ONT-503/506/512 Multi-Channel Testing

A Powerful Breakthrough in Test Capabilities

Demand for speed, capacity, flexibility, and reliability drive the need for more robust network element performance

New SONET/SDH network elements – primarily used in the metro portion of a network - support several important functions, including grooming, switching, and add/drop multiplexing. The industry demand to deliver high-quality voice, video, and data services to the masses is pushing both equipment and network design to the cutting edge. Powerful new integrated platforms, with very high port density and port counts, are being developed to meet the industry need for speed, capacity, flexibility, and reliability. Cross-connects and multi-service provisioning platforms (MSPPs) are early examples of this new type of platform. These devices are much more complex than legacy SONET/SDH equipment and will no doubt continue to increase in complexity to meet the growing demand for broadband services.

Cutting-edge network elements must support multiple network configurations, including ring, point-to-point, and meshed topologies, as well as protection schemes for both line and path level. These requirements, along with the implementation of large low order switch matrices and the need to support more packet-based technologies, demand a new approach for comprehensive network and equipment testing.

Traditional single-channel-based test instruments either take a very long time to test these new network elements sequentially, or they do not provide sufficient coverage or verify the performance of capacity to ensure the performance level expected from the network elements under real traffic load conditions. High coverage is critical in order to evaluate the enormous number of complex interactions of these network elements and to stress the performance of their large switch matrices.

The JDSU solution

The multi-channel test capabilities of the JDSU ONT family of test instruments provide realistic network simulations with mixed mappings and parallel analysis of thousands of channels on a single interface (Figure 1).

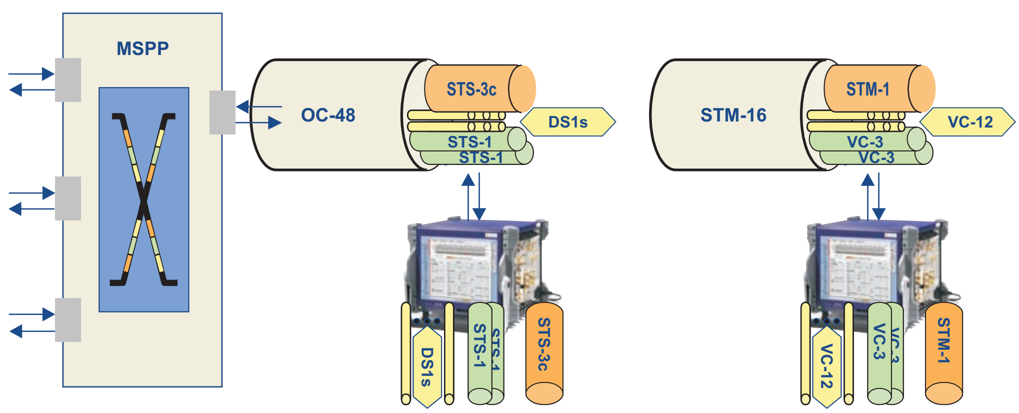


Figure 1: Parallel testing on all channels.

This breakthrough test capability shortens development and verification times by testing the interaction of multiple channels simultaneously. Multiple test ports can be supported in a single mainframe, and multiple mainframes can be combined to generate and analyze tens of thousands of channels. Thorough testing ensures that the new generation of network elements meets the communications industry's demands for increased capacity, reliability, and flexibility and will perform as expected under all load conditions.

JDSU delivers this powerful multi-channel test capability in the ONT-503, ONT-506 and ONT-512 platforms. The ONT-503 is a portable three slot mainframe with a large 15" TFT touch screen and the ONT-506 is a six slot bench-top mainframe with a large 15" touch screen. The ONT-512 is a twelve slot rack mount test solution. All three the ONTs are Linux-based platforms and come complete with built-in central processing units (CPUs). They can be controlled manually by a single user, or they can be easily networked and utilized remotely by many users simultaneously. The ONT family's scripting capability, facilitates easy automation of complex test routines and maximizes test resources. With the widest range of applications available on one test platform, including Next Gen SONET/SDH/EoS/VCat/GFP/LCAS, Ethernet, Jitter/Wander, OTU1/2/G.709/FEC, Multi-Channel, and OSA/DWDM testing, the ONT-503, ONT-506 and ONT- 512 help customers optimize instrument budgets and to reduce the cost of testing by providing many applications in a highly flexible and easy-to-use platform.

