T-BERD®/MTS-6000A

Multi-Services Application Module

Applications

- NEW! ***Tests Ethernet Services transported via SONET/SDH using VCAT, GFP, and LCAS***
- NEW! ***Tests the higher layer protocol stack using packet capture and analysis capabilities***
- Tests 10 GigE LAN- and WAN-PHY at 850, 1310, and 1550 nm wavelengths (single-port)
- Tests dual- and single-port 10 Mb/s to 1 GigE
- Supports 1G/2G/4G/10G FC and FICON for SANs with automated FC testing and buffer-to-buffer control verification, FC Login
- Tests OTN at 2.7, 10.7, 11.05, and 11.1 Gb/s bit rates with SONET/SDH and Ethernet client emulation as well as ODU Multiplexing
- Tests T-carrier and PDH with T1, E1, E3, DS3, and E4 interfaces and mappings
- Tests SONET/SDH at OC-3/STM-1 through OC-192/STM-64 line rates
- Tests Layer 1-4 Ethernet with RFC2544, VLAN, Q-in-Q, VPLS, and MPLS
- Tests Ethernet OAM, PBB/PBT, and transparency of L2 services
- Tests TCP/UDP at 10 Mb/s to 10 Gb/s with stateful emulation
- Tests FTP/HTTP/Telnet
- Tests IP Video at 10 Mb/s to 10 GigE line rates

Key Features

- ***Supports higher layer analysis via supported packet capture and analysis capabilities*** NEW!
- Modular form-factor enables field upgrade of test capabilities by adding or replacing PIMs and optics
- Multi-service capability allows simultaneous Ethernet, Fibre Channel, and SONET/SDH/PDH/OTN testing through physical port
- Performs two independent tests in parallel with dual-port chassis
- Enables Ethernet OAM, PBB/PBT, MPLS/VPLS, VLAN, QinQ, IP, and higher layer test
- Fibre Channel and FICON support for SANs with automated FC testing and buffer-to-buffer control verification
- Identifies problems with fiber optics faster with optical power source, high accuracy power meter, OTDR, CD, PMD, and WDM
- Provides visual fault locator and fiber microscope
- Provides remote control via Ethernet/IP and VT-100 emulation

The rugged, handheld T-BERD/MTS-6000A Multi-Services Application Module (MSAM) provides the industry's most compact and powerful multifunction, multilayer 10-Gigabit tester for installing and maintaining carrier-grade Ethernet and Internet Protocol (IP) services. Technicians can also add testing capability with pluggable physical interface modules (PIMs), small form-factor pluggable modules (SFPs), and 10 Gb/s small form-factor modules (XFPs) to create a variety of field-configurable optical/electrical test combinations.

Transport and Special Services technicians using this modular handheld field tester can quickly turn up and maintain Metro Core networks. Interfaces on the unit range from 1.5 Mb/s to 11.1 Gb/s on various synchronous and asynchronous technologies, including, synchronous optical network technologies/synchronous digital hierarchy (SONET/SDH), optical transport network (OTN), Ethernet and Fibre Channel (FC). It can also verify and troubleshoot higher-layer IP video, Layer 4 (L4) User Datagram Protocol/Transmission Control Protocol (UDP/TCP), File Transfer Protocol (FTP), and Hypertext Transfer Protocol (HTTP). A powerful user interface helps technicians quickly set up and evaluate tests as well as troubleshoot problems, reducing operational expense.

With field applications for servicing Metro Core telecom networks, wireless/cable switch centers and backhaul networks, government telecommunications and network equipment manufacturer field installation and support groups, the MSAM is the latest innovation for the award-winning, industry-leading T-BERD/MTS family of test solutions.

Ethernet, IP, and Beyond

The MSAM enables transport technicians to quickly turn up and maintain Metro Core networks following the workflow for application-centric testing (see Figure 1). As part of traditional Layer 2/Layer3 (L2/L3) testing, the MSAM can verify end-to-end connectivity, measure bit error rate (BER), and determine whether throughput, utilization, frame loss, packet jitter, and round-trip delay (RTD) characteristics meet service level agreements (SLA). It can perform Ethernet tests at line rates from 10 Mb/s to 10 Gb/s. The MSAM can also test a wide range of tunneling technologies and mechanisms, including 10 GigE within 11.05 and 11.1 Gb/s OTN as well as Ethernet and IP analysis within a SONET/SDH signal. It can also verify the full transparency of L2 networks by generating and analyzing a large number of control plane frames, which the user can customize. With Ethernet operation, administration, and maintenance (OAM), users can verify the link connectivity, insert alarms, and initiate loopbacks. On electrical Ethernet circuits, the MSAM can display the link speed, link status, cable status, media delivery index/media delivery index crossover media delivery index/media delivery index crossover (MDI/MDI-X), and distance to fault with the press of a button.

