OTN - What's Important to Test

MT1000A Network Master Pro

MU100010A 10G Multirate Module

MT1100A Network Master Flex

MU110010A 10G Multirate Module
MU110011A 100G Multirate Module
MU110012A 40/100G Module CFP2

Contents

Background

It is becoming increasingly important to complete testing on the OTN (Optical Transport Network) at different layers and levels to ensure the underlying transport layer is performing correctly. This is necessary to ensure upper layers can transport their payload without causing any network errors.
As modern operators move OTN closer to customers, all ODU (Optical channel Data Unit) layers must be tested to ensure the circuit delivers or exceeds “five 9s” performance.

Recommended Reading

We have published several White Papers on OTN, starting at a basic level and moving up to the engineer level; for details, refer to the Further Reading section. We also offer a free OTN wall poster as a quick reference guide; for details refer to the Free OTN Wall Poster section.

The Network

A major benefit of OTN is the Frame structure, which is constructed so that it can be associated directly with a network segment. Understanding this network segmentation allows an engineer to identify the location of an issue quickly and understand how much effect the issue is likely to have on the operator’s customers.
As shown in Figure 1, the network can be divided into logical sections based on the OTN frame, such as:

- OTU (Optical channel Transport Unit)
- ODU (Optical channel Data Unit)
- OPU (Optical channel Payload Unit).

These sections are commonly represented by major physical boundaries within the network. The Core sections sometimes involve optical amplification (especially for long-haul networks). The Metro sections will often become the end points of the OTN or the end of the path, as shown by the OPU/ODU section.

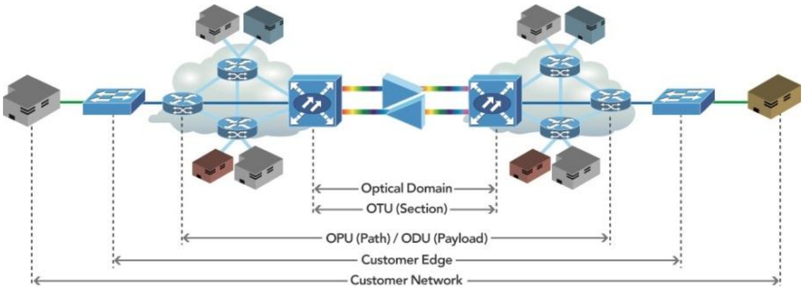


Figure 1. OTN Segmentation

Testing OTN Layer

Since OTN is a transport layer, it's important to have the flexibility to test all the standard OTN layers for Alarms and Errors. This is often done using a PRBS (Pseudo Random Binary Sequence) payload, allowing test equipment to determine whether or not there is an error in the payload while still effectively randomizing the information; this is commonly referred to as a BERT (Bit Error Rate Test).
Although the BER (Bit Error Ratio) is a good indication of possible issues affecting an operator's customers, in order to test fully and obtain detailed insight into the higher layers (customer traffic layers), it is far more important to complete testing on the higher layers as well.
The three sections **'Errors are reported in several ways'**, **'Understanding TCM'** and **'Standard BER testing'** below discuss some of the more traditional BERT methods for testing an OTN network. For more advanced testing, refer to our OTN – Advance Testing and Dividing the Network Application Note discussing in detail different ways to test the higher layers and how to troubleshoot errors caused by the OTN or higher layers.

Errors are reported in several ways

It is possible to confirm whether a network element is responding correctly to an error by configuring a tester with two ports inline between two network elements. Figure 2 shows a dual-port, 10 Gbps connection for an OTN network. Placing the tester inline in a pass-through (or pass-through with overwrite ability) mode supports this type of testing. By using this configuration it's possible to observe both traffic directions and evaluate whether one element is responding correctly to different error conditions. For example, if an SM–AIS (Section Monitoring – Alarm Indication Signal) alarm is inserted as shown in Figure 3 (top) from direction A to B, an SM–BDI (Section Monitoring – Backward Defect Indication) alarm should be reported back from the network element in the other direction as shown in Figure 3 (bottom). It is also important to note they are both on the SM layer.
If a PM–CSF (Path Monitoring – Client Signal Fail) error is inserted from direction A to B, a PM–BDI error should be reported back in the other direction from B to A.
It's important to note the different layers mentioned above; the SM layer is very likely to be an issue in a Core network because it's part of the OTU layer. While a PM layer can often be associated with an end-customer circuit because it's part of the ODU layer. Understanding the layer format allows an engineer to focus on the most important issues first.
For more details on errors caused by errors in the other direction, refer to the Maintenance Signal section in the Free Wall Poster.

