Mobile Backhaul Testing and Monitoring Reference Poster

EtherSAM Methodology (ITU.T Y.1564)

Phase 1: Service Configuration Test (Ramp Test)

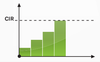
Objective: Validate the network configuration of each defined services (rate limiting, traffic shaping, quality of service).

Methodology: For each service, a ramp test is used to gradually reach and exceed the CIR; all key performance indicators (KPIs) are measured against a threshold.

Step	CIR (%)	Frame Loss (%)	Max Jitter (ms)	Max Latency (ms)	Verdict	Average Throughput (Mbit/s)
1	50.0	0.0	0.100	5.051	✓	1.988
2	75.0	0.0	0.098	5.051	✓	2.981
3	90.0	0.0	0.098	5.051	✓	3.577
CIR	100.0	0.0	0.098	5.051	✓	3.974
Overshoot		0.0	0.100	5.051		4.002

The above values are for example purposes only.

Phase 1: CIR Test

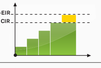


- Service is ramped up from minimum value to CIR rate
- At each step, KPIs are measured and validated against pass/fail criteria

CIR Pass/Fail Criteria:

- ☑ • Rx rate = Tx rate • KPIs within SLA
- ☒ • Rx rate < Tx rate • Any KPI fails

Phase 2: Service is tested at EIR

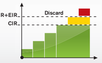


- Service is tested at EIR
- KPIs are not guaranteed
- Pass/fail based on Rx throughput

EIR Pass/Fail Criteria:

- ☑ • CIR ≤ Rx rate ≤ CIR+EIR
- ☒ • CIR ≥ Rx rate

Phase 3: Service is tested at overshoot rate



- Service is tested at overshoot rate
- KPIs are not guaranteed
- Pass/fail based on Rx throughput

Overshoot Pass/Fail Criteria:

- ☑ • CIR ≤ Rx rate ≤ CIR+EIR
- ☒ • CIR+EIR ≥ Rx rate

Phase 2: Service Performance Test

Objective: Validate the quality of service of each defined service and prove service-level agreement (SLA) conformance.

Methodology: All services are generated at once to their CIR and all KPIs are measured for all services.

Service No.	Average Throughput (Mbit/s)	Frame Loss (%)	Max Jitter (ms)	Max Latency (ms)	Verdict
1	5.0	0.0	0.262	5.179	✓
2	0.126	0.0	0.296	5.175	
3	3.972	0.0	0.259	5.051	✓

The above values are for example purposes only.

Service Test

Service Test Pass/Fail Criteria:

- ☑ • KPIs within SLA per service
- ☒ • Any KPI fails

- Simultaneous generation of all services at CIR and simultaneous measurement of all parameters
- Pass/fail threshold for each parameter (in each direction)
- Suggested test time: 2 hours; depending on customer procedures, test time can be as low as 2 minutes
- Can be scaled to longer term test (e.g., 24 hours or more)

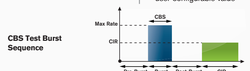
Burst (CBS, EBS) Test

Objective: Verify that the expected burst (CBS or EBS) size can be transmitted with minimal loss.

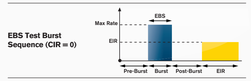
Methodology:

- Test sequence
  - Initialization period: Off time before executing the burst sequences to ensure the network can absorb the first burst
  - Burst sequences
  - Termination period
- Each direction is tested individually to ensure the policing/shaping mechanism is properly configured
- Burst sequence can be repeated for user-configurable value

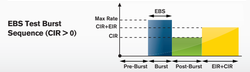
CBS Test Burst Sequence



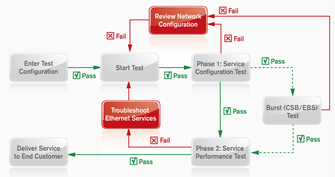
EBS Test Burst Sequence (CIR = 0)



EBS Test Burst Sequence (CIR > 0)