Figure 1. Workflow for Application-Centric Turn-Up

Additional Ethernet-Specific Test Features

– 10 Gb/s local/wide area network (LAN/WAN) Single-port
– 10 Mb/s to 1 Gb/s (electrical/optical) Single- and dual-port
– 850, 1310, and 1550 nm Wavelength
– Provider Backbone Bridge/Transport (PBB/PBT), Ethernet OAM, Virtual LAN (VLAN), 802.1q Tunnel Tags (Cisco) (Q-in-Q), virtual private LAN service (VPLS), Multiprotocol Label Switching (MPLS)
– Layer 1 (L1) BER test
– L2 Multiple streams, L2 transparency, and traffic generation[1]
– L3 Multiple streams and traffic generation[2]
– L4 TCP/UDP stateful emulation, traffic blasting
– FTP/HTTP/Telnet connectivity and Throughput test
– RFC2544
– Optical power measurement
– Cable diagnostics including fault types, distance, skew and polarity-per-pair, as well as Power over Ethernet (PoE) detection

[1] Constant, bursty, ramp, configurable source and destination address, frame format, type field (for Digital, Intel, Xerox [DIX]), frame length (including jumbo and undersized), VLAN tag, pause frames, payload, utilization percent

[2] Configurable source and destination IP address, Domain Name Server (DNS) type, DNS server, transmit (TX) payload, type of service/differentiated services code point (TOS/DSCP), transistor-to-transistor logic (TTL), packet size length (34 to 1500 bytes), ping, traceroute

Class of Service Verification with Multiple Streams

The MSAM relies on multiple stream traffic generation, allowing users to emulate various types of traffic with the appropriate Class of Service (CoS) mappings and assess the impact of such traffic on the overall network design, as Figures 2 and 3 illustrate.