Highlights of ONT-503/506/512 multi-channel testing

- Real-time load generation and load analysis with mixed low order and high order mapping signal structures, including SONET: VT1.5/2, STS-1/-3/-3c/-6c/-9c/-12c/-24c/-48c; SDH: VC-12, VC-11, VC-3, VC-4-2c/3c/4c/8c/16c, AU-3, AU-4.
- Parallel generation and analysis of up to 1,344 VT1.5 or 1,008 VC-12 mappings provides full load coverage of an OC-48/STM-16 interface and can be duplicated four times to provide full load coverage on an OC-192/STM-64 interface.
- Multi-channel test capabilities are supported by all SONET/SDH test interfaces.
- Parallel testing on all channels for bit error rate (BER), service disruption, and errors and alarms, including details per channel and framed-based event resolution.
- Event log tables store and track individual events.
- Remote operation via an Internet browser and support of multiple users simultaneously.
- Standard Commands for Programmable Instrumentation (SCPI) and C command prompt support for all test functions. Tool Command Language (TCL) libraries are available for easy automation of highly complex test routines.
- A best-in-class service disruption test with high resolution includes user settings for trigger criteria and separation time.
- Single, rate, and burst error/alarm insertion into any combination of channels simulates "flooding" of events for stress testing.
- Multi-channel connectivity check ensures correct provisioning and restoration to allow for the quick confirmation of complex signal structures.
- Industry-leading user interface provides unmatched ease-of-use for signal structure setup and results viewing of multiple channels (Figure 2).
- Multiple mainframes with many test interfaces can be easily "daisy-chained" and can literally test tens of thousands of channels in parallel.
- The service disruption test captures data from all channels with a frame-based resolution of 125 µs and a display resolution of 1 ms. The separation time can be set down to 1 ms for all 1,344 channels in order to identify bouncing. In addition, each error/alarm sensor can be enabled/disabled individually.
- The signal structure viewer/editor provides a complete overview of all channels under test. It can be used to zoom into each channel and check for errors/alarms and to quickly change settings for individual channels.
- The easy receiver setup feature scans the entire payload and sets the receiver in seconds, even for the most complex signal structures.
- Setup filters allow the user to include/exclude specific channels for the measurement. Non-commissioned channels with continuous alarms will not overwrite the status of all of the traffic bearing channels.

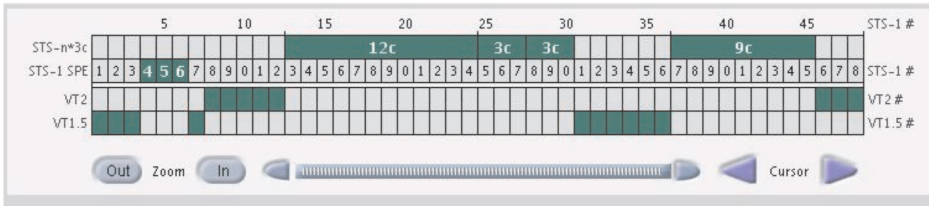


Figure 2: User interface to view/edit signal structure.

Challenging test scenarios made easy

Legacy test instruments that only address one active payload per interface are very limited in their ability to effectively test the latest network elements. For example, if a single high-speed interface is tested in a system with many lower-rate tributary interfaces, the technician can terminate the high-speed line with a test instrument, set up a single tributary, and "daisy-chain" all of the lower-rate interfaces to simulate a load. The problem arises when an error is detected. In this case, a series of time-consuming tests and retests with different cabling would be required in order to determine what part of the system caused the error. Another very time-consuming and costly approach is to utilize many lower-speed test sets terminated to the lower speed interfaces and loop back to the high-speed interface transmitter to the receiver. In order to test all of the DS1/E1 interfaces supported by a single OC-48/STM-16, this method would require 1,344/1,008 test instruments!

Single channel testers only support active testing of one tributary at a time (Figure 3). Serial testing of high-capacity systems is very time consuming and costly and does not thoroughly stress the device under test (DUT) or system under test (SUT). In single channel testing, problems are very difficult to detect, isolate, and correct.