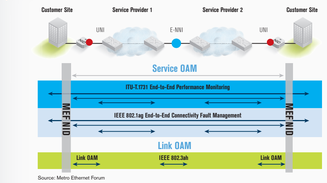


EtherSAM Methodology



EtherSAM
The new standard in Ethernet service testing

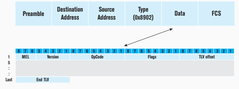
Ethernet Service OAM



Source: Metro Ethernet Forum

Definitions	
Connectivity Fault Management (CFM)	Capabilities for detecting, verifying and isolating connectivity failures in local area networks
Maintenance Association (MA)	A set of MEPs established to verify the integrity of a single service instance
Maintenance Domain (MD)	The network or part of the network for which faults in connectivity can be managed
Maintenance Entity (ME)	Entity that requires management and is a relationship between two maintenance entity group endpoints
Maintenance Entity Group (MEG)	A group of MEs that are in the same administrative boundary, have the same MEG level and belong to the same point-to-point Ethernet connection or multipoint Ethernet connectivity
Maintenance Association Endpoint (MEP)	Endpoint that can initiate and terminate OAM frames for fault management and performance monitoring
Maintenance Domain Intermediate Point (MIP)	Intermediate point in a MEG that is capable of reacting to some OAM frames. It does not initiate OAM frames
Traffic Conditioning Point (TrCP)	Ethernet flow point which is capable of an Ethernet traffic conditioning function

OAM Frame Format



MEL (MEG Level): OAM level to which this frame is applicable

OpCode: Operation being performed (e.g., ping, connectivity check, traceroute, loop detection, error message, etc.)

Version: Specifies the version of the OAM protocol

Sequence Number: Useful to detect out of order OAM frame (useful for loop detection)

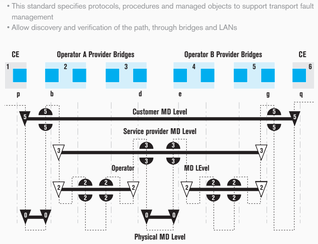
Flags: Use of the bits in this field is dependent on the OAM PDU type

TLV Offset: Offset to the first TLV (Type/Length/Value) in an OAM PDU relative to the TLV offset field

OpCode	Value OAM PDU type	Definition
1	CCM	Continuity check message
3	LBM	Loopback message
2	LBR	Loopback reply
5	LTM	Link trace message
4	LTR	Link trace Reply
33	AIS	Alarm indication signal
35	LCK	Locked
37	TST	Test PDU
39	Linear APS	Linear automatic protection switching
40	Ring APS	Ring automatic protection switching
41	MCC	Maintenance control communication channel
43	LMM	Loss measurement message
42	LMR	Loss measurement Reply
45	1DM	One-way delay measurement
47	DMM	Delay measurement message
46	DMR	Delay measurement reply
49	EXM	Experimental administration and management reply
51	VSM	Vendor-specific OAM message
50	VSR	Vendor-specific OAM reply

OAM with 802.1ag

- This standard specifies protocols, procedures and managed objects to support transport fault management
- Allow discovery and verification of the path, through bridges and LANs



Bridge with two Bridge Ports
Down MEP
Up MEP (number is MD Level)
MIP
Maintenance Association
Logical path of CFM PDUs

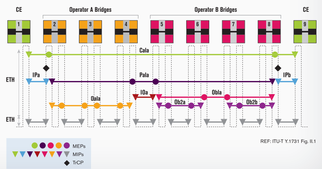
REF: IEEE Std 802.1ag-2007 Fig. 18-7

OAM with 802.3ah

- EFM (Ethernet in the First Mile) collection of 802.3 protocols
- Specifies link monitoring, fault signaling and remote loopback for the access network

OAM with Y.1731

- Specifies mechanisms required to operate and maintain the network and service aspects of the Ethernet layer
- Specifies the Ethernet OAM frame formats as well as the syntax and semantics of OAM frame fields