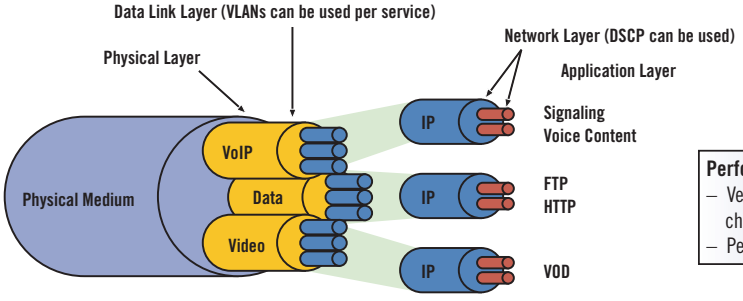

Figure 2. Multiple data streams

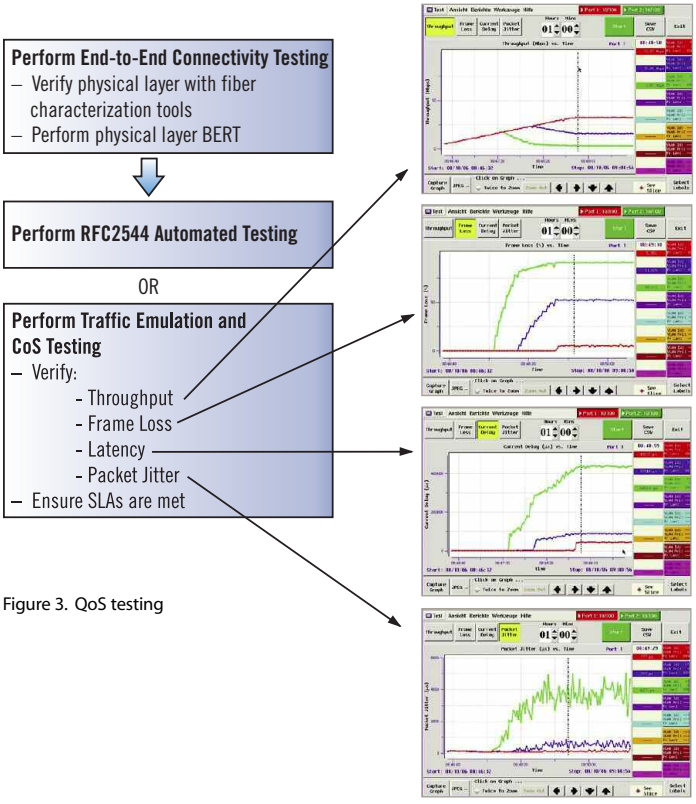

Figure 3. QoS testing

PBB/PBT, Ethernet OAM, VLAN, Q-in-Q, VPLS, and MPLS Tunneling Technologies

Various mechanism and tunneling technologies exist today that let providers effectively deliver carrier-grade Ethernet services across their networks, while maintaining a specified CoS. These technologies are grouped into categories:

– Native Ethernet protocol extensions (IEEE-based)—VLAN tags (often referred to as 802.1q/p) and Q-in-Q (often referred to as VLAN stacking or 802.1ad) techniques

– PBB/MAC-in-MAC (IEEE 802.1ah), PBB-TE (802.1Qay), and Ethernet OAM (IEEE 802.1ag/ITU Y.1731)

– Encapsulations by MPLS networks, which also come in L2 (VPLS) and L3 versions

The MSAM enables the installation and maintenance of these technologies.

Application-Centric Layer 4 and Higher Turn-Up

The MSAM offers L4 and higher Application-Centric Turn-up that enables technicians to go beyond the traditional Ethernet service turn-up process that verifies the ability of the network to meet SLAs for L2 (Ethernet) and L3 (IP) performance. Upon completion of the basic connectivity and throughput testing, the MSAM Triple-Play Turn-up test application can be used to simplify the test and verify the ability of a network to carry Triple-Play Traffic. Users simply configure the desired number of representative standard definition (SDTV) and high definition (HDTV) television channels along with voice calls and data traffic, and the unit presents an easy-to-understand summary screen shown in Figure 4, including a network pipe diagram shown in Figure 5.

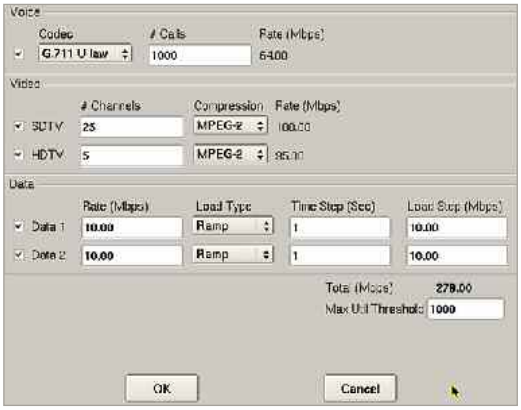

Figure 4. Configuring triple-play profiles

Figure 5. Triple-play summary network pipe screen

Troubleshoot Faster and Cheaper Using Packet Capture and Analysis

In the ever-changing Ethernet and IP world, providers must be able to troubleshoot problems at all layers of the stack quickly, cost-efficiently, and reliably. The MSAM offers powerful filter and packet capture at all Ethernet lines rates (10 Mb/s to 10 GigE). The captured data can then be analyzed on the tester or a PC using industry-leading decoding engines. This capability lets field technicians solve network problems right away rather than needing a specialist to travel on site, which results in shorter mean time to repair and lower operating costs.

Scripts Automate TCP Window Optimization, FTP, and HTTP Throughput Testing

The MSAM automates the process of setting the Transmission Control Protocol (TCP) Window, which is critical to an application's performance. The TCP Throughput script tests performance over a range of window sizes and provides an easy-to-understand test report that clearly highlights the optimal Window size. The MSAM also simplifies FTP and HTTP throughput testing with a wizard-like configuration interface. The FTP test results show FTP upload and download throughput for a wide range of file sizes. The HTTP throughput test is run with a live Web server and the test report highlights the Web page sizes versus throughput for each universal resource locator (URL).

