

OAM for Carrier-Class Ethernet

Overview

Ethernet originally evolves from Local Area Networks (LAN) that consist of several small stations and are controlled by a single entity. In local area networks, the detection of link failure is usually simple and performed manually. However, as LAN environments migrate to bigger networks such as Metro Area Networks (MAN) that require high availability standards and fast fault detection and recovery abilities, the requirements for management functions has become more and more demanding especially for carrier-class networks. Due to the lack of integrated management capabilities in LAN, physically separated LANs that are used as enterprise-class network are continuously replaced by carrier-class networks that are more suitable for wider and large deployments. For carrier-class networks, without integrated management functions such as link monitoring, fault discovery or fault isolation, it is not only difficult for service providers or operators to respond to faults occurred in a node in a timely manner but also difficult to guarantee and improve Service-Level Agreements. To serve this end, operations, administration and maintenance (OAM), proposed by IEEE 802.3 task force and ITU, is one of the most important functions of a carrier-class technology to address the importance of discovering faults, monitoring and troubleshooting Ethernet links in an automatic manner.

OAM (Operations, Administration, and Maintenance) is largely used by service providers or network operators to monitor network operation such as fault detection and delivery of fault-related information. With OAM-enabled networks, administrators do not need to be on site when faults occur. This has greatly reduced truck rolls to the minimum. Compared with manual detections, automatic detections triggered by OAM protocols provide immediate information to notify the administrator of the faults happen in one node so that network problems can be easily and quickly localized and network services can be recovered within acceptable maintenance time. In this way, stable network availability and reduced network downtimes can be assured using this cost-effective way.

The major benefits that OAM brings to service providers or network operators

are highlighted below:

- Migrate the Ethernet service network to carrier-grade level
- Provide proactive network monitoring
- Reduce truck rolls
- Manage OPEX or CAPEX effectively
- Continuous Ethernet Connectivity
- Immediate fault discovery and recovery

Recognizing the needs for management capabilities in carrier-class Ethernet, a variety of protocols and tools have been developed for IP or Ethernet networks available at different layers. The common OAM protocols operating at Layer 2 Introduced below include: IEEE 802.3ah, IEEE802.1ag, and ITU-Y.1731.

Introduction to Common OAM Protocols

Currently, there are many OAM tools available for use. However, the following sections only focus on three common OAM tools that are used in Layer 2; these are IEEE 802.3ah, IEEE 802.1ag, and ITU-Y.1731.

1. IEEE802.3ah EFM (Ethernet First Mile)

IEEE 802.3ah is a standard for Ethernet in the first mile that contains a link level OAM mechanism. In order to monitor link status, IEEE 802.3ah detects link failures in both bi-directional and uni-directional links by sending CCM messages. If either end receives a CCM message within the specified duration, then a fault is detected against the service.

Features:

Auto discovery: To learn the peer's 802.3ah OAM capability without manual configuration.

Remote loopback (Fault verification): To provide on-demand link diagnostics including bit-error-rate approximation.

Link monitoring (Fault detection): To offer proactive traffic-based threshold link monitoring.

Critical events (Fault notification): To support communication of network element conditions that may cause link failure.