REF: ITU-T Y.1731 Fig. 8.1

Two-Way Active Measurement Protocol (TWAMP)—RFC 5357

- Open protocol for measurement of two-way or round-trip metrics
- Based on the methodology and architecture of one-way active measurement protocol (OWAMP)–RFC 4656

TWAMP Inner Protocols

TWAMP-Control	Initiate, start and stop test sessions
TWAMP-Test	Used to exchange test packets between two TWAMP entities

Logical Entities

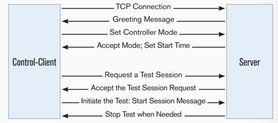
Session-Sender	Sending endpoint of an TWAMP-Test session
Session-Reflector	Receiving endpoint that creates and sends a measurement packet when it receives one
Server	End system that manages one or more TWAMP sessions and is capable of configuring per-session state in the endpoints
Control-Client	An end-system that initiates requests for TWAMP-Test sessions, triggers the start of a set of sessions and may trigger their termination

TWAMP Test UDP Packet Format
(Authenticated and Encrypted Mode)

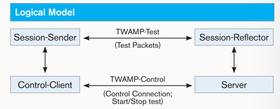
Source Port Number	Destination Port Number
Length	Checksum
Sequence Number	
MBZ (12 octets)	
Timestamp	
Error Estimate	MBZ (6 octets)
Receive Timestamp	
Sender Sequence Number	
MBZ (12 octets)	
Sender Timestamp	
Sender Error Estimate	MBZ (6 octets)
Sender TTL	MBZ (15 octets)
HMAC (16 octets)	
Packet Padding	

- **Error estimate:** Specifies the estimate of the error and synchronization
- **Hashed message authentication code (HMAC)**: Covers everything sent in a given direction; once encryption is set up, each bit of the TWAMP-Control connection is authenticated once by an HMAC
- **MBZ**: Must be zero
- **Packet padding**: Should be pseudo-random
- **Receive timestamp**: The time the test packet was received by the reflector
- **Sender error estimate**: Exact copy of the error estimate from the Session-Sender test packet that corresponds to this test packet
- **Sender timestamp**: Exact copy of the timestamp from the Session-Sender test packet that corresponds to this test packet
- **Sender sequence number**: A copy of the Sequence Number of the packet transmitted by the Session-Sender that caused the Session-Reflector to generate and send this test packet
- **Sender TTL**:
  - Is 255 when transmitted by the Session-Sender
  - Is set to the time to live (or hop count) value of the received packet from the IP packet header when transmitted by the Session-Reflector
- **Sequence number**: Sequence number of the test packet according to its transmit order
- **Timestamp**: Session-Reflector's transmit timestamp

Control Client–Server Communication Process



Logical Model



TWAMP Test UDP Packet Format
(Unauthenticated Mode)

Source Port Number	Destination Port Number
Length	Checksum
Sequence Number	
Timestamp	
Error Estimate	MBZ
Receive Timestamp	
Sender Sequence Number	
Sender Timestamp	
Sender Error Estimate	MBZ
Sender TTL	
Packet Padding	

- **Error estimate**: Specifies the estimate of the error and synchronization
- **MBZ**: Must be zero
- **Packet padding**: Should be pseudo-random
- **Receive timestamp**: The time the test packet was received by the reflector
- **Sender error estimate**: Exact copy of the error estimate from the Session-Sender test packet that corresponds to this test packet
- **Sender sequence number**: A copy of the Sequence Number of the packet transmitted by the Session-Sender that caused the Session-Reflector to generate and send this test packet
- **Sender timestamp**: Exact copy of the timestamp from the Session-Sender test packet that corresponds to this test packet
- **Sender TTL**:
  - Is 255 when transmitted by the Session-Sender
  - Is set to the time to live (or hop count) value of the received packet from the IP packet header when transmitted by the Session-Reflector
- **Sequence number**: Sequence number of the test packet according to its transmit order
- **Timestamp**: Session-Reflector's transmit timestamp

