurred during a specified period that has exceeded a threshold. These errors are coding symbol errors.
- **Error Frame (error frames per second):** The number of frame errors detected during a specified period that has exceeded a threshold.
- **Error Frame Period (error frames per *n* frames):** The number of frame errors within the last *n* frames that has exceeded a threshold.

- **Error Frame Seconds Summary (error seconds per *m* seconds):** The number of error seconds (1-second intervals with at least one frame error) within the last *m* seconds that has exceeded a threshold.

10.4.2.3 Remote Failure Indication

Faults in Ethernet connectivity that are caused by slowly deteriorating quality are difficult to detect. Ethernet OAM provides a mechanism for an OAM entity to convey these failure conditions to its peer via specific flags in the OAM PDU. The following failure conditions can be communicated:

- **Link Fault:** Loss of signal is detected by the receiver; for example, the peer's laser is malfunctioning. A link fault is sent once per second in the information OAM PDU. Link faults only apply when the physical sublayer is capable of independently transmitting and receiving signals.
- **Dying Gasp:** An unrecoverable condition has occurred; for example, a power failure. This type of condition is vendor specific. A notification about the condition may be sent immediately and continuously.
- **Critical Event:** An unspecified critical event has occurred. This type of event is vendor-specific. A critical event may be sent immediately and continuously.

10.4.2.4 Remote Loopback

An OAM entity can put its remote peer into loopback mode using the loopback control OAM PDU. Loopback mode helps an administrator ensure the quality of links during installation or when troubleshooting. In loopback mode, every frame received is transmitted back on the same port except for OAM PDUs and pause frames. The periodic exchange of OAM PDUs must continue during the loopback state to maintain the OAM session.

The loopback command is acknowledged by responding with an information OAM PDU with the loopback state indicated in the state field. This acknowledgement allows an administrator, for example, to estimate if a network segment can satisfy a service-level agreement. Acknowledgement makes it possible to test delay, jitter, and throughput.

Note: For the MSBR, loopback is supported for the GigaEthernet/Fiber interfaces only and not for the EFM interface.

10.4.2.5 OAM Messages

Ethernet OAM messages or OAM PDUs are standard length, untagged Ethernet frames within the normal frame length bounds of 64 to 1518 bytes. The maximum OAM PDU frame size exchanged between two peers is negotiated during the discovery phase.

OAM PDUs always have the destination address of slow protocols (0180.c200.0002) and an Ether type of 8809. OAM PDUs do not go beyond a single hop and have a hard-set maximum transmission rate of 10 OAM PDUs per second. Some OAM PDU types may be transmitted multiple times to increase the likelihood that they will be successfully received on a deteriorating link.

Four types of OAM messages are supported:

- **Information OAM PDU:** A variable-length OAM PDU that is used for discovery. This OAM PDU includes local, remote, and organization-specific information.
- **Event notification OAM PDU:** A variable-length OAM PDU that is used for link monitoring. This type of OAM PDU may be transmitted multiple times to increase the chance of a successful receipt; for example, in the case of high-bit errors. Event notification OAM PDUs also may include a time stamp when generated.

- **Loopback control OAM PDU:** An OAM PDU fixed at 64 bytes in length that is used to enable or disable the remote loopback command.
- **Vendor-specific OAM PDU:** A variable-length OAM PDU that allows the addition of vendor-specific extensions to OAM.

10.4.3 Configuration

The table below shows how to configure OAM on a Gigabit Ethernet, EFM or Fiber interface.

Command	Description
`# configure data`	Enters Data configuration menu.
`interface giga/efm/fiber slot/port`	Enters the Interface command mode.
`ethernet oam`	Enables OAM on the interface
`ethernet oam link-monitor capable`	Enables Link monitor supported
`ethernet oam link-monitor frame`	Enables Link Monitor Errored Frame Event
`ethernet oam link-monitor frame threshold xxx`	Changes the Link monitor threshold [1- 65535]
`ethernet oam link-monitor frame window xxx`	Changes the Link Monitor Frame Window in seconds [10-60] Sec,
`ethernet oam remote-loopback capable`	EFM OAM supported remote loopbacks
`ethernet oam timeout [value]`	Sets timeout value in seconds [5-30]

- Enabling Ethernet OAM:

```
Mediant 800B - MSBR# configure data
Mediant 800B - MSBR(config-data)# interface gigabitethernet 0/0
Mediant 800B - MSBR(conf-if-GE 0/0)# ethernet oam
Mediant 800B - MSBR(conf-if-GE 0/0)#
```

- Configuring Ethernet OAM link-monitor capability and parameters:

```
Mediant 800B - MSBR# configure data
Mediant 800B - MSBR(config-data)# interface gigabitethernet 0/0
Mediant 800B - MSBR(conf-if-GE 0/0)# ethernet oam
Mediant 800B - MSBR(conf-if-GE 0/0)# ethernet oam link-monitor capable
Mediant 800B - MSBR(conf-if-GE 0/0)# ethernet oam link-monitor frame threshold 5
Mediant 800B - MSBR(conf-if-GE 0/0)# ethernet oam link-monitor frame window 10
Mediant 800B - MSBR(conf-if-GE 0/0)#
```

- Configuring Ethernet OAM link-monitor remote-loopback capability:

```
Mediant 800B - MSBR# conf data
Mediant 800B - MSBR(config-data)# interface gigabitethernet 0/0
Mediant 800B - MSBR(conf-if-GE 0/0)# ethernet oam
Mediant 800B - MSBR(conf-if-GE 0/0)# ethernet oam remote-loopback capable
```

```
Mediant 800B - MSBR(conf-if-GE 0/0)# exit
Mediant 800B - MSBR(config-data)#
```

- Configuring Ethernet OAM link timeout parameter:

```
Mediant 800B - MSBR# conf data
Mediant 800B - MSBR(config-data)# interface gigabitethernet
0/0
Mediant 800B - MSBR(conf-if-GE 0/0)# ethernet oam
Mediant 800B - MSBR(conf-if-GE 0/0)# ethernet oam timeout 5
Mediant 800B - MSBR(conf-if-GE 0/0)#
```

- Configuring Ethernet OAM loopback action:

```
Mediant 800B - MSBR# debug ethernet loopback interface
gigabitethernet 0/0

Interface is in LOOPBACK mode.
You will be unable to pass traffic across that interface.
```

10.4.4 Show Commands

The following table describes the Ethernet OAM show commands.