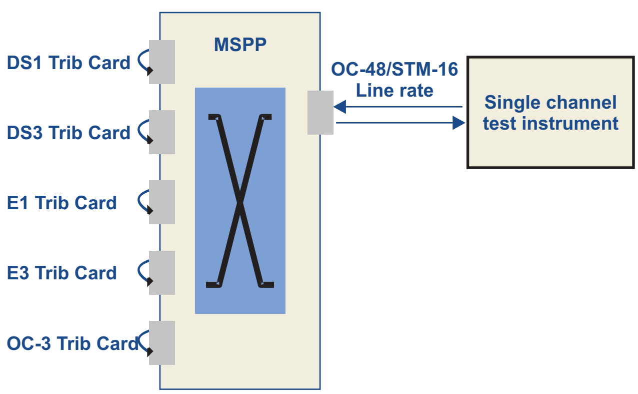


Figure 3: Example test setup using traditional single channel test instrument.

Multi-channel testing, on the other hand, greatly reduces the complexity and cost of performing these essential tests on SONET/SDH networks by generating and analyzing all of the necessary traffic loads in a single interface. This enables the testing of complex systems from the high-speed line interface with complete visibility into the payload and total control over the test parameters. One multi-channel test instrument can generate and analyze the full payload and provide per channel error, alarm, service disruption, overhead, and trace results (Figures 4 and 5).

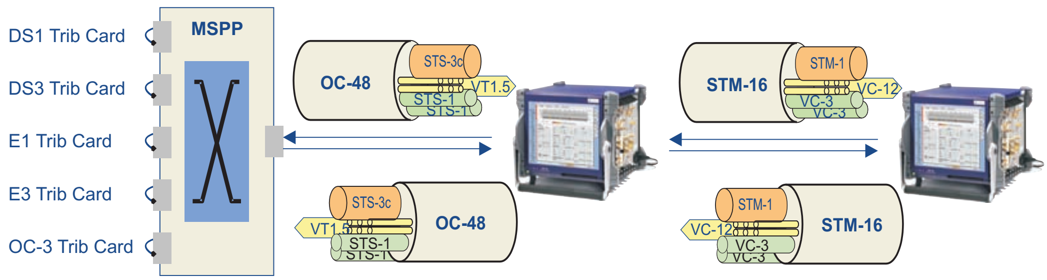


Figure 4: Example test setup using ONT multi-channel test solution.

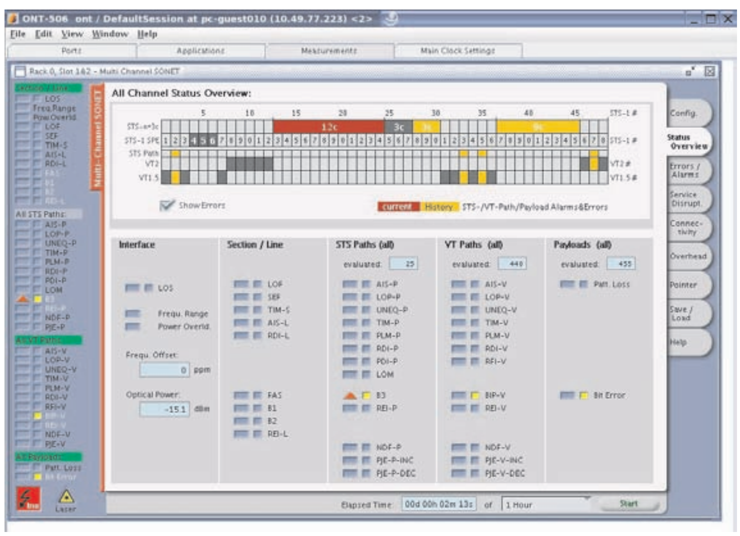


Figure 5. The All Channel Status Overview provides error/alarm information in real-time for all channels under test at a glance.

Complex signal structures can be easily identified with the Auto-Setup function

Many test cases require hundreds or even thousands of signal structures to be provisioned and tested in order to ensure proper function of the network under load conditions. Many hours are spent configuring the network elements in test beds. Then, the test equipment must also be configured to generate, receive, and analyze the traffic.