Powerful IPTV Test Abilities

The MSAM provides comprehensive Internet Protocol television (IPTV) test capabilities. Technicians can verify network provisioning through video stream access at various network points and analyze receipt of the streams and their quality of service (QoS) at each point. This capability enables them to verify that the physical, transport, and video stream layers are free of errors and alarms. Technicians also can perform detailed troubleshooting in selected streams to verify transport layer conditions, including packet loss, jitter, MDI, distance error, and period errors. Technicians also can verify conditions of video stream layer, including program clock reference (PCR) jitter, sync loss errors, and continuity counter errors, such as video packet loss, transport error indicators, and packet identification (PID) errors. Figure 6 provides an example of the detail provided about IPTV transport stream quality.

Additional IPTV-Specific Test Features

– 10 Mb/s to 10 GigE line rate test for IPTV

– Single program transport stream (SPTS)

– Multiple program transport stream (MPTS)

– Video Explorer: up to 512 SPTS and 32 MPTS

– Bandwidth, packet loss, packet jitter

– Video Analyzer up to 16 SPTS and 1 MPTS:

  - PCR jitter, MDI (per RFC4445), continuity error bit,and error indicator bit

  - TR 101 290 priority 1 errors such as program identification (PID), program association table (PAT), and program map table (PMT)

  - Loss distance and period errors (per RFC3357)

  - Results per transport stream, and per PID

  - Internet Group Management Protocol (IGMP) support

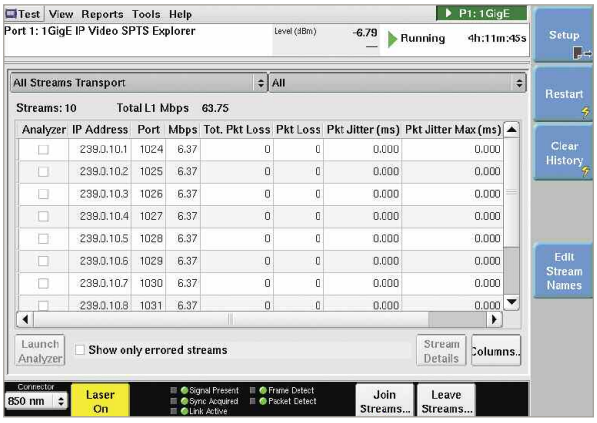

Figure 6. IPTV transport stream quality detail

Storage Area Networking

Fibre Channel/FICON Overview

The MSAM tests 1, 2, 4, and 10 Gb/s fibre channel (FC) and fiber connection (FICON) services. Users can manipulate various fields of the FC frames to emulate end-customer traffic and perform BER measurements on L1 and L2 circuits. The MSAM supports buffer crediting capability, which lets providers verify the effect of delay on the link throughput and test the ability of the link to obtain the optimum buffer credit values. The MSAM also allows users to turn up storage area networks (SANs) efficiently using the FC automated test script producing reliable throughput, packet loss, RTD, and burstability results with a consistent test methodology. Figure 7 displays an example of a testing in a SAN.

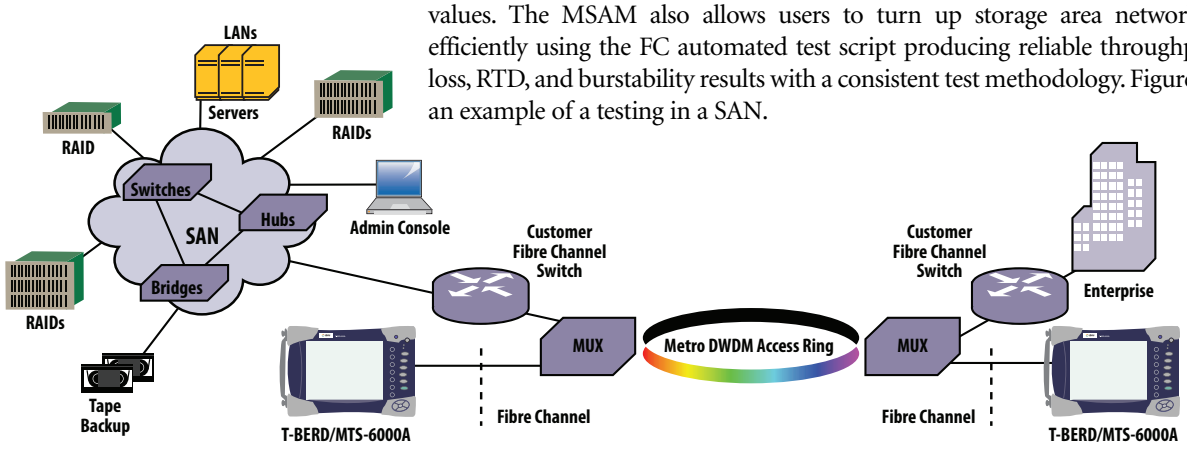

Figure 7. Storage area network

'RFC-like' Fibre Channel Testing

– Adapts RFC2544 testing methodology to FC circuits
– Allows for automated test routines and results analysis
– Allows for the saving of specific test configurations and routines