1 CONSTRUCTION

Objectives
- Characterize physical link
  - Tower raise (singlemode and multimode)
  - Backhaul
- Ensure loss budget is in range (splice, connectors)
- Locate and fix problems (macrobends, dirty or bad connectors, bad splice)

How
- Inspect and analyze connectors with video probe
- Link loss and return loss measurements with OTDR and/or OLTS

Key Concerns
- Do it right the first time (if physical layer is not well tested, it affects the rest of the steps)
- Put tower in service as fast as possible

EXFO Solution—Key Benefits
- Ease of use, one start button
- Reduced test time with FastTest/FastTrace: OPEX reduction

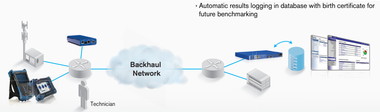
2 SERVICE TURN-UP AND BURN-IN

Objectives
- Verify backhaul connection configuration and performance
- Validate circuit and service performance against SLA

How
- Perform EtherSAM (Y.1564) or RFC 2544 from RTU-310 to handheld or performance endpoint
  - Using the handheld (instead of loopback device) at the tower will provide bidirectional results
  - Optional: If in-service burn-in is required, perform 24-hour burn-in via Ethernet OAM
- Test results automatically saved: service birth certificate

Key Concerns
- Minimize technician intervention and truck rolls
- Put tower in service as fast as possible
- Proof of quality with all SLA parameters

EXFO Solution—Key Benefits
- Combination of RTU-310 and BV10 allows for complete remote turn-up with zero truck rolls
- EtherSAM: complete validation of SLA with a single test allowing 8x faster deployment using standards-based method
- When testing to handhelds: providing highest level of confidence with bidirectional results for all services and all KPIs
- Automatic results logging in database with birth certificate for future benchmarking



3 SERVICE MONITORING

Objectives
- 24/7 performance monitoring of live network/services
- Network trend information

How
- Metrics gathered via OAM-compliant Ethernet devices (IEEE 802.1ag and Y.1731)
- Alerts/alarms to report service degradations and initiate the service troubleshooting process
- Aggregation and analysis of KPIs for historical and near-real-time reports

Key Concerns
- Detection of issues before end customers
- Historical data and network trends
- Integration with OSS and other systems (e.g., billing)

EXFO Solution—Key Benefits
- Fully standards-based leveraging OAM standards (IEEE 802.1ag and Y.1731) and TWAMP
- Unique BV10 providing low-cost PEP for network-wide visibility
- Advanced user-specific reporting

4 SERVICE TROUBLESHOOTING

Objectives
- Detect and locate issue/failure
- Determine cause of issue/failure

How
- Perform on-demand OAM test to confirm issue
- Perform RFC 2544 or EtherSAM (Y.1564) test to PEP. If handheld is used, bidirectional results are available (Dual Test Set)
- If required, use additional troubleshooting tools to determine cause of issue:
  - Packet capturing and decoding
  - Advanced filtering

Key Concerns
- Minimize time to determine source of issue
- Eliminate or minimize truck roll

EXFO Solution—Key Benefits
- Combination of RTU-310 and BV10 allows for complete remote troubleshooting with zero truck roll
- EtherSAM: Troubleshooting of complete of SLA with a single test

FIP-400
Fiber Inspection Probe

FTB-860
10 Mbit/s to 10 Gbit/s Ethernet Test Set

BrixNGN
Ethernet Performance Monitoring

FTB-200
Compact Multiservice Field Platform

BV10
Performance Endpoint

BV-3000
Gigabit Ethernet Service Assurance Probe

RTU-310
IP Services Test Head

SyncWatch-110
Synchronization Testing Unit

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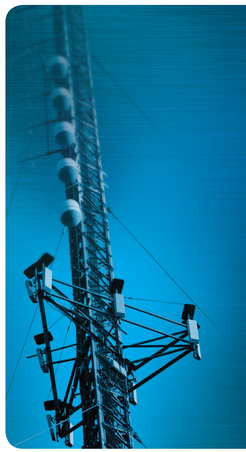

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