Command	Description
`show data ethernet oam brief`	Show Ethernet OAM brief
`show data ethernet oam configuration`	Show Ethernet OAM configuration
`show data ethernet oam counters`	Show Ethernet OAM counters
`show data ethernet oam interface giga/fiber/efm slot/port`	Show Ethernet OAM status per interface
`show data ethernet oam status`	Show Ethernet OAM status

The following example includes CLI output for the above commands:

```
Mediant 800B - MSBR# show data ethernet oam brief
Local                                   Remote
Interface   Mode       Capability    MAC Address
Vendor(oui)   Mode    capability
Gi    0/0   Passive    L  R     V    10:05:CA:2D:8D:89   0C
Active     L  R
Fiber 0/3   Not enabled

Capability codes: L - Link Monitor, R - Remote Loopback, U -
Unidirection, V - Variable Retrieval
Mediant 800B - MSBR#

Mediant 800B - MSBR# show data ethernet oam configuration
Interface GigabitEthernet 0/0:
==============================
Local client
------------
    Configurations:
    Mode:                           Passive
```

```
    Time Out:                          5 Sec
    Unidirection :                     Not supported
    Link monitor :                     Supported
    Remote loopback :                  Supported
    Variable rerievel :                Not supported
    Link monitor Errored Symbol Period Event Enabled: Window = 30
Sec Threshold = 65535 Symbols
    Link monitor Errored Frame Event         Enabled: Window = 10
Sec Threshold = 5 Frames
    Status:
    Port status:                       Operational
    Loopback status:                   Operational
Remote client
-------------
    MAC address:   10:5:CA:2D:8D:89
        Vendor(oui):   0C
    Configurations:
    Mode:                              Active
    Unidirection :                     Not supported
    Link monitor :                     Supported
    Remote loopback :                  Supported
    MIB variable retrieval :           Not supported
==================================================================


Mediant 800B - MSBR# show data ethernet oam counters
GigabitEthernet 0/0
==============================
    Counters:
----------------------------
    Total PDU packets:                       476391
    ERRORED PDU packets:                     0
    Total_tx_packet:                         234813
    Total_rx_packet:                         241578
    Information OAMPDU Tx:                   234813
    Information OAMPDU Rx:                   241578
    Event Notification OAMPDU Tx:            0
    Event Notification OAMPDU Rx:            0
    Duplicate Event Notification OAMPDU TX: 0
    Duplicate Event Notification OAMPDU RX: 0
    Loopback Control OAMPDU Tx:              0
    Loopback Control OAMPDU Rx:              0
    Variable Request OAMPDU Tx:              0
    Variable Request OAMPDU Rx:              0
    Variable Response OAMPDU Tx:             0
    Variable Response OAMPDU Rx:             0
Local Faults:
----------------------------
    Link Fault records                       0
    Dying Gasp records                       0
    Critical Event records                   0
Remote Faults:
```

```
----------------------------
    Link Fault records                      0
    Dying Gasp records                      0
    Critical Event records                  0

Ethernet OAM is not enabled on FIBER 0/3.
============================
Mediant 800B - MSBR#

Mediant 800B - MSBR# show data ethernet oam status
GigabitEthernet 0/0
============================
     Runtime Settings:
----------------------------
local_pdu:           ANY
local_mux:           FWD
local_par:           FWD
local_link_status:   UP
local_satisfied:     Yes
local_stable:        Yes
enter_loopback:      No
lost_link_timer:     Runing
remote_state_valid:  Yes
remote_stable:       Yes
remote_evaluating:   Yes
State Machine:
----------------------------
    state:   SEND_ANY
Ethernet OAM is not enabled on FIBER 0/3.
Mediant 800B - MSBR#
```

This page is intentionally left blank.

11 Multiple DSL Connection

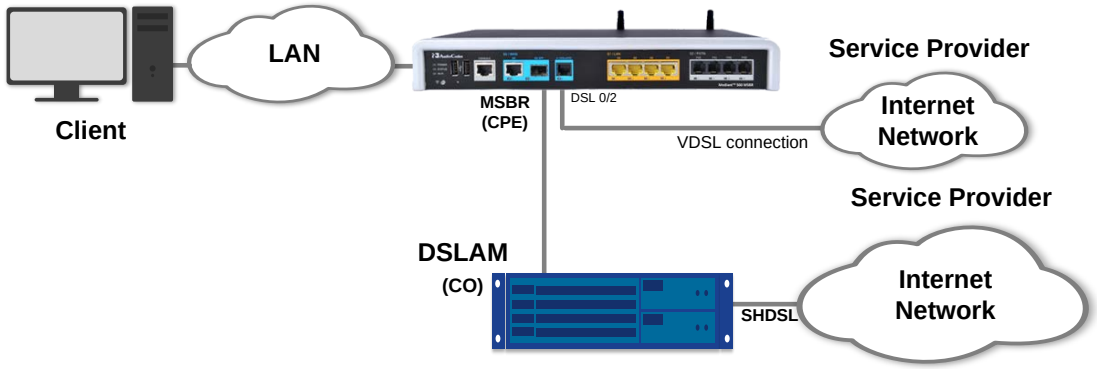
Multilink PPP (MLPPP) is a communications protocol that enables a PC to use two PPP communications ports as if they were a single port of greater bandwidth. MLPPP can be used with other communication media such as telephone dial-up modems, cable modems, fiber optic systems or satellite Internet connections.

PPP is a full-duplex protocol for communication between computers using a serial interface. PPP offers error correction and can handle synchronous as well as asynchronous data.

11.1 Examples

This example shows how to connect MSBR through SHDSL and VDSL at the same time.

Figure 11-1: Multiple DSL Example



1. Configure an SHDSL connection on the ATM mode:

```
# configure data
(config-data)# interface shdsl 0/1
(conf-if-shdsl 0/1)# mode atm
(conf-if-shdsl 0/1)# no group 1
(conf-if-shdsl 0/1)# no group 2
(conf-if-shdsl 0/1)# no group 3
(conf-if-shdsl 0/1)# group 0
(conf-if-shdsl-0)# termination cpe
(conf-if-shdsl-0)# linerate auto
(conf-if-shdsl-0)# annex A
(conf-if-shdsl-0)# caplist-style new
(conf-if-shdsl-0)# pairs 0
(conf-if-shdsl-0)# exit
(conf-if-shdsl 0/1)# exit
```