The MSAM provides an automated test routine and results analysis that can be configured to automatically verify the optimal buffer credit size to meet the desire SLAs of the link by:

1) Finding the optimal buffer size

2) Calculating the minimum buffer credit size for the specified throughput at each frame length (see Table 1)

3) Measuring throughput at various buffer credit sizes (see Table 2)

Frame Length (Bytes)	Cfg Rate (Mb/s)	Minimum Buffer Size (Credits)
76	1700.0	375
128	1700.0	278
256	1700.0	155
512	1700.0	83
1024	1700.0	43
1536	1700.0	30
2076	1700.0	22
2140	1700.0	22

Table 1. Buffer credit test limits

Frame Length (Bytes)	Buffer Size (Credits)	Cfg Rate (Mb/s)	Measured Rate (Mb/s)	Measured Rate (%)	Measured Rate (frames/s)
76	1	1700.0	4.1	0.24	4802
76	2	1700.0	8.3	0.49	9604
76	4	1700.0	16.7	0.98	19208
76	8	1700.0	33.1	1.95	38416
76	16	1700.0	66.3	3.90	76832
76	32	1700.0	132.8	7.81	153664
76	64	1700.0	265.5	15.62	307328
76	96	1700.0	398.3	23.43	460911
76	128	1700.0	531.1	31.24	614610
76	160	1700.0	663.7	39.04	768176
76	192	1700.0	796.5	46.85	921833
76	224	1700.0	928.2	54.60	1074402
76	256	1700.0	1060.8	62.40	1227849
76	288	1700.0	1193.4	70.20	1381315
76	320	1700.0	1326.0	78.00	1534774
76	352	1700.0	1458.6	85.80	1688229
76	375	1700.0	1554.0	91.41	1798528

Table 2. Throughput at incremental buffer credit size

SONET/SDH

1.5 M to 10 G SONET/SDH BER Testing

The MSAM performs BER testing on all line inter-faces in end-to-end or loopback applications, inserts errors and alarms to verify NE conformance and connectivity, and measures BERs to ensure QoS.

SONET/SDH Overhead Byte Manipulation and Analysis

Using the overhead byte manipulation and analysis capability of the MSAM, users can modify K1 and K2 bytes to test automatic protection switching (APS) to specify and identify user-configurable path trace messages and payloads.

Service Disruption Measurements

The MSAM measures the protection switch times of SONET/SDH rings and their effects on tributaries. Simultaneous monitoring of various error conditions on the tributaries, lets providers verify that their transport network is providing adequate redundancy to guarantee SLAs, as Figures 8 and 9 show.