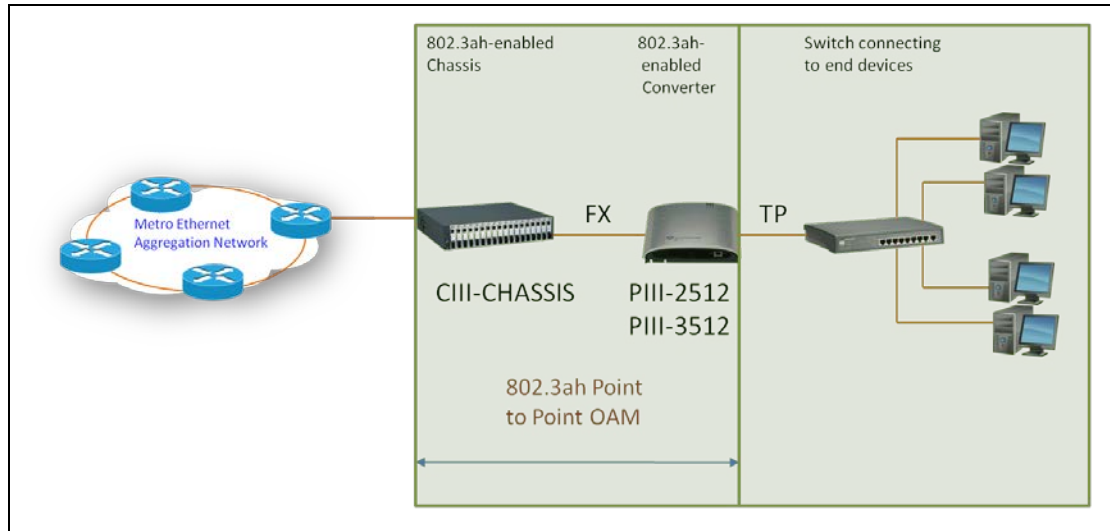


Figure 1. 802.3ah Point to Point OAM (Chassis + Converter)

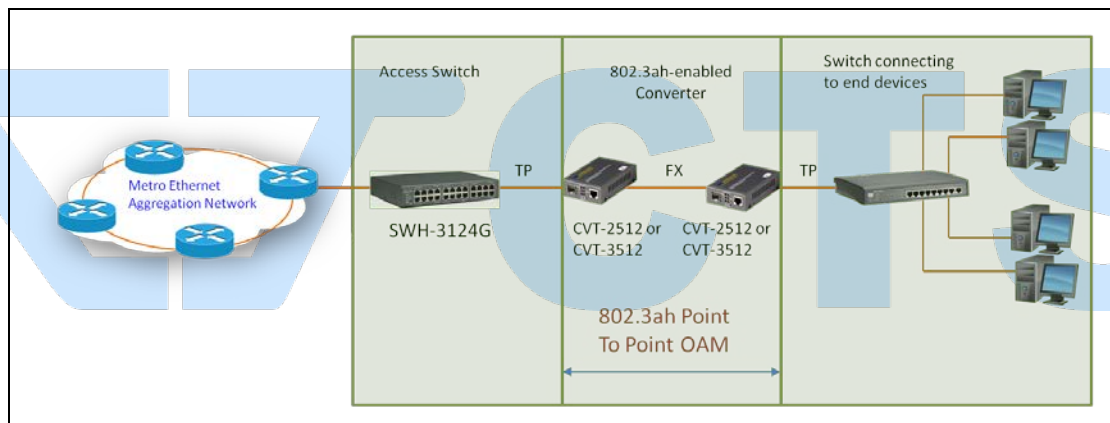


Figure 2. 802.3ah Point to Point OAM (Switch + Converter)

CTS 802.3ah Solution:

In Figure 1, it illustrates a network using CTS 802.3ah-compliant devices to perform OAM. As depicted in the figure, CIII-Chassis can be interconnected with PIII and CIII series products (Non-management product with no IP) and is able to initiate discovery packets to 802.3ah-enabled counterpart to establish point to point link. This OAM combination can provide the following functions:

- Peer discovery
- Link status monitoring
- Remote fault indication
- Remote loopback (slave)

- Remote loopback (master/slave)
- Remote echo loopback*

* This function is only for PIII-2512 and PIII-3512.

In Figure 2, an 802.3ah-enabled converter on the left connects to a multiple-port switch, such as SWH-3124G, and is used to convert copper signals to fiber ones. On the other end of the converter, it connects to the other 802.3ah-enabled converter. When connections for both converters are satisfactory, they both CVT-2512/3512 converters can perform peer discovery and remote loopback test.

2. IEEE802.1ag CFM (Connectivity Fault Management)

The IEEE 802.1ag allows the operator to detect, locate and verify faults for an Ethernet service. The connectivity protocol is able to monitor the services continuously through periodically exchanging messages to verify connectivity at a maintenance domain. If a failure is detected, the “Loopback” (for fault verification) and “Linktrace” (for fault isolation) protocols are triggered to discover vital connectivity data in a specific bridge or LAN.

Features:

Continuity Check Message (CCM; Fault detection): To periodically exchange messages to verify connectivity.

Loopback Message (LBM; Fault verification): To provide on-demand or proactive indication about the location of the defected device.

Linktrace Message (LTM; Fault isolation): To provide on-demand or proactive Ethernet network topology information.