The Auto-Setup function of the JDSU ONT greatly simplifies this process by automatically "learning" the complex signal structure of a communication link and setting up the test interface receiver in a matter of seconds (Figure 6). This function identifies the payload mapping, overhead, high order (HO) and low order (LO) path traces, and payload. The learned receiver settings can be copied to the transmitter of the test set with the press of one button. Subsequently, the total time to set up the receiver and transmitter, for even the most complex signal structures, is less than ten seconds!

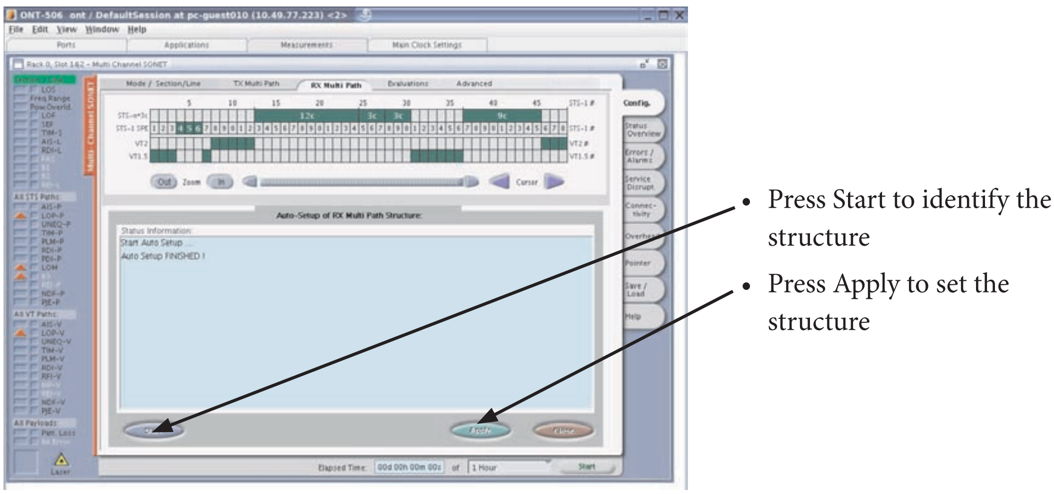
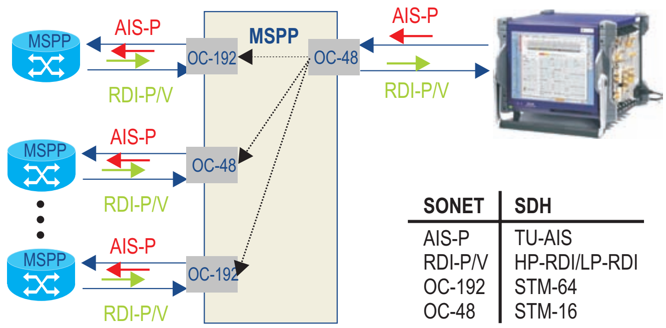


Figure 6: The Auto-Setup function identifies complex signal structures, overhead, section and path traces, and payloads in a matter of seconds.

Alarm and error "flooding" stresses network performance

Many of the newest network elements rely heavily on hardware- and software-based switching to achieve a high level of flexibility, scalability, and support of the many different payload types. These sophisticated and highly integrated switching matrices may perform perfectly well under normal traffic conditions, but they can collapse when experiencing extraordinary error and alarm loads that can occur under severe conditions. It is vital to have tools that can effectively stress these next-generation network elements in order to ensure robust performance and proper reporting of errors, alarms, and service outages when under high load conditions.

The test interface generates a "flood" of errors and alarms on many channels or all of the channels, for example an AIS-P (TU-AIS) (Figure 7). The remote network elements will report an RDI-P/V (HP-RDI/LP-RDI). The network elements will switch traffic to other optical interfaces at the STS/STM or VT/VC level. The Performance Monitoring (PM) engine of the network elements should report activity matching the information collected by the test instrument. This test capability is implemented in both Terminate and through modes on the ONT to provide the most comprehensive support of complex testing scenarios.



SONET	SDH
AIS-P	TU-AIS
RDI-P/V	HP-RDI/LP-RDI
OC-192	STM-64
OC-48	STM-16

Figure 7: Error and alarm "flooding" of the network (SONET example).