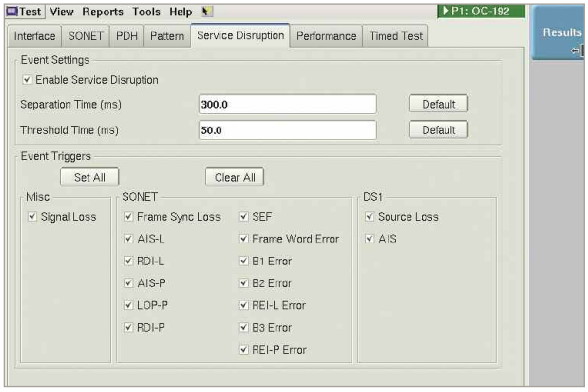

Figure 8. Trigger multiple simultaneous events

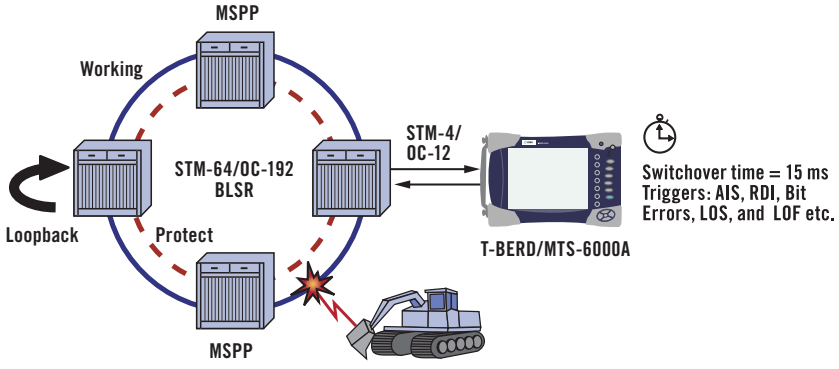

Figure 9. Service Disruption

Testing Ethernet and IP services transported via VCAT, GFP, and LCAS

As Ethernet services become more prominent, carriers are presented with the challenge to offer them in an economic manner reusing their existing SONET/SDH infrastructure. As an extension to classic SONET/SDH functionality, Virtual Concatenation (VCAT), Generic Framing Procedure (GFP) and Link Capacity Adjustment Scheme (LCAS) offer a solution.

The MSAM offers the industry's smallest and lightest solution for testing SONET/SDH to the Ethernet layer–using one module and one graphical user interface (GUI) for all SONET/SDH interfaces up to 10 G, which is particularly useful for troubleshooting problems in the field. The GUI will guide users directly to the layer that is causing the trouble without the need for them to be an expert in every layer.

Beside the classical SONET/SDH test capabilities (including overhead analysis, round-trip-delay testing, and Service Disruption) the MSAM also offers full flexibility to set up and analyze VCAT structures as well as verify the correct transformation of the asynchronous Ethernet frames into the synchronous SONET/SDH containers on the GFP layer.

For Ethernet, the MSAM is able to perform tests on L2 (Ethernet) and L3 (IP) such as RFC2544 tests, packet jitter analysis, and ping tests. Alarm, error insertion and analysis capabilities at all layers can be used to stress test the network and verify correct reporting in network management.

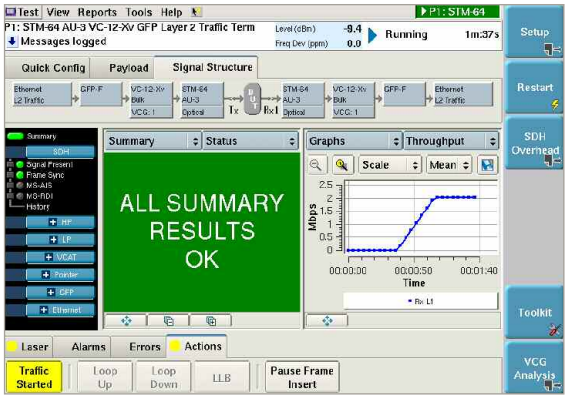

Figure 10. Ethernet Throughput testing inside 10G SONET / SDH link

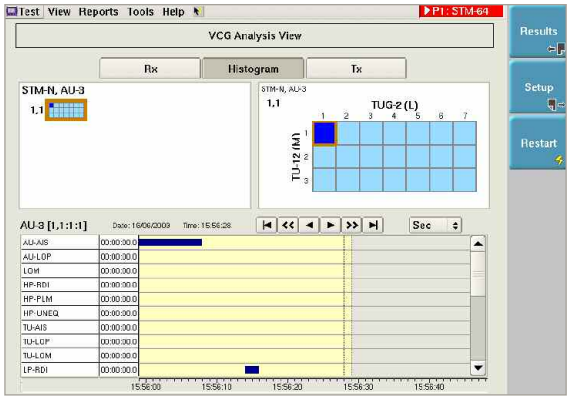

Figure 11. Analysis of a virtually concatenated group

OTN

The goal of the OTN, or digital wrapper technology, is to combine and accelerate the benefits of SONET/SDH with the bandwidth expandability of dense wavelength division multiplexing (DWDM). OTN applies the operations, administration, maintenance, and provisioning (OAM&P) functionality of SONET/SDH, which allows for protocol transparency; optimized, error-free transmission; and reduces the number of Reamplify – Reshape – Retime (3R) regeneration points in an optical network. OTN can also aggregate lower rate traffic into higher rate signals (similar to SONET/SDH), commonly referred to as Optical Density Unit (ODU) multiplexing. This capability enables operators to cost-effectively install, maintain, and scale their next-generation networks. Figures 12 and 13 provide a view of the OTN frame.