Figure 2. 10 Gbps Dual-Port Connection

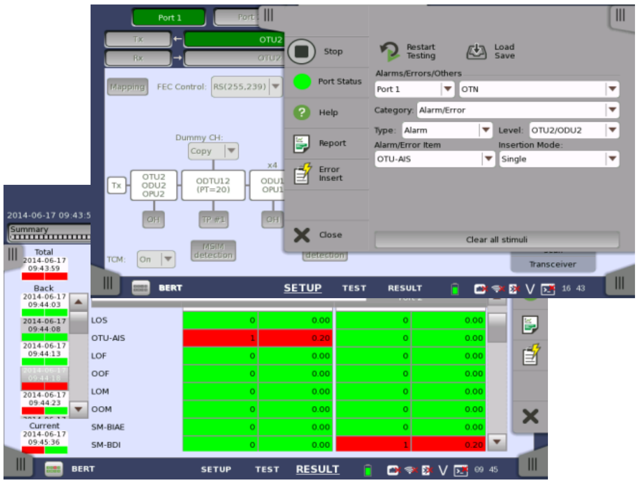


Figure 3. Alarm Injection and Detection in Dual-Port BERT

Understanding TCM

The release of OTN implemented some major enhancements to TCM (Tandem Connection Monitoring) compared to the SDH/SONET (Synchronous Digital Hierarchy/Synchronous Optical NETwork) implementation. A major difference was taking TCM from a single-layer to six-layer system allowing much more flexible implementation. An example is as follows:

Figure 4. OTU transmitter Overhead

Receiving a TCM1-BDI error might indicate an error in the payload or overhead. If the payload is received without errors, it indicates that some part of the overhead might be corrupted. Of course, if this is in the TCM1 (lowest layer), it's also much more critical than a TCM2 error or another higher-layer error.

One point to note is the standards don't define how TCM layers should be set-up, so the effect of an error on each TCM layer is dependent on how each operator decides to define them.

It's important to have the ability to fully manipulate alarms and errors on each of the six TCM layers plus the flexibility to edit the overhead fully as shown in Figure 4. This allows an engineer to inject alarms and errors at every level and confirm that each network element responds correctly, based on its layer within the network.

Figure 5. OTU TCM Receiver Alarms and Errors

The ability to see all alarms and errors per TCM layer allows an engineer to quickly identify many key areas, such as which part of the network is causing the issue or even the error direction. One example might be an IAE (Incoming Alignment Error) indicating an alignment issue has occurred between the transmitting network element and the network equipment receiver port, while a BIAE (Backward IAE) is sent by the network element receiving the IAE to notify the far-end network element about the original IAE. Figure 5 shows an example of the type of alarms and areas that assist an engineer in troubleshooting the network, and the ability to select the relative TCM layer.

For full details about TCM, refer to the [OTN – The Deep Dive into Details that Make it Tick] White Paper; for information on how errors and alarms respond to each other across a network, refer to the Maintenance Signal section in the [Free Wall Poster].

Standard BER testing

The normal method for deploying a new link is to complete a BERT. It's important to complete this test using the same mappings as the network will eventually use. As an example, if an OTU2 (10 Gbps) network is to eventually carry an ODUflex payload, it would be ideal to test the network using the smallest ODUflex frame size planned to be implemented over the network. If this is unknown, the safest solution is to complete the BERT within a 1.25 Gbps ODUflex mapped configuration, because this is the smallest possible available frame size. This mapping can be seen in Figure 6.