Service disruption: A true test of service reliability and performance

Service disruption is one of the most important service-level measurements used to qualify the absolute performance of networks and network elements . Many customers will pay a premium for protected circuits to ensure that their communications links are always operational. It is important for network operators and equipment manufacturers to perform exhaustive service disruption measurements to verify that the implemented network elements and infrastructure can support their customers' mission-critical applications. Years of testing have concluded that the ability of network elements and networks to deliver protected, error-free service is severely impacted when all or part of the network is troubled by high occurrences of errors and alarms. Legacy test instruments have several limitations that do not support adequate testing of the latest network elements and topologies. Legacy test instruments provide only basic measurement support. In addition, they have limited trigger criteria, fixed measurement settings, minimal resolution, and only a single channel testing capability.

The JDSU ONT family of test instruments is equipped with the industry's most powerful suite of service disruption test capabilities for both single and multi-channel testing.

The key service disruption application features include:

- An adjustable separation time down to 1 ms ensures complete analysis of all possible service impacting events with no blind spots (Figure 9).
- Selectable triggers for one, all, or any combination of SONET/SDH errors and alarms offers complete and customizable trigger criteria and test flexibility (Figure 9).
- Support of all SONET/SDH errors and alarms, including those found in the overhead and payload, ensures analysis of the entire SONET/SDH frame.
- Records all disruptions and events in tabular format with a high-resolution timestamp.
- Supports full service disruption in Multi-channel mode for up to 1,344 VT/1,008 VC channel measurements in parallel.
- High error and alarm trigger sensitivity ensures that no events are missed even at low error/alarm rates.
- Per channel service disruption measurements and high-speed, all-channel event lists support complex test scenarios that are not possible with legacy equipment.

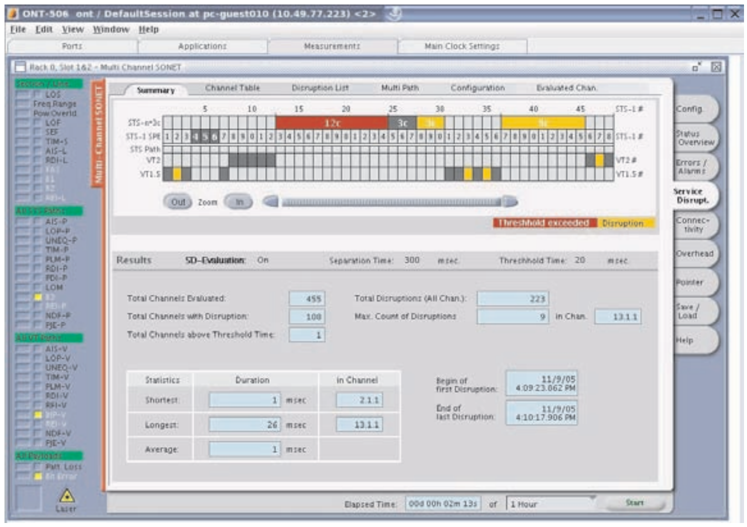


Figure 8: Overview and status of all channels under test and real-time display of Shortest, Longest and Last service disruption measurements.

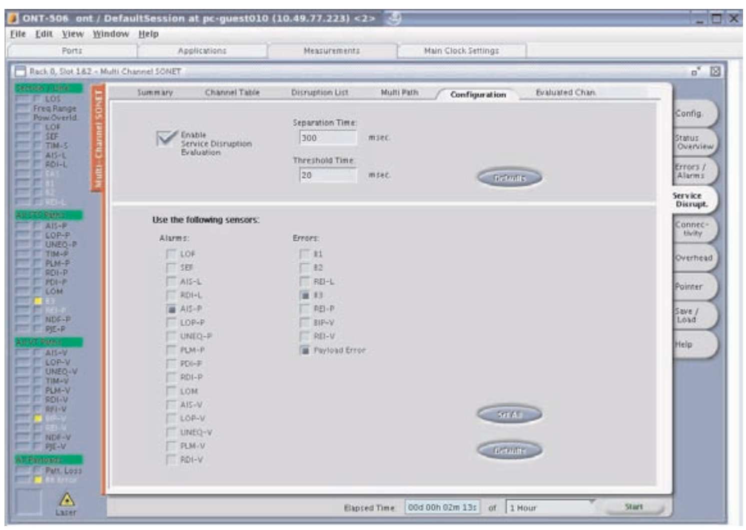


Figure 9: Flexible trigger criteria allow for full customization of service disruption measurements.

