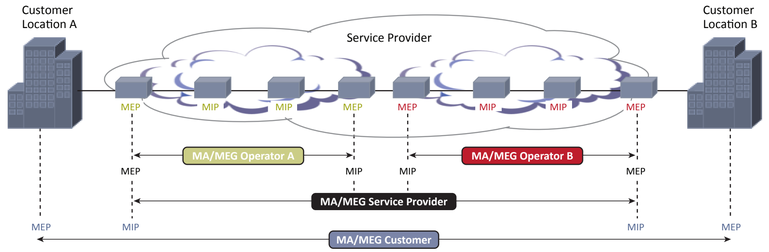
# Key Carrier Ethernet Testing and OAM Standards

## IEEE 802.1ag/ITU Y.1731 OAM

### Connectivity Fault and Performance Management

| 802.1ag/Y.1731 Terminology | |
|---|---|
| **IEEE 802.1ag** | **ITU Y.1731** |
| Maintenance Domain (MD) | No equivalent |
| Maintenance Association (MA) | Maintenance Entity Group (MEG) |
| Maintenance End Point (MEP) | Maintenance Entity Group End Point (MEP) |
| Maintenance Intermediate Point (MIP) | Maintenance Entity Group Intermediate Point (MIP) |

| Maintenance Level Assignment | |
|---|---|
| **MEG/MD Level** | **Assignment** |
| 5, 6, 7 | Customer Domain |
| 3, 4 | Provider Domain |
| 0, 1, 2 | Operator Domain |




**IEEE 802.1ag/ITU Y.1731 Functions**

| | IEEE 802.1ag | ITU Y.1731 | Role |
|---|---|---|---|
| Fault Management: Continuity Check Message | Yes (CCM) | Yes (ETH-CC) | Heartbeat message configured to be sent at one of seven standard intervals: 3.3ms, 10ms, 100ms, 1s, 10s, 1min, 10min |
| Fault Management: Link Trace | Yes (LTM) | Yes (ETH-LT) | Trace route function to identify all OAM entities between maintenance points |
| Fault Management: Loopback | Yes (LBM) | Yes (ETH-LB) | Equivalent to Ping to verify connectivity to OAM maintenance point |
| Fault Management: RDI (Remote Defect Indication) | Yes | Yes (ETH-RDI) | Flag embedded in the Continuity check message indicates defect condition |
| Fault Management: AIS (Alarm Indication Signal) | No | Yes (ETH-AIS) | Used to suppress alarms following detection of a defect condition |
| Fault Management: Locked Signal | No | Yes (ETH-LCK) | Indicates an administrative lock condition (e.g. out of service ETH-TEST) resulting in traffic disruption |
| Fault Management: Test Signal | No | Yes (ETH-TEST) | Used to perform 1-way on-demand in or out of service test (throughput, frame loss, bit error, etc.) |
| Fault Management: APS Signal | No | Yes (ETH-APS) | Used to control Automatic Protection Switching operations |
| Fault Management: Maintenance Communication Signal | No | Yes (ETH-MCC) | Provides maintenance communication channel between MEPs; can be used to perform remote management |
| Performance Management: Frame Loss Measurement | No | Yes (ETH-LM) | Single ended or dual ended loss measurement |
| Performance Management: Frame Delay Measurement | No | Yes (ETH-DM) | On-demand frame delay and frame delay variation measurement |

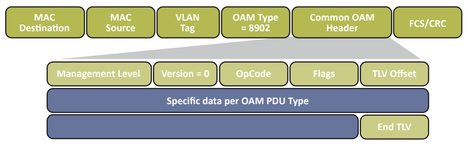
**OpCode List**

| OpCode | OAM PDU Type |
|---|---|
| 1 | CCM Continuity Check Message (Common with 802.1ag) |
| 2 | LBR Loopback Reply (Common with 802.1ag) |
| 3 | LBM Loopback Message (Common with 802.1ag) |
| 4 | LTR Linktrace Reply (Common with 802.1ag) |
| 5 | LTM Linktrace Message (Common with 802.1ag) |
| 33 | AIS Alarm Information Signal |
| 35 | LCK Lock Message |
| 37 | TST Test Message |
| 39, 40 | APS APS Message |
| 41 | MCC Maintenance Communication Channel Message |
| 42 | LMR Loss Measurement Reply |
| 43 | LMM Loss Measurement Message |
| 45 | 1DM 1-Way Delay Measurement Message |
| 46 | DMR Delay Measurement Reply |
| 47 | DMM Delay Measurement Message |