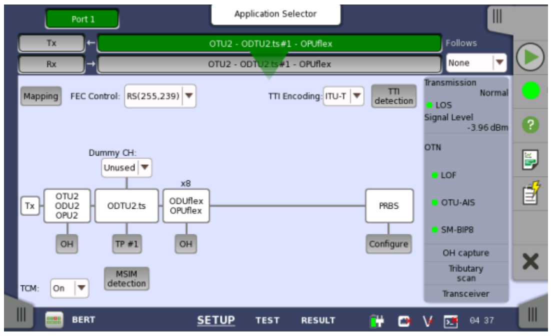


Figure 6. ODUflex Transmitter Setup

Before starting a test, it's a good idea to know the tester has been connected correctly and all areas of the overhead are working. To do this, usually an engineer quickly views the current status of all alarms and errors on the network. Figure 7, shows how all overhead can be viewed on one screen. Since the tester has been configured to interoperate with an ODUflex network, it is possible to view both the base ODU2 Alarms and Errors as well as the ODUflex level of Alarms and Errors. This quick but in-depth view allows an engineer to confirm that the tester and network elements are configured correctly all the way to the highest layer before starting any long-term test.

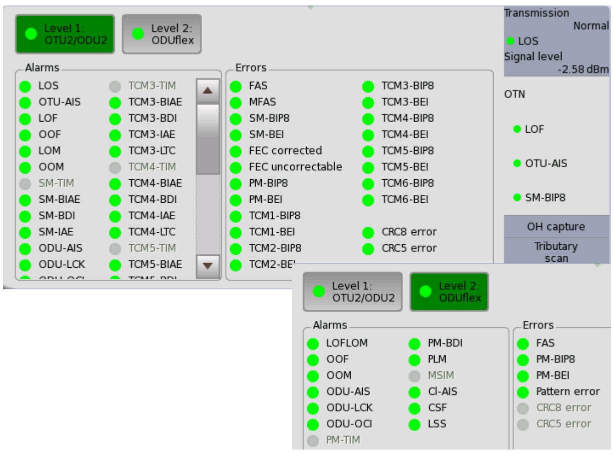


Figure 7. ODUflex Alarms and Errors

Once the test has started, it's important to have a clear view of all Alarms and Errors in a format that allows the user to see the total count and ratio for the duration of the test for a specific timeframe within the test, as shown in Figure 8. This supports the ability to understand the full details of all Alarms and Errors recorded for the total test time and whether they were generated continually during the test or whether they occurred all at once within a short time period. Using this insight, an engineer can quickly determine the troubleshooting direction. Of course, it is equally important to understand the network performance versus the relative standard by viewing all the standardized Alarm and Error information, such as SES (Severely Errored

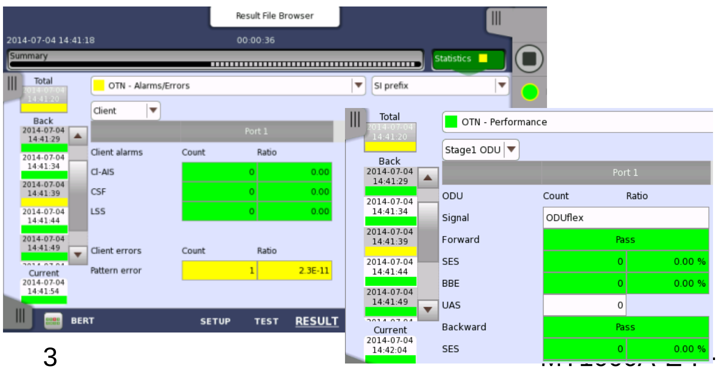


Figure 8. ODUflex BERT Results

Seconds) and BBE (Background Block Error), as well as Pass or Fail indications.

- SES occurs when more than 15% of the blocks are errored, or a defect is detected in 1 second.
- BBE occurs when an errored block that is not a SES is detected in 1 second.

The BERT duration is according to the operator's standards and procedures but a multi-day test is not uncommon. Sometimes, testing runs for up to 7 days. Common times vary, but are often completed in 15-minute, 1-hour, 2-hour, 24-hour, and 7-day blocks.

Summary
OTN offers a modern telecom operator large advantages, and the movement of the OTN closer to the end user (Access network) is happening quickly today. Due to this movement, it's important for operators to test methods and advances in equipment as the network changes to ensure the same QoS and fault resolution time. For more details on OTN, refer to our White Papers on OTN and Free Wall Poster.