2. Configure the DSL interface on the VDSL mode with EFM interface:

```
(config-data)# interface dsl 0/2
(conf-if-dsl 0/2)# mode vdsl
(conf-if-dsl 0/2)# no shutdown
(conf-if-dsl 0/2)# exit
(config-data)# interface EFM 0/2
(conf-if-efm 0/2)# no ip address
(conf-if-efm 0/2)# mtu 1524
(conf-if-efm 0/2)# desc "VDSL"
(conf-if-efm 0/2)# no service dhcp
(conf-if-efm 0/2)# ip dns server auto
```

```
(conf-if-efm 0/2)# no shutdown
(conf-if-efm 0/2)# exit
```

3. Configure the ATM interface to work with SHDSL:

```
(config-data)# interface ATM 0/0
(conf-atm0/0)# encapsulation ethoa-snap
(conf-atm0/0)# pvc 0/32
(conf-atm0/0)# ubr
(conf-atm0/0)# ip address 192.168.27.3 255.255.255.0
(conf-atm0/0)# ip dns server auto
(conf-atm0/0)# no napt
(conf-atm0/0)# no firewall enable
(conf-atm0/0)# mtu auto
(conf-atm0/0)# exit
```

4. Secure the EFM interface using PPPoE:

```
(config-data)# interface pppoe 0
(conf-pppoe-0)# no firewall enable
(conf-pppoe-0)# no napt
(conf-pppoe-0)# mtu auto
(conf-pppoe-0)# ppp user acl119@014 pass F3YpKykvKSs=
(conf-pppoe-0)# ppp authentication chap
(conf-pppoe-0)# ppp authentication ms-chap
(conf-pppoe-0)# ppp authentication ms-chap-v2
(conf-pppoe-0)# ppp authentication pap
(conf-pppoe-0)# ppp lcp-echo 6 5
(conf-pppoe-0)# ip dns server auto
(conf-pppoe-0)# underlying EFM 0/2
(conf-pppoe-0)# no shutdown
(conf-pppoe-0)# exit
```

5. Configure a primary and secondary IP route:

```
(config-data)# ip route 0.0.0.0 0.0.0.0 PPPOE 0 1 [Primary IP
Route]
(config-data)# ip route 192.168.27.0 255.255.255.0 ATM 0/0 2
[Secondary IP Route]
```

12 E1/T1 (PRI)

Primary Rate Interface (PRI) is a standardized telecommunications service level within the Integrated Services Digital Network (ISDN) specification for carrying voice and data transmissions between a network and a user.

PRI is the standard for providing telecommunication services to offices. It is based on the T-carrier (T1) line in the US and Canada, and the E-carrier (E1) line in Europe. The T1 line consists of 24 channels, while an E1 has 32.

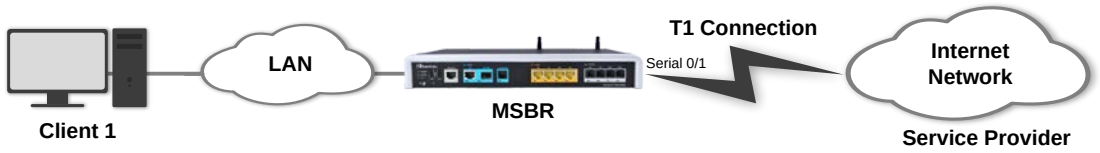
PRI provides a varying number of channels depending on the standards in the country of implementation. In North America and Japan, it consists of 23xB (B channels). In Europe and Australia it is 30xB-Channel + 1xD-Channel on an E1 2.048 Mbit/s. One timeslot on the E1 is used for synchronization purposes and is not considered to be a B or D channel.

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# interface t1/e1 slot/port`	Enter the E1/T1 interface command mode.
`(config-if-t1 slot/port)# line-code [b8zs| b6zs|]`	▪ b8zs: Commonly used in the North American T1 (Digital Signal 1) 1.544 Mbit/s line code. ▪ b6zs: same as b8zs, but only for T2 (6.312MB).
`(config-if-t1 slot/port)# framing-method [sf|esf]`	Frame synchronization is necessary to identify the timeslots within each 24-channel frame. Synchronization takes place by allocating a framing, or 193rd bit. This results in 8 kbit/s of framing data, for each framing type. Because this 8-kbit/s channel is used by the transmitting equipment as overhead. ▪ sf: super frame consists of twelve consecutive 193-bit frames. ▪ esf: Extended Super Frame consists of twenty-four consecutive 193-bit frames of data. Due to the unique bit sequences exchanged, the framing schemes are not compatible with each other.
`(config-if-t1 slot/port)# clock-source inline`	T1 ports synchronize with outside clock source provide.
`(config-if-t1 0/0)# channel-group 1-24`	Configure which timeslots should be used.
`(config-if-t1 0/0)# line-buildout-loss [Number]`	LBO compensates for the loss in decibels based on the distance from the device to the first repeater in the circuit. A longer distance from the device to the repeater requires that the signal strength on the circuit be boosted to compensate for loss over that distance.

12.1 Examples

This example shows how to configure the MSBR connection to the Internet Service Provider, using the T1 port.

Figure 12-1: E1/T1 Example




```
(config-data)#interface t1 0/0
(config-if-t1 0/0)# line-code b8zs
(config-if-t1 0/0)# framing-method sf
(config-if-t1 0/0)# clock-source line
(config-if-t1 0/0)# line-buildout-loss 0
(config-if-t1 0/0)# max-cable-loss 0.6
(config-if-t1 0/0)# channel-group 1-24
(config-if-t1 0/0)# no shutdown
(config-if-t1 0/0)# exit
```

To view the T1 interface status, use the following command:

```
# show data interfaces t1 0/0

t1 0/0 is Up
  Line code is B8ZS, framing is SF
  Clock source is Line, line build-out-loss is 0dB
  Time slots used 1-24
  Loopback is off

  LOF alarm: no
  LOS alarm: no
  RAI alarm: no
  AIS alarm: no
  BER test is off
```

13 Serial HDLC

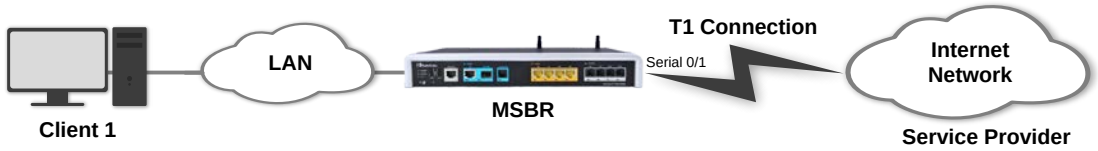
High-level Data Link Control (HDLC) is a protocol or rules for transmitting data between network points. In HDLC, data is organized into a frame and sent across a network to a destination that verifies its successful arrival. HDLC is a Layer 2 protocol and a simple protocol used to connect point-to-point serial devices. HDLC can also perform error correction similar to Ethernet.