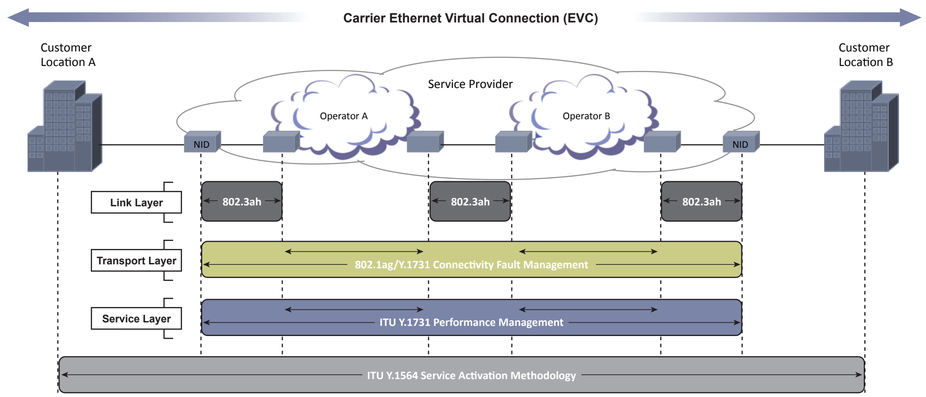
**Maintenance Point Roles**

| Function | MEP | MIP |
|---|---|---|
| Initiates CCM messages | ✓ Yes | ✗ No |
| Initiates Loopback and Linktrace messages | ✓ Yes | ✗ No |
| Responds to Loopback and Linktrace messages | ✓ Yes | ✓ Yes |
| Y.1731 Performance Management messages initiates and responds | ✓ Yes | ✗ No |
| Forwards messages | ✓ Yes (*upper maintenance layer*) ✗ No (*lower maintenance layer*) | ✓ Yes (*upper maintenance layer*) ✗ No (*lower maintenance layer*) |

**OAM PDU**




## NETWORK OVERVIEW

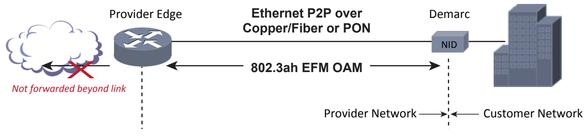



## IEEE 802.3ah EFM OAM

### Link Fault Management

**EFM OAM 802.3ah**

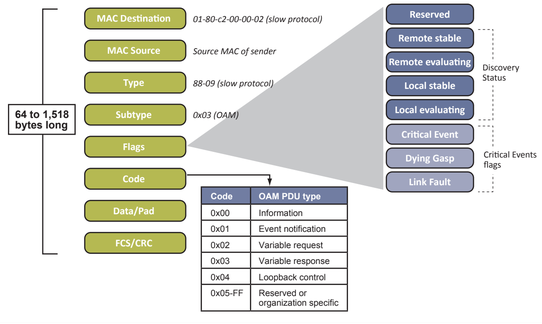
- Defined in IEEE 802.3 standard clause 57
- Developed for EFM (Ethernet in the First Mile)
- Not forwarded beyond the link
- Slow protocol limited to 10 frames per second
- Not mandatory for backward compatibility with older Ethernet equipment




**802.3ah Functions**

| | |
|---|---|
| **Discovery** | Information about OAM entities capabilities, configuration, and identity are exchanged |
| **Remote Failure Indication** | Notification of critical link failures:<br>• Link Fault: receive path broken<br>• Dying Gasp: unrecoverable local fault (e.g. power failure, reboot, reset)<br>• Critical Event: severe error condition |
| **Remote Loopback** | Loopback request command for link performance testing and fault isolation |
| **Performance Monitoring** | Link events threshold crossing notification. Transfer of Ethernet counters and stats via MIB querying mechanism |
| **Proprietary Extensions** | Mechanism to add proprietary extensions for organization or vendor specific use |

**802.3ah OAM PDU**




| Code | OAM PDU type |
|---|---|
| 0x00 | Information |
| 0x01 | Event notification |
| 0x02 | Variable request |
| 0x03 | Variable response |
| 0x04 | Loopback control |
| 0x05-FF | Reserved or organization specific |