Support OTU-1 (2.7 G) and OTU-2 (10.7, 11.05, 11.1 Gb/s) Optical Interfaces

– Test end-to-end connectivity by transmitting and receiving OTN (Reed Solomon [RS], 255/239) signals including a variety of client signals and pseudorandom bit sequence (PRBS) test patterns
– Save time by simultaneously and independently testing 11.1, 11.05, 10.7, and 2.7 Gb/s interfaces

Transmit and Analyze Correctable and Uncorrectable FEC Errors

– Verify Network Management alarm and error detection with alarm and error injection capabilities on line and client level
– Verify the ability of a NE to correct conditions through the use of forward error correction (FEC)-enabled signals

Perform Service Quality Testing at Line, Client, and Payload Level

– Emulate 10 GigE client within 11.1 and 11.05 Gb/s OTN interface
– Perform SONET BER testing within 2.7 and 10.7 Gb/s OTN interface
– Generate and analyze ODU-multiplexed signals (ODU-1 in ODU-2) to verify correct aggregation of the signal
– Perform overhead analysis on both line rate and client signal level

Figure 12. OTN Frame

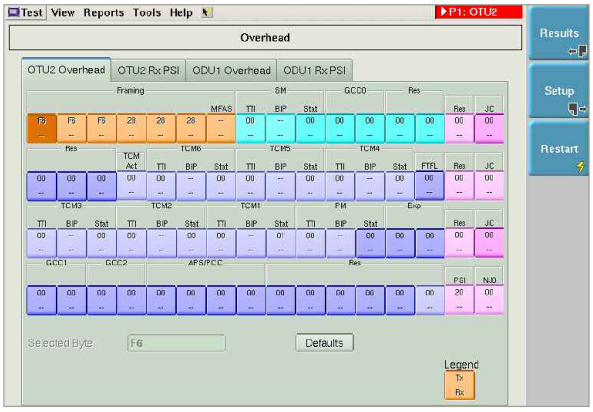

Figure 13. OTN overhead byte manipulation

Very Easy to Use

The GUI of the MSAM makes it easy for even relatively inexperienced technicians to perform a broad range of tests, as Figure 14 shows. The screen displays test results stacked in layers on top of each other, with each OK indicated in green and errors indicated in red. Tabular results are provided in the form of graphs for easier understanding, such as throughput, frame loss, delay, and jitter presented as functions of time. Wizard-driven scripts now automate formerly complicated testing procedures. For example, the Walk the Window script automates the process of determining the proper TCP Send Window size. Scripts are also provided to determine FTP and HTTP throughput.