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# interface serial slot/port`	Enter the serial interface command mode.
`(conf-if-serial slot/port)# serial-protocol [Serial_Protocol]`	Configures the specific serial protocol. (Most important command on this interface.)
`(conf-if-serial slot/port)# ip address [IP] [Subnet Mask]`	Enter the IP address to the serial port.
`(conf-if-serial slot/port)# no shutdown`	Enables the port.

13.1 Examples

This example shows a pre-configured T1 connection. On this type of interface, HDLC needs to be used.

Figure 13-1: HDLC Example




```
# configure data
(config-data)#interface t1 0/0
(config-if-t1 0/0)# line-code b8zs
(config-if-t1 0/0)# framing-method sf
(config-if-t1 0/0)# clock-source line
(config-if-t1 0/0)# line-buildout-loss 0
(config-if-t1 0/0)# max-cable-loss 0.6
(config-if-t1 0/0)# channel-group 1-24
(config-if-t1 0/0)# no shutdown
(config-if-t1 0/0)# exit
(config-data)# interface serial 0/1
(conf-if-SERIAL 0/1)# no shutdown
(conf-if-SERIAL 0/1)# serial-protocol hdlc
(conf-if-SERIAL 0/1)# ip address 192.168.27.181 255.255.255.252
(conf-if-SERIAL 0/1)# exit
(config-data)# ip route 0.0.0.0 0.0.0.0 serial 0/1
```

To view the serial interface status, use the following command:

```
# show data interface serial 0/1

SERIAL 0/0 is Connected
  Underlying hardware is interface T1 0/1
  Protocol encapsulation is HDLC
  IP address is 192.168.27.182 netmask is 255.255.255.252
  MTU is 0 bytes
  Available bandwidth is 1536 kbps

  149 input packets, 57655 bytes
  0 dropped input packets
  0 output packets, 0 bytes
  0 dropped output packets
```

14 Fiber Optic

Fiber-optic consist of a bundle of thin glass or plastic strands. This is coated or surrounded in material that allows light to pass through the fibers without escaping out the sides. Signals can pass through them at very high speeds from the point of origin to the destination, with minimal loss in quality or data. Companies use fiber-optics to transmit Internet data, audio information for telephones, and images for television or medical cameras.

The concept behind fiber-optics is fairly simple. A user transmits a signal as light, often in the form of a laser beam, through a length of thin strands of glass or plastic. The optical fiber acts as the medium through which the light passes, while a coating on the outside of each strand keeps the light trapped within the fiber. People can send just about any type of digital data through fiber-optics, though conversion for some signals may be necessary.

Telephones and Internet signals are often transmitted through fiber-optics. Companies simply convert phone audio signals into digital information, which can then be sent as light transmissions through the fibers. Many services convert the data into a binary signal of ones and zeroes, which they relay through pulses of light. Once a phone or other device receives the signal, it converts it back into audio information that the listener on the other end hears. Internet providers transmit data in much the same way, with computers converting digital signals into visible or auditory output.

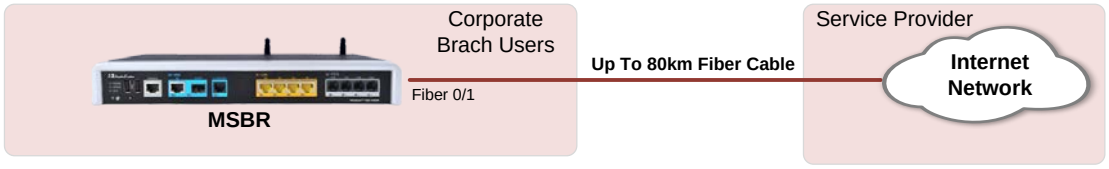
The important area of fibers is the physical layer and the use and differences between connectors and SFP (special external module that is used to connect specific connectors).

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# interface fiber slot/port`	Enter the fiber interface commands. Optical fiber interfaces are exactly like a Layer-3 port and Gigabit Ethernet is the same as a fiber port.
`(conf-if-FIBER slot/port)# ip address [IP] [Subnet Mask]`	Configure the IP address of the fiber interface.

14.1 Examples

This example shows a fiber interface configuration for creating a simple connection between the MSBR and the Service Provider:

Figure 14-1: Fiber Example




```
# configure data
(config-data)# interface fiber 0/1
(conf-if-FIBER 0/1)# ip address 10.10.10.1 255.255.255.0
(conf-if-FIBER 0/1)# no shutdown
(conf-if-FIBER 0/1)# exit
(config-data)# ip route 0.0.0.0 0.0.0.0 fiber 0/1
```

This page is intentionally left blank.

15 WAN Failover

WAN failover is the process in which redundant WAN connections are configured to increase WAN uptime. To establish WAN failover, two separate WAN connections from different ISPs are required, which operate as primary and secondary connections. It is important that both WAN connections are from different ISPs so that if any problem arises in the WAN link from one ISP, the link from the second ISP can be used to establish a WAN connection. If both connections are from the same ISP and the ISP link goes down, both primary and secondary connections will fail, hence making WAN links unavailable even if WAN failover has been configured.

When WAN failover is configured, the two WAN links are configured as active-passive connections. This means that under normal conditions (when no WAN downtime occurs), the primary WAN connection from one ISP is used to route all network traffic and it works as the active connection. In this case, the secondary connection from the other ISP remains in inactive/idle state (passive mode).

When the primary WAN connection fails, the secondary connection automatically becomes active. This process is known as failover and is completely transparent to end-users. Once automatic failover occurs, network traffic is automatically routed through the secondary WAN connection. The secondary WAN connection remains active until the primary connection is up again to route the network traffic. As soon as the primary WAN connection becomes active, the secondary connection automatically becomes idle and enters passive mode. This process is known as WAN failback.

The MSBR supports two methods for implementing WAN Failover:

- Cold Backup: In normal operation, only the primary WAN interface is up and active; all the other backup WAN interfaces are down. When a failover occurs, only the newly active backup WAN interface is up.
- Hot Backup: In normal operation, all WAN interfaces are up (primary and backup WAN interfaces), but only the primary WAN interface is active. When a failover occurs, the backup WAN interface becomes active (all the other WAN interfaces still remain in up-state).

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# backup-group [NAME]`	Create a backup WAN group with a specific name.
`(backup-group)# description [WORD]`	Add a description for the backup group.
`(backup-group)# exit`	Exit the backup-group state and return to the data configuration menu.