**DTE 802.3ah OAM Operation**

| OAM operation | Mode Passive | Mode Active |
|---|---|---|
| Initiates OAM discovery | No | Yes |
| Responds to OAM discovery | Yes | Yes |
| Sends Information OAM PDU | Yes | Yes |
| Sends Event Notification OAM PDU | Yes | Yes |
| Sends Variable Request OAM PDU | No | Yes |
| Sends Loopback Control | No | Yes |
| Reacts to Loopback Control | Yes | Yes |

**802.3ah OAM Discovery**

- First phase of 802.3ah protocol
- Local and Remote exchange information OAM PDUs indicating capabilities and configuration information (mode, PDU size, loopback support, etc.)
- After successful negotiation, the OAM protocol is enabled on the link
- If no OAM PDU received for 5 seconds, discovery is restarted
- DTE can be configured in Active or Passive mode

| DTE Mode Combos | Local Active | Local Passive |
|---|---|---|
| Remote Active | ✓ Yes | ✓ Yes |
| Remote Passive | ✓ Yes | ✗ No |

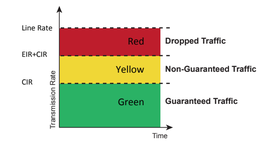
## ITU Y.1564 SAM

### Service Activation Methodology (SAM)

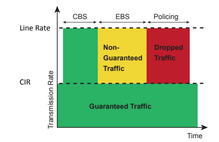
**Carrier Ethernet Service Bandwidth Profile**

| | |
|---|---|
| **Committed Information Rate** | Guaranteed maximum rate at which frames are assured to be forwarded through the network without being dropped |
| **Excess Information Rate (EIR)** | Maximum rate above the CIR at which frames will be forwarded on a best effort basis, but may be dropped in the event of congestion |
| **Committed Burst Size (CBS)** | Maximum number of consecutive frames sent at full line rate that the service is allowed to transmit and that are assured to be forwarded |
| **Excess Burst Size (EBS)** | Maximum number of frames sent at full line rate on top of the CBS that will be forwarded on a best effort basis, but may be dropped in the event of congestion |
| **Color Mode (CM)** | Allows the customer to pre-mark their traffic with a priority tag rather than letting the carrier blindly enforce the CIR/EIR/CBS/EBS metering algorithm on the traffic |

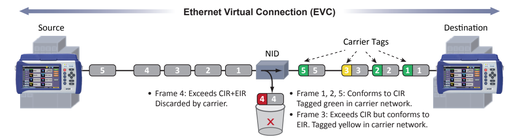
**Service Information Rate**




**Service Burst Rate**




**Service Bandwidth with Profile Enforcement**




**Carrier Ethernet Service Acceptance Criteria (SAC)**

| | |
|---|---|
| **Frame Transfer Delay (FTD)** | Maximum transfer time from source to destination allowed by SLA. FTD is only guaranteed for traffic conforming to the CIR. |
| **Frame Delay Variation (FDV)** | Maximum frame jitter allowed by SLA. FDV is only guaranteed for traffic conforming to the CIR. |
| **Frame Loss Ratio (FLR)** | Maximum ratio of lost frames to the total transmitted frames allowed by SLA. FLR is only guaranteed for traffic conforming to the CIR. |
| **Availability (AVAIL)** | Minimum percentage of service availability allowed by SLA. Service becomes unavailable if more than 50% of the frames are errored or missing in a one second interval. Availability is only guaranteed for traffic conforming to the CIR. |

**Test Methodology**

**Phase 1: Configuration Test**

All Services running on the same line are tested one by one to verify the correct Bandwidth Profile provisioning.

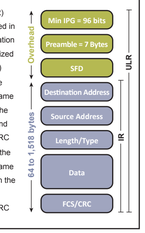
| | | |
|---|---|---|
| Step 1 | **CIR Test** | Tx at CIR rate; verify SLA on Rx traffic |
| Step 2 | **EIR Test** (optional) | Tx at CIR+EIR rate; verify that Rx traffic is ≥ CIR |
| Step 3 | **Policing Test** (optional) | Tx at 25% > CIR+EIR; verify that traffic greater than CIR+EIR is blocked |
| | ***CBS/EBS Tests*** | *Experimental; not integral part of standard* |

**Phase 2: Service Performance Test**

All Services running on the same line are tested simultaneously over an extended period of time to verify network robustness.

**Ethernet Rate Measurement**

- Rates (CIR, EIR) can be expressed in terms of Information Rate (IR) or Utilized Line Rate (ULR)
- **IR** measures the avg. Ethernet frame rate starting at the MAC address and ending at the CRC
- **ULR** measures the avg. Ethernet frame rate starting with the overhead and ending at the CRC

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