Flexible service disruption test settings and frame-based analysis in the ONT provide capabilities to measure and diagnose service disruption like never before

Most legacy test instruments provide fixed separation time settings, pass thresholds, and trigger criteria. They are not capable of diagnosing software-based switching issues that plague today's sophisticated network elements. Phenomena such as bouncing and disruptions, caused by multiple triggers (bit errors and AIS, for example), can not be measured by tools that are not capable of frame-based analysis. The ONT family of test instruments solves all of these issues and more with its flexible settings and high-speed analysis capabilities. The following example shows the same service disruption scenario measured with different separation time settings to highlight the effect that different test settings can have on the reported result (Figure 10).

a)	**Separation time (ST) is set to 300 ms (default).** This value combines events as they occur (usually during an APS) into one service disruption (SD). Result: SD = 40 ms Use of this setting ensures that the device is not exceeding the maximum allow time for SD.
b)	**ST is set to 10 ms.** This value separates the events into two SDs since the time between the two events is longer than the 10 ms value set for ST. Result: SD1 = 8 ms, SD2 = 20 ms Use of this setting identifies if the gaps between events are causing the unexpectedly long SD times (for example, bit errors occurring after the APS was executed).

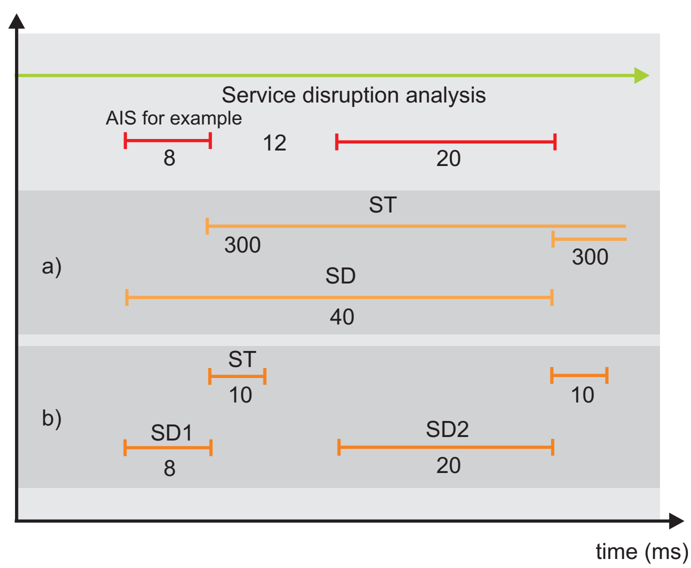


Figure 10: An example of one service disruption scenario measured with two different separation time settings.

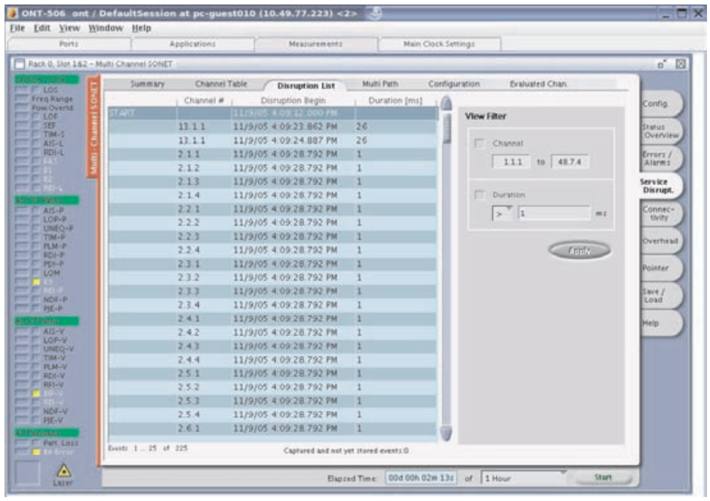


Figure 11: Service disruption list of all channels under test.

Details of service disruptions can be displayed for all channels. Columns can be easily sorted on the ONT display or exported to a spreadsheet for incorporation into test reports (Figure 12).