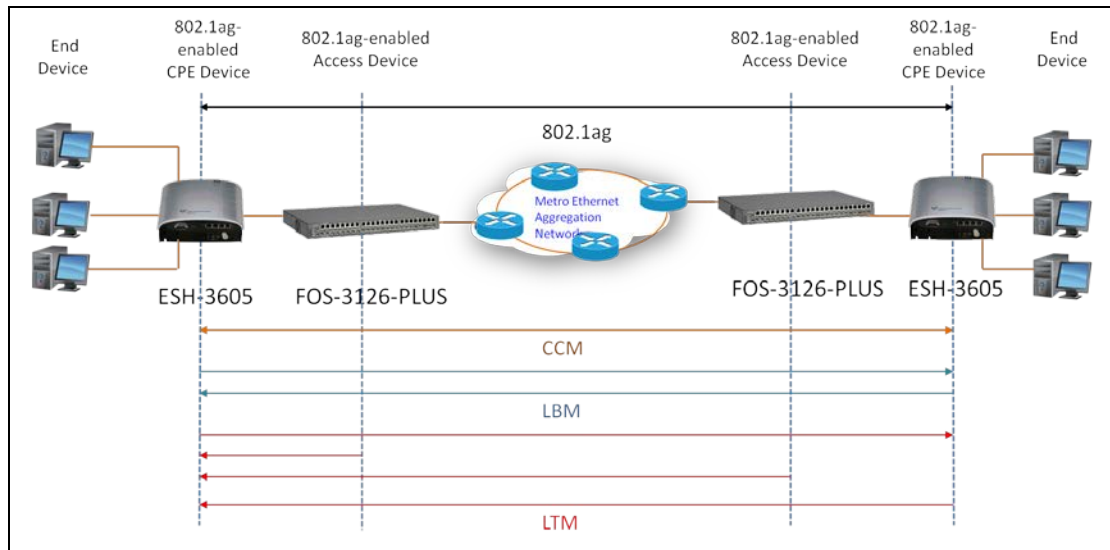


Figure 3. 802.1ag End to End OAM

CTS 802.1ag Solution:

CTS FOS-3126-PLUS is an access switch with 802.1ag functions that can be used to connect to ESH-3605 with 802.1ag functions to provide connectivity to end devices. When devices are successfully connected, they can perform the following functions to achieve end-to-end OAM.

- Peer discovery CCM
- Fault detection CCM
- Fault verification loopback (LBM)
- Fault isolation linktrace (LTM)
- Support 802.1ag MIP*

* This function is only for FOS-3126-PLUS.

Please note that when the access switch is replaced with the one without 802.1ag functions, such as FOS-2128, then the maintenance points, ESH-3605 devices, can not perform linktrace protocol for path discovery.

3. ITU-Y.1731

ITU-Y.1731 specifies the maintenance mechanisms for network and service of the Ethernet and defines ETH-CC (Ethernet Connectivity Check), ETH-LB (Ethernet Loopback), and ETH-LT (Ethernet Linktrace) OAM functions that are equivalent to IEEE802.1ag CCM, LBM, and LTM respectively. In addition to these functions, it also supports Performance Monitoring. The major difference between IEEE802.1ag and ITU-Y.1731 is that the former one intends to bridging applications; whereas, the latter one has already incorporated bridging and transporting applications.

Features:

Alarm Indication Signal (ETH-AIS): To prevent the Network Operation Center from receiving duplicated alarm message due to the same failure cause.

Remote Defect Indication (ETH-RDI): To actively inform the connection failure to the other device in an Ethernet service connectivity.

Locked Signal (ETH-LCK): To provide OAM message based tool to force the remote device to stop data traffic service then perform measurement of unidirectional throughput/frame loss/misorder/bit-error in Ethernet service connectivity.

Test Signal (ETH-Test): To send an one-way, on-demand, test signal to test throughput or detect frame loss.

Performance Monitoring (ETH-PM): To monitor traffic performance on a point-to-point, end-to-end VLAN-based Ethernet service.

Frame Delay Measurement (ETH-DM): To provide OAM message based tool to measure the end-to-end frame delay and delay variation which indicate the quality of Ethernet service.

Frame Loss Measurement (ETH-LM): To provide OAM message based tool to measure the end-to-end frame loss ratio which indicates the Ethernet service transportation availability.