Configure a WAN backup group on the interface:

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# interface <physical_interface>  slot/port`	Enter the physical interface commands.
`(conf-if-<int_name>  Slot/Port)# backup backup monitoring group [Group_name] Priority [1/2/3]`	Add an interface to the backup group and configure the group's priority. **Note:** Only one interface can be configured for each priority.

Configure a conditional route for Hot Backup:

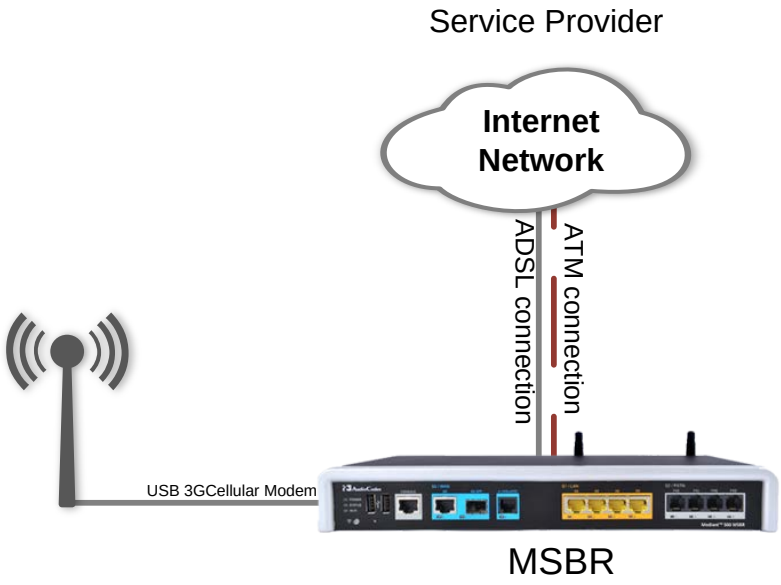
Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# track [track_ID] [icmpecho|icmpv6echo] [Network Destination] [Interface_track] [interval|retries]`	▪ track_ID: number identifier between 1 and 100 for track command. ▪ icmpecho/icmpv6echo: choose between IPv4 and IPv6 ▪ Network Destination: Network commands tracks ▪ Interface_track: interface on which command operates on ▪ Interval: interval between probes ▪ Retries: how much time pass before track goes down.

15.1 Examples

15.1.1 Cold Backup WAN Failover

This example shows configuration for a Cold Backup WAN failover. The MSBR needs to be configured so that when the ATM connection fails, the 3G cellular modem becomes active.

Figure 15-1: WAN Failover Example




```
(config-data)# backup-group wan_failover
(backup-group)# exit
(config-data)# interface atm 0/0
(conf-if-atm0/0)# backup monitoring group wan_failover Priority 1
(config-data)# interface Cellular 0/0
(conf-if-cel0/0)# backup monitoring group wan_failover Priority 2
```

To view the **active** interface, use the following command:

```
# show data backup-group
Group Name:   wan_failover
```

```
Priority 1    atm 0/0
Priority 2    Cellular 0/0
Priority 3
Currently active interface:   atm 0/0
```

After the atm 0/0 interface disconnects, the `show` command displays the following:

```
# show data backup-group
Group Name:   wan_failover
Priority 1    atm 0/0
Priority 2    Cellular 0/0
Priority 3
Currently active interface:   Cellular 0/0
```

15.1.2 Hot Backup WAN Failover

The following configuration example demonstrates *Hot Backup* and is based on the previous example.

1. Set the monitor routing for the primary default route:

```
(config-data)# track 1 icmpecho 8.8.8.8 atm 0/0 1
# first priority route – all traffic will be redirected to
primary WAN (atm 0/0 interface).
(config-data)# ip route 0.0.0.0 0.0.0.0 10.1.1.1 [Default
Gateway] atm 0/0 track 1
```

2. Set the secondary WAN IP route:

```
(config-data)# ip route 0.0.0.0 0.0.0.0 Cellular 0/0 100
# The metric 100 is set to create a secondary routing rule
with lower priority, using Cellular 0/0 as the secondary WAN
interface.
```

3. The `traceroute` command shows the path to the destination. The `traceroute` command shows how destination address 8.8.8.8 can be reached through the ATM interface. When the ATM interface is down, the destination 8.8.8.8 is reached through the cellular interface.

```
# ATM is the active WAN interface:
# traceroute 8.8.8.8
10.1.1.1 (10.1.1.254)  0.849 ms  0.337 ms  0.523 ms
10.1.1.254 (8.8.8.8)  0.745 ms  0.304 ms  0.511 ms

# ATM is down and the cellular interface is the active WAN
interface:
# traceroute 8.8.8.8
172.30.254.108 (172.30.254.1) 0.802 ms  0.356 ms  0.540 ms
172.30.254.1 (8.8.8.8) 0.798 ms  0.347 ms  0.501 ms
Traceroute: Destination reached
```

This page is intentionally left blank.

16 Wi-Fi

Wi-Fi is a term for certain types of wireless local area networks (WLAN) that use specifications in the 802.11 family, Originally, Wi-Fi certification was applicable only to products using the 802.11b standard. Wi-Fi can apply to products that use any 802.11 standard. The 802.11 specifications are part of an evolving set of wireless network standards known as the 802.11 family.

Any entity that has a wireless LAN should use security safeguards such as the Wired Equivalent Privacy (WEP) encryption standard, the more recent Wi-Fi Protected Access (WPA), Internet Protocol Security (IPsec), or a virtual private network (VPN).

Command	Description
`# configure data`	Enter data configuration menu.
`(config-data)# no shutdown radio`	Enable the Wireless interface.
`(config-data)# interface dot11radio [Number_Radio]`	Enter the radio interface configuration mode.
`(conf-if-dot11radio 1)# beacon [dtim-period|period]`	▪ beacon: contains all the information about the network. Beacon frames are transmitted periodically to announce the presence of a Wireless LAN. ▪ dtim-period: sets the data rate of the beacon interval [1-100]. ▪ period: sets the milliseconds of beacon interval [20-4000].
`(conf-if-dot11radio 1)# ssid [NAME]`	Configures the service set identifier (SSID) which uniquely identifies any given wireless network.
`(conf-if-dot11radio 1)# mode [a,b,g,n,na,ngb,ngba]`	Allows the interface to operate in a different 802.11 family protocols. ▪ 802.11a: transmits at 5 GHz and can move up to 54 megabits of data per second. It also uses orthogonal frequency-division multiplexing (OFDM), a more efficient coding technique that splits that radio signals into several sub-signals before they reach a receiver. This greatly reduces interference. ▪ 802.11b: slowest and least expensive standard. 802.11b transmits in the 2.4 GHz frequency band of the radio spectrum. It can handle up to 11 megabits of data per second, and it uses complementary code keying (CCK) modulation to improve speeds. ▪ 802.11g: transmits at 2.4 GHz like 802.11b, but it's much faster. It can handle up to 54 megabits of data per second. 802.11g is faster because it uses the same OFDM coding as 802.11a. ▪ 802.11n: most widely available of the standards and is backward compatible