Ordering Information MT1000A

Mainframe	
MT1000A	Network Master Pro
Test Module	
MU100010A	10G Multirate Module
Options	
MU100010A-001	Up to 2.7G Dual Channel
MU100010A-051	OTN 10G Single Channel
MU100010A-052	OTN 10G Dual Channel

Ordering Information MT1100A

Mainframe	
MT1100A	Network Master Flex
Test Modules	
MU110010A	10G Multirate Module
MU110011A	100G Multirate Module
MU110012A	40/100G Module CFP2
Power Supply Module	
MU110001A	Power Supply Module AC/DC
MU110002A	High Power Supply Module AC
Options	
MU110010A-001	Up to 2.7G Dual Channel
MU110010A-051	OTN 10G Single Channel
MU110010A-052	OTN 10G Dual Channel
MU110011A/12A-053	OTN 40G Single Channel
MU110011A/12A-054	OTN 40G Dual Channel
MU110011A/12A-055	OTN 100G Single Channel
MU110012A-056	OTN 100G Dual Channel

Further Reading
White Papers on OTN

OTN – What is it and Why is it Important?

Technical Level 1 (Basic)

Introduction to P-OTS, its different components and a basic overview of OTN.

OTN – What is it and How does it Work?

Technical Level 2 (Engineer)

How OTN works; breaks down and explains the five major frame sections. Written for engineers, but readable by all.

OTN – The deep dive into details that make it tick. (coming soon)

Technical Level 3 (OTN Engineer)

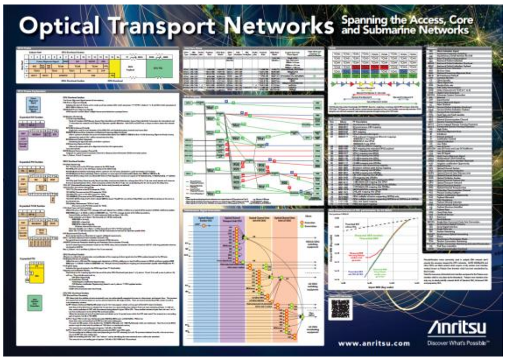
All you need to know about OAM, TCM, FTFL and FEC. W written for OTN engineers, but readable by anyone with a keen interest in OTN technology.

Application Notes on OTN

OTN – Advance Testing and Dividing the Network.

Testing across different network layers and how to troubleshoot them.

Free OTN Wall Poster
Many of the above details are shown in an A1 size wall poster. Simply register online to get your free copy mailed directly to you.



References

ITU-T G.709 (Interfaces for the optical transport network)
http://www.itu.int/rec/T-REC-G.709

List of Acronyms

Acronym	Definition
ADM	Add/Drop Multiplexer
AIS	Alarm Indication Signal
BBE	Background Block Error
BDI	Backward Defect Indication
BEI	Backward Error Indication
BER	Bit Error Ratio
BERT	Bit Error Rate Test
BIAE	Backward Incoming Alignment Error
CSF	Client Signal Fail
FEC	Forward Error Correction
FTFL	Fault Type Fault Location
IAE	Incoming Alignment Error
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector
OCh	Optical Channel

Acronym	Definition
ODU	Optical channel Data Unit
OMS	Optical Multiplex Section
OPU	Optical channel Payload Unit
OTN	Optical Transport Network
OTS	Optical Transmission Section
OTU	Optical Transport Network
PDH	Plesiochronous Digital Hierarchy
PM	Path Monitoring
PRBS	Pseudo Random Binary Sequence
SDH	Synchronous Digital Hierarchy
SES	Severely Errored Seconds
SM	Section Monitoring
SONET	Synchronous Optical NETwork
TCM	Tandem Connection Monitoring

Note: Screen shots in this application note are made using the MT1000A. You can make similar screen shots with the MT1100A

Anritsu

Specifications are subject to change without notice.

- **United States**
Anritsu Company
1155 East Collins Blvd., Suite 100, Richardson,
TX 75081, U.S.A.
Toll Free: 1-800-267-4878
Phone: +1-972-644-1777
Fax: +1-972-671-1877

- **Canada**
Anritsu Electronics Ltd.
700 Silver Seven Road, Suite 120, Kanata,
Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

- **Brazil**
Anritsu Eletrônica Ltda.
Praça Amadeu Amaral, 27 - 1 Andar
01327-010 - Bela Vista - São Paulo - SP - Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