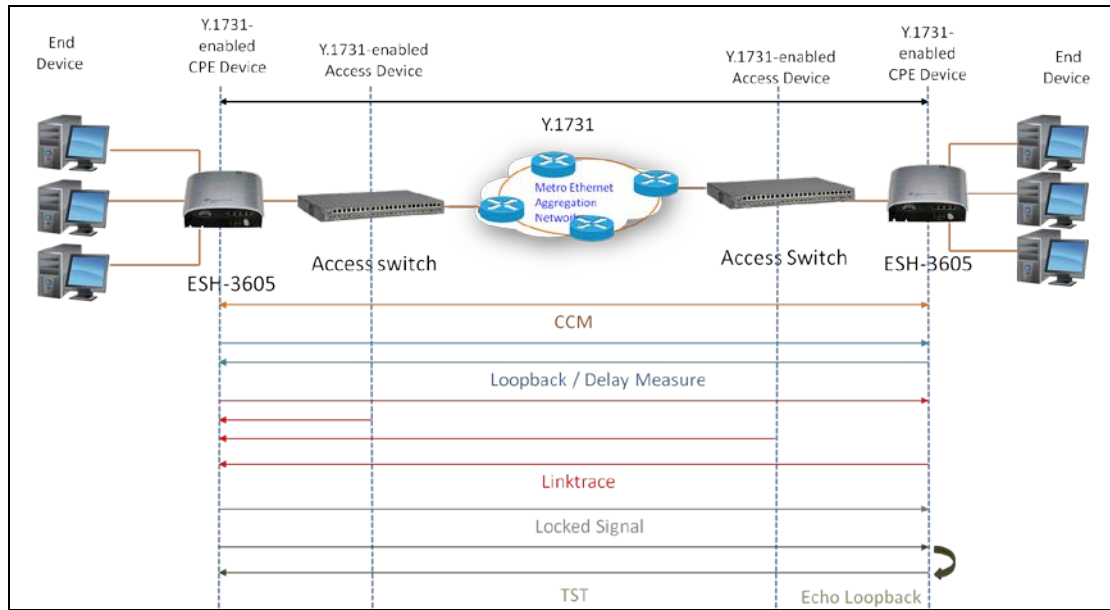


Figure 4. Y.1731 Service to Service OAM

CTS Y.1731 Solution:

CTS ESH-3605 is a CPE switch with advanced Y.1731 functions. In the figure provided above, ESH-3605 at each side is configured as MEP and is interconnected with an access device (MIP) with Y.1731 functions. When devices are successfully connected, they can perform the following functions to achieve service layer OAM.

- Peer discovery CCM
- Fault detection CCM
- Fault verification loopback (LBM)
- Fault isolation linktrace (LTM)
- Fault notification (RDI)
- Test function
- Frame loss measurement
- Frame delay measurement
- Wire-speed traffic generation/verification
- Wire-speed traffic echo loopback

Recommended Products with OAM Features:

Products		CIII-CHASSIS	CIII-2512	PIII-2512	CVT-2512	ESH-3105	ESH-3605	FOS-3126
			CIII-3512	PIII-3512	CVT-3512			-PLUS
Protocols								
802.3ah	Peer discovery	✓	✓	✓	✓	✓	✓	
	Link status monitoring	✓	✓	✓		✓	✓	
	Remote fault indication	✓	✓	✓		✓	✓	
	Remote loopback (slave)	✓	✓	✓		✓	✓	
	Remote loopback (master/ slave)	✓	✓	✓	✓			
	Remote echo loopback			✓		✓	✓	
802.1ag	Peer discovery CCM					✓	✓	✓
	Fault detection CCM						✓	✓
	Fault verification loopback (LBM)					✓	✓	✓
	Fault isolation Linktrace (LTM)					✓	✓	✓
	Support 802.1ag MIP							✓
Y.1731	Peer discovery CCM						✓	
	Fault detection CCM						✓	
	Fault verification loopback						✓	
	Fault isolation linktrace						✓	
	Fault notification (RDI)						✓	
	Test function (LCK/TST)						✓	
	Frame loss measurement						✓	
	Frame delay measurement						✓	
	Wire-speed traffic generation/verification						✓	
	Wire-speed traffic echo loopback						✓	

* Please refer to each product datasheet for detailed OAM features.