Command	Description
	with a, b and g. It significantly improved speed and range over its predecessors. For instance, although 802.11g theoretically moves 54 megabits of data per second, it only achieves real-world speeds of about 24 megabits of data per second because of network congestion. 802.11n, however, reportedly can achieve speeds as high as 140 megabits per second. 802.11n can transmit up to four streams of data, each at a maximum of 150 megabits per second, but most routers only allow for two or three streams.
`(conf-if-dot11radio 1)# security [802.1x, mac , mode , wep , wpa]`	Configures security on different types and modes on the radio interface. ▪ 802.1x: In a wireless LAN with 802.1X, a user (known as the supplicant) requests access to an access point (known as the authenticator). The access point forces the user (actually, the user's client software) into an unauthorized state that allows the client to send only an EAP start message. The access point returns an EAP message requesting the user's identity. The client returns the identity, which is then forwarded by the access point to the authentication server, which uses an algorithm to authenticate the user and then returns an accept or reject message back to the access point. Assuming an accept is received, the access point changes the client's state to authorized and normal traffic can now take place. The authentication server may use the Remote Authentication Dial-In User Service (RADIUS). ▪ wep: Wired Equivalent Privacy (WEP) is a security protocol, specified in the IEEE Wireless Fidelity (Wi-Fi) standard, 802.11b, that is designed to provide a wireless local area network (WLAN) with a level of security and privacy comparable to what is usually expected of a wired LAN. WEP seeks to establish similar protection to that offered by the wired network's physical security measures by encrypting data transmitted over the WLAN. Data encryption protects the vulnerable wireless link between clients and access points; once this measure has been taken, other typical LAN security mechanisms such as password protection, end-to-end encryption, virtual private networks (VPNs), and authentication can be put in

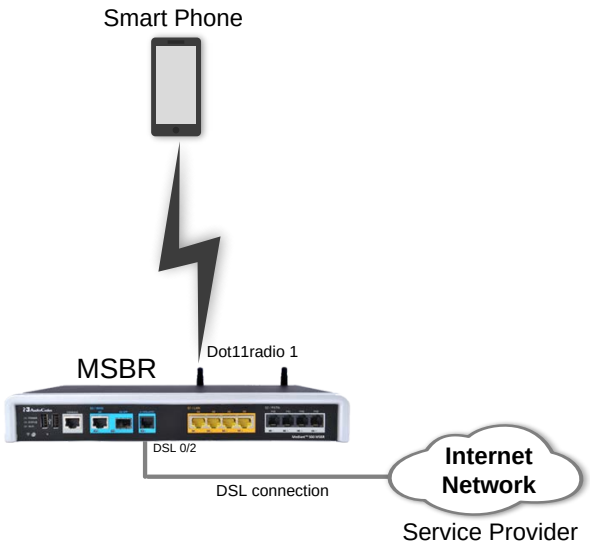
Command	Description
	place to ensure privacy. ▪ wpa: Wi-Fi Protected Access (WPA) is a security standard for users of computers equipped with Wi-Fi wireless connection. It is an improvement on and is expected to replace the original Wi-Fi security standard, Wired Equivalent Privacy (WEP). WPA's encryption method is the Temporal Key Integrity Protocol (TKIP). TKIP addresses the weaknesses of WEP by including a per-packet mixing function, a message integrity check, an extended initialization vector, and a re-keying mechanism. WPA provides "strong" user authentication based on 802.1x and the Extensible Authentication Protocol (EAP). WPA depends on a central authentication server such as RADIUS to authenticate each user. ▪ mac: allow or deny specific MAC addresses to the access point. ▪ mode: Security mode.
`(conf-if-dot11radio 1)# channel [Channel_Number|width|auto]`	802.11b, 802.11g, and 802.11n-2.4 use the 2.400 – 2.500 GHz spectrum. 802.11a and 802.11n use the more heavily regulated 4.915 – 5.825 GHz band. Each spectrum is sub-divided into channels with a center frequency and bandwidth The 2.4 GHz band is divided into 14 channels spaced 5 MHz apart, beginning with channel 1 which is centered on 2.412 GHz, 2 is centered on 2.417, and so on. ▪ width: Bandwidth in use (20Mhz Only, or 40/20 as dynamic). ▪ auto: scanning for best frequency to sign interface. ▪ [number]: allows you to specify frequency of the channels (between 1-13, 36-64,100-140,149-165).
`(conf-if-dot11radio 1)# cts [mode|type]`	Clear to send (CTS) protection mode is a wireless setting that ensures computers on a network can connect to a wireless router when many communications devices are present, network computers may experience difficulty in reaching the Internet as they all try to connect at the same time. When switched on, a computer must receive a CTS frame from the wireless access point (WAP) before information can be sent. An auto setting determines which computer can reach a WAP at a specific through a request to send (RTS) packet, Computers are unable to detect when other devices on a network attempt to transmit data.

Command	Description
	Without CTS, information collisions can occur, causing the WAP to return an error message to the originating computer. CTS determines the order in which computers contact the WAP: ▪ Mode: auto or none. ▪ Type: CTS-only (cts) and CTS-RTS (rts_cts) are the two methods of protection: ✓ CTS-only: computers must receive a self-directed CTS frame before sending data. ✓ CTS-RTS: the computer must send an RTS and receive a CTS before transmission. The rate of data transmission can also be adjusted to regulate how fast communication occurs.

16.1 Examples

This example shows how a smartphone connects to MSBR through Wi-Fi in order to obtain access to the internet.

Figure 16-1: Wi-Fi Example




```
(config-data)# no radio shutdown
(config-data)# interface dot11radio 1
(conf-if-dot11radio 1)# ip address 172.30.254.250
(conf-if-dot11radio 1)# description "LAN Wireless 802.11n Access
Point"
(conf-if-dot11radio 1)# ssid MSBG [Access Point name]
(conf-if-dot11radio 1)# security mode NONE [open access point]
(conf-if-dot11radio 1)# no security mac mode [allow all]
(conf-if-dot11radio 1)# power 100 [full power signal]
```

```
(conf-if-dot11radio 1)# beacon dtim-period 1
(conf-if-dot11radio 1)# beacon period 100
(conf-if-dot11radio 1)# wmm [Allow Multimedia]
(conf-if-dot11radio 1)# no shutdown
```

Once you have performed the above configuration, the smartphone searches for an Access Point and locates the MSBR.