- **Mexico**
Anritsu Company, S.A. de C.V.
Av. Ejército Nacional No. 579 Piso 9, Col. Granada
11520 México, D.F., México
Phone: +52-55-1101-2370
Fax: +52-55-5254-3147

- **United Kingdom**
Anritsu EMEA Ltd.
200 Capability Green, Luton, Bedfordshire, LU1 3LU, U.K.
Phone: +44-1582-433200
Fax: +44-1582-731303

- **France**
Anritsu S.A.
12 avenue du Québec, Bâtiment Iris 1- Silic 612,
91140 VILLEBON SUR YVETTE, France
Phone: +33-1-60-92-15-50
Fax: +33-1-64-46-10-65

- **Germany**
Anritsu GmbH
Nemetschek Haus, Konrad-Zuse-Platz 1
81829 München, Germany
Phone: +49-89-442308-0
Fax: +49-89-442308-55

- **Italy**
Anritsu S.r.l.
Via Elio Vittorini 129, 00144 Roma, Italy
Phone: +39-6-509-9711
Fax: +39-6-502-2425

- **Sweden**
Anritsu AB
Kistagången 20B, 164 40 KISTA, Sweden
Phone: +46-8-534-707-00
Fax: +46-8-534-707-30

- **Finland**
Anritsu AB
Teknobulevardi 3-5, FI-01530 VANTAA, Finland
Phone: +358-20-741-8100
Fax: +358-20-741-8111

- **Denmark**
Anritsu A/S
Kay Fiskers Plads 9, 2300 Copenhagen S, Denmark
Phone: +45-7211-2200
Fax: +45-7211-2210

- **Russia**
Anritsu EMEA Ltd.
Representation Office in Russia
Tverskaya str. 16/2, bld. 1, 7th floor.
Russia, 125009, Moscow
Phone: +7-495-363-1694
Fax: +7-495-935-8962

- **United Arab Emirates**
Anritsu EMEA Ltd.
Dubai Liaison Office
P O Box 500413 - Dubai Internet City
Al Thuraya Building, Tower 1, Suit 701, 7th Floor
Dubai, United Arab Emirates
Phone: +971-4-3670352
Fax: +971-4-3688460

- **India**
Anritsu India Private Limited
2nd & 3rd Floor, #837/1, Binnamangla 1st Stage,
Indiranagar, 100ft Road, Bangalore - 560038, India
Phone: +91-80-4058-1300
Fax: +91-80-4058-1301

- **Singapore**
Anritsu Pte. Ltd.
11 Chang Charn Road, #04-01, Shriro House
Singapore 159640
Phone: +65-6282-2400
Fax: +65-6282-2533

- **P.R. China (Shanghai)**
Anritsu (China) Co., Ltd.
Room 2701-2705, Tower A,
New Caohejing International Business Center
No. 391 Gui Ping Road Shanghai, 200233, P.R. China
Phone: +86-21-6237-0898
Fax: +86-21-6237-0899

- **P.R. China (Hong Kong)**
Anritsu Company Ltd.
Unit 1006-7, 10/F., Greenfield Tower, Concordia Plaza,
No. 1 Science Museum Road, Tsim Sha Tsui East,
Kowloon, Hong Kong, P.R. China
Phone: +852-2301-4980
Fax: +852-2301-3545

- **Japan**
Anritsu Corporation
8-5, Tamura-cho, Atsugi-shi, Kanagawa, 243-0016 Japan
Phone: +81-46-296-1221
Fax: +81-46-296-1238

- **Korea**
Anritsu Corporation, Ltd.
5FL, 235 Pangyoyeok-ro, Bundang-gu, Seongnam-si,
Gyeonggi-do, 463-400 Korea
Phone: +82-31-696-7750
Fax: +82-31-696-7751

- **Australia**
Anritsu Pty. Ltd.
Unit 21/270 Ferntree Gully Road, Notting Hill,
Victoria 3168, Australia
Phone: +61-3-9558-8177
Fax: +61-3-9558-8255

- **Taiwan**
Anritsu Company Inc.
7F, No. 316, Sec. 1, NeiHu Rd., Taipei 114, Taiwan
Phone: +886-2-8751-1816
Fax: +886-2-8751-1817

1404

Please Contact:

Printed on Recycled Paper

No. MT1000A-E-F-1-(3.00) 公知 Printed in Japan 2014-10 MG