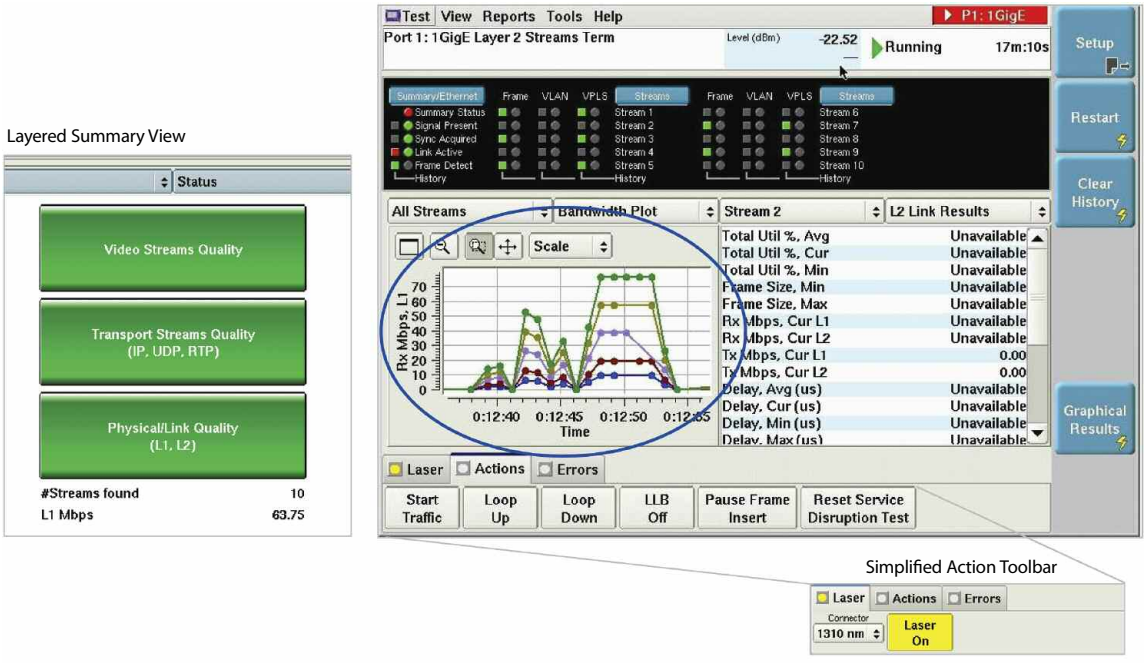

Figure 14. The GUI on the MSAM makes performing a broad range of tests easy for even relatively inexperienced technicians.

Fiber Optics

Faulty fibers and connectors continue to be the most common problems in today's transport networks. Even the smallest issue with the fiber plant can adversely affect high-speed transmission services. The T-BERD/MTS-6000A user interface module provides fiber test functionality without adding excess size or weight, eliminating the need to carry and manage separate test sets or additional modules. Never lose time due to faulty patch cords or optical connectors when turning up services.

High-Accuracy Power Meter and Source

Using the stable power source and high-accuracy power meter of the T-BERD/MTS-6000A, users can measure power at any point in an active network, measure the insertion loss of a link between transmitter and receiver, and verify the loss characteristics of patch cords before turning up services. Providing this high-accuracy loss test set eliminates the need for a separate handheld instruments or additional test modules.

Visual Fault Locator

Considered a mandatory tool for technicians dealing with fiber patch cords, the built-in visible light source allows for quick fiber continuity checks and visual break locations.

Fiber Optic Microscope

Upon installation and maintenance of transmission systems, the optical inspection scope allows for the quality verification of the front optical connector during measurement or system turn-up. The use of the video probe allows for visualization of the connector in a safe environment, even if the fiber is active.

Additional Features and Applications

Numerous configurations and options are available for the T-BERD/MTS-6000A, including a dual test option that enables performing two independent tests in parallel; optical power source, high-accuracy power meter, optical time domain reflectometer (OTDR), chromatic dispersion (CD), polarization mode dispersion (PMD), and wavelength division multiplexing (WDM) test options that help identify fiber optic problems faster.

Specifications

General (Typical 25°C)

Display

Touchscreen, TFT color, 8.4 in LCD, 800 x 600, high-visibility

Storage and I/O Interfaces

Internal memory	1000 test results
Extended memory	Minimum 1 GB

2x USB V1.1, 1x RJ45 Ethernet

Power Supply

Battery type	Standard removable Li-ion battery
AC/DC adapter	Input 100–240 V, 50–60 Hz Output 19 V DC/3.1 A
Operation time	Typical operation time is 3 hours, depending on the application

Size and Weight

Mainframe with one plug-in module and battery (l x h x w)	285 x 195 x 93 mm (11.2 x 7.7 x 3.7 in)
Mainframe only (without battery and module)	2.4 kg (5.3 lb)
Mainframe with one plug-in module and battery	4 kg (9 lb)

Environmental

Operating temperature range (no options)	–20 to +50°C (–4 to 122°F)
Operating temperature range (all options)	0 to +40°C (32 to 104°F)
Storage temperature range	–20 to +60°C (–4 to 140°F)
Humidity, non-condensing	95%

Base Unit Optical Interfaces (optional)

Power Meter

Power level	+10 to –55 dBm
Calibrated wavelengths	850, 1310, and 1550 nm
Connector type	Universal push/pull (UPP)

Talk Set

Wavelength	1550 nm ±20 nm
Dynamic range	>45 dB range
Function	With data/file transfer
Laser safety	Class 1M laser
Connector type	Field interchangeable

Visual Fault Locator (VFL)

Wavelength	635 nm ±15 nm
Output power level	<1 mW
Laser safety	Class 2 laser
Connector type	Universal push/pull (UPP)

Continuous Wave (CW) Light Source

Wavelengths (selection)	1310, 1550, and 1625 nm
Output power level	–3.5 dBm
Stability in 15 min	± 0.02 dB
Stability in 8 hrs	± 0.2 dB
Laser safety	Class 1M laser
Connector type	Field interchangeable

Video Inspection Scope (via USB)

Magnification 250X or 400X, through the USB port

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