To view device association with the specific radio/Wi-Fi interface of MSBR, use the following command:

```
# show data dot11radio interface 1

dot11radio 1 is Connected.
  Description: LAN Wireless 802.11n Access Point
  Hardware address is 00:90:8f:48:cd:80
  State Time:   0:03:09
  Time since creation:   0:45:55
  Time since last counters clear :   0:03:09
  mtu auto
  network lan
  ssid MSBG
  broadcast
  security mode NONE
  no security mac mode
  mode ngb
  channel width 40/20
  channel auto
  power 100
  beacon dtim-period 1
  beacon period 100
  fragment threshold 2346
  cts mode  none
  cts type  cts
  burst num 3
  burst time  2
  rts threshold 2346
  wmm
  country code 0x178 (376)
  IPv6 is disabled
  rx_packets 67 rx_bytes 6942 rx_dropped 0 rx_errors 0
  tx_packets 44 tx_bytes 5928 tx_dropped   tx_errors 0

  15-seconds input rate:   89 bits/sec, 0 packets/sec
  15-seconds output rate:  89 bits/sec, 0 packets/sec
  5-minutes input rate:  318 bits/sec, 0 packets/sec
  5-minutes output rate: 271 bits/sec, 0 packets/sec

  no shutdown
```

To view device association with all radio/Wi-Fi interfaces of MSBR, use the following command:

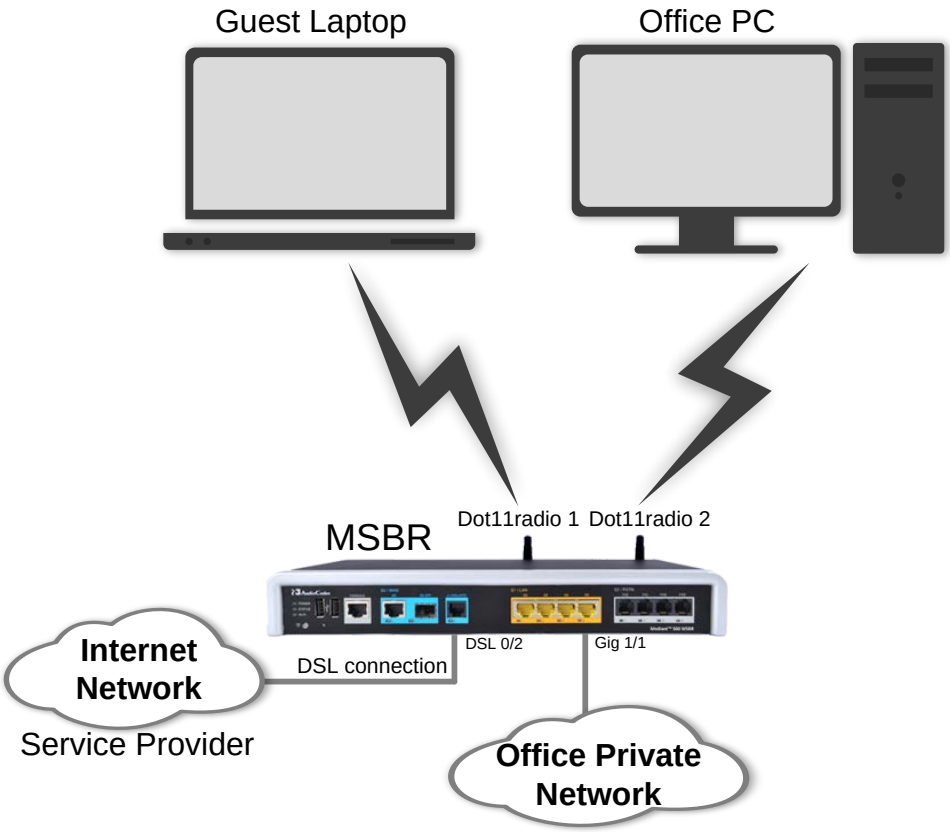
```
# show data dot11radio associations all
```

```
dot11radio 1:
ADDR               CHAN   RATE   Power
ec:85:2f:96:37:b2     9    52M   16dBm
```

16.2 Advanced Wi-Fi Example

In this example, a guest laptop wishes to connect with Wi-Fi within office desk. The company does not want the guest to access the private network; only the internet. However, when one of the company's office PCs wants to sign in to MSBR, it needs to connect to another radio interface that allows connection to the private network office.

Figure 16-2: Wi-Fi Advanced Example



1. Configure two BVI interfaces and configure VLAN 1 and VLAN 2 as DHCP for different networks (internet network and office private network):

```
(config-data)# interface bvi 1
(conf-if-BVI 1)# no shutdown
(conf-if-BVI 1)# ip address 192.168.0.1 255.255.255.0
(conf-if-BVI 1)# ip dhcp-server network 192.168.0.2
192.168.0.50 255.255.255.0
+(conf-if-BVI 1)# service dhcp
(conf-if-BVI 1)# exit
(config-data)# interface vlan 1
(conf-if-VLAN 1)# bridge-group 1
(conf-if-VLAN 1)# exit
(config-data)# interface bvi 2
(conf-if-BVI 2)# no shutdown
(conf-if-BVI 2)# ip address 172.30.0.1 255.255.255.0
```

```
(conf-if-BVI 2)# ip dhcp-server network 172.30.0.2 172.30.0.10
255.255.255.0
(conf-if-BVI 2)# service dhcp
(conf-if-BVI 2)# exit
(config-data)# interface vlan 2
(conf-if-VLAN 2)# bridge-group 2
(conf-if-VLAN 2)# exit
```

2. Perform the same configuration as in the example in Section 16.1 on page 64:

```
(config-data)# no radio shutdown
(config-data)# interface dot11radio 1
(conf-if-dot11radio 1)# bridge-group 1
(conf-if-dot11radio 1)# description "private network"
(conf-if-dot11radio 1)# ssid MSBG [Access Point name]
(conf-if-dot11radio 1)# security mode NONE [open access point]
(conf-if-dot11radio 1)# no security mac mode [allow all]
(conf-if-dot11radio 1)# power 100 [full power signal, effects
all radio interfaces]
(conf-if-dot11radio 1)# beacon dtim-period 1
(conf-if-dot11radio 1)# beacon period 100
(conf-if-dot11radio 1)# wmm [Allow Multimedia]
(conf-if-dot11radio 1)# no shutdown
(conf-if-dot11radio 1)# exit
```

3. Add another radio interface for the private network:

```
(config-data)# interface dot11radio 2
(conf-if-dot11radio 1)# bridge-group 2
(conf-if-dot11radio 1)# description "internet network"
(conf-if-dot11radio 1)# ssid MSBG_Private [Access Point name]
(conf-if-dot11radio 1)# power 100
(conf-if-dot11radio 1)# no shutdown
(conf-if-dot11radio 1)# security wpa psk ascii 12345678 [if
any guest try to connect he will need this password]
(conf-if-dot11radio 1)# security wpa mode psk
(conf-if-dot11radio 1)# security wpa enc alg TKIP_AES
(conf-if-dot11radio 1)# security mode WPA_WPA2
(conf-if-dot11radio 1)# no security mac mode
(conf-if-dot11radio 1)# channel mode auto [choose frequency
automatically]
(conf-if-dot11radio 1)# exit
(config-data)# access-list 1 deny ip 172.30.0.0 0.0.0.255
192.168.0.0 0.0.0.255 [deny any device that assigned through
wifi connection to private network]
```

This page is intentionally left blank.

17 LLDP

MSBR supports the LLDP protocol. To configure LLDP, perform the following configuration:

Command	Description
`# configure data`	Enter the data configuration level.
`(config-data)# lldp timer 5`	Set the LLDP transmission timer to 5 seconds.
`(config-data)# lldp run`	Enable LLDP.

To view the neighbors discovered by LLDP, use the following command:

Command	Description
`# sh data lldp neighbors`	Displays LLDP neighbors.

17.1 Examples

To configure LLDP:

```
# configure data
 (config-data)# lldp timer 5
(config-data)# lldp network-policy profile 1
(conf-lldp-pol-1)# voice vlan 1
(conf-lldp-pol-1)# cos 5
(conf-lldp-pol-1)# dscp 46
(conf-lldp-pol-1)# exit
(config-data)# lldp network-policy profile 2
(conf-lldp-pol-2)# video vlan 2
(conf-lldp-pol-2)# cos 6
(conf-lldp-pol-2)# dscp 40
(conf-lldp-pol-2)# exit
(config-data)# lldp run
```

To view LLDP neighbors, use the following command:

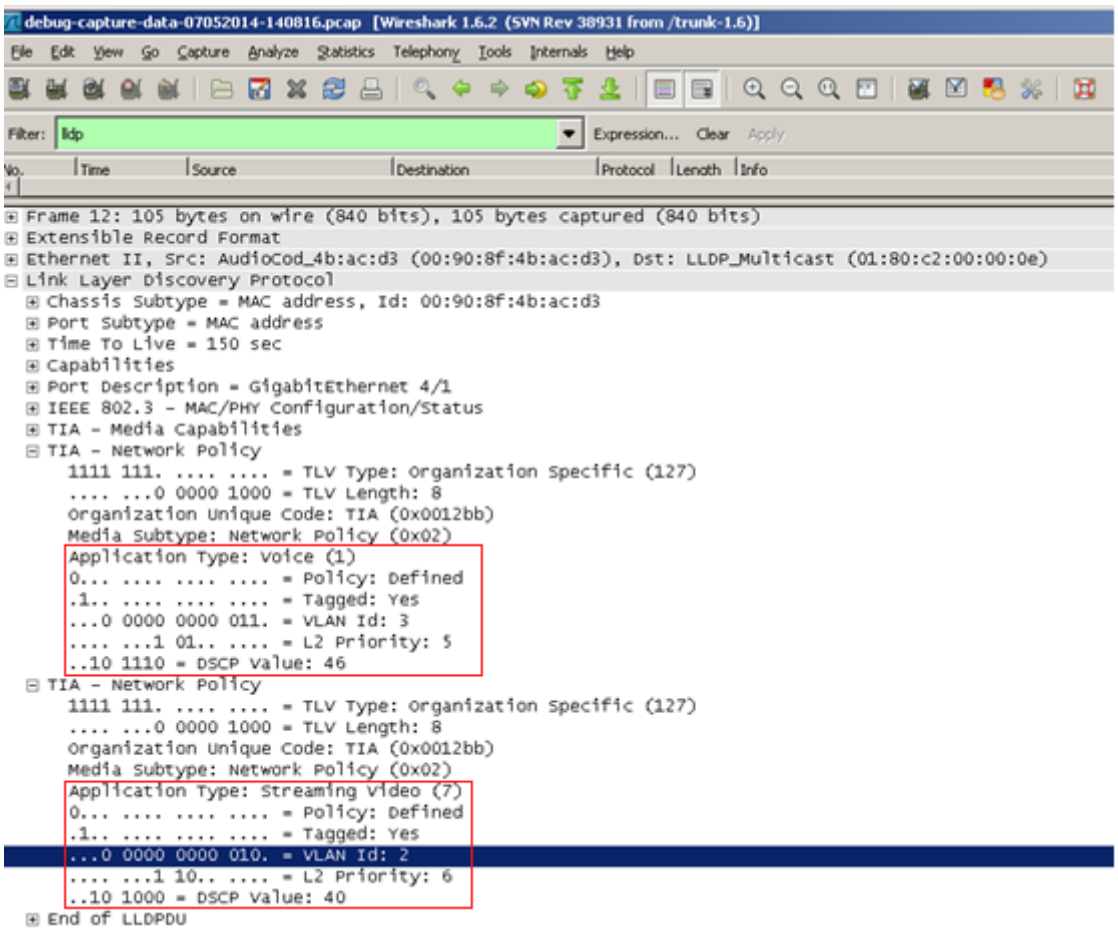
```
# sh data lldp neighbors
LLDP totals: received 60 packets, sent 62 packets

++ 00:90:8f:4b:bd:d7 on interface GigabitEthernet 4/2
   Received 56 LLDPDUs, timeout 25 seconds
   Capabilities: Router Bridge
   Port description: GigabitEthernet 4/3
```

The MAC address, 00:90:8f:4b:bd:d7 belongs to an adjacent MSBR. The adjacent MSBR port GigabitEthernet 4/3 is connected to port GigabitEthernet 4/2 of the local MSBR where the command `show data lldp neighbors` was issued.

Once LLDP is configured, the debug capture shows that the LLDP packet provides two different VLANs with suitable parameters:

Figure 17-1: LLDP



This page is intentionally left blank.

AudioCodes

Configuration Guide

www.audiocodes.com