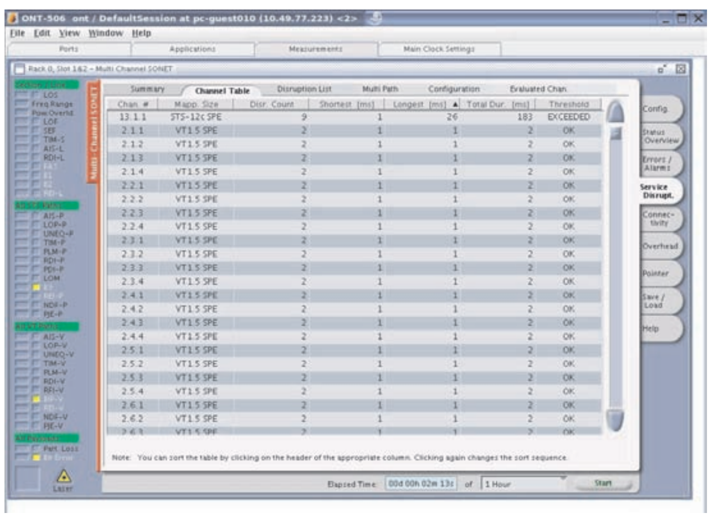


Figure 12: Channel Table details.

Intrusive through mode and high-speed event logging for low order and high order payloads provides a higher level of testing for compliance, acceptance, and interoperability

Many compliance, acceptance, and interoperability test plans require testing “back-to-back” performance of network elements. Test solutions that are capable of monitoring traffic and events as well as injecting errors and alarms in through-mode are essential to effectively and efficiently test how well different network elements functions in various configurations and topologies. The ONT is capable of performing through-mode testing in both Passive and Intrusive modes and has the ability to capture and timestamp events with frame-based resolution and compare results from various interfaces. These unique capabilities allow test groups to use the ONT to efficiently perform very complex and sophisticated test scenarios with the highest level of accuracy and repeatability.

One example of an interoperability test that is all but impossible to implement with legacy test equipment is the detection time measurement. One of the components that contributes to the time it takes a network element to switch from a working line to a protection line during a service-impacting event is the amount of time it takes for the service-providing network element to detect errors or alarms on the working circuit and respond with a K1/K2 switch request (Figure 13). The time it takes to detect errors and alarms and respond with K1/K2 switch requests is known as the detection time. Other example test scenarios that can be easily implemented with the ONT are an error/alarm line side to AIS client side detection time (Figure 14) and service disruption measurements on the client side (Figure 15). These are but a few examples of thousands of different tests scenarios that can be performed with the ONT platform using the vast suite of capabilities supported by the multi-channel application to verify network compliance, interoperability and performance.

Example 1

Step 1:

An error or alarm is generated on the line from Node A to Node B, which is detected by the ONT and time-stamped.

Step 2:

Node B detects the error or alarm and responds with a K1/K2 switch command back to Node A. The K1/K2 command is detected and time-stamped by the ONT.

The error or alarm and K1/K2 timestamps can then be compared to determine the line side detection and response time of the network under test.

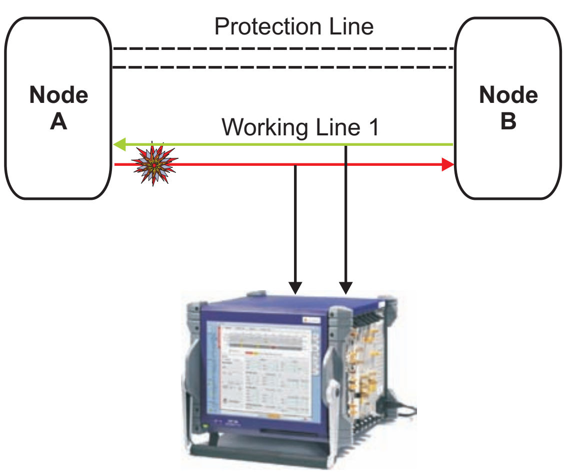


Figure 13: An interoperability network test to determine the line side error/alarm detection and K1/K2 command response time.

Example 2

Step 1:

An error or alarm is generated on the line from Node A to Node B, which is detected by the ONT and time-stamped. Node B detects the error and alarm and sends and alarm indication signal (AIS) to the client interface.

Step 2:

The AIS is received from the client interface by the ONT and time-stamped.

The timestamps of the error or alarm on the line side and the AIS on the client side can be compared to determine the line side to client side detection and response time of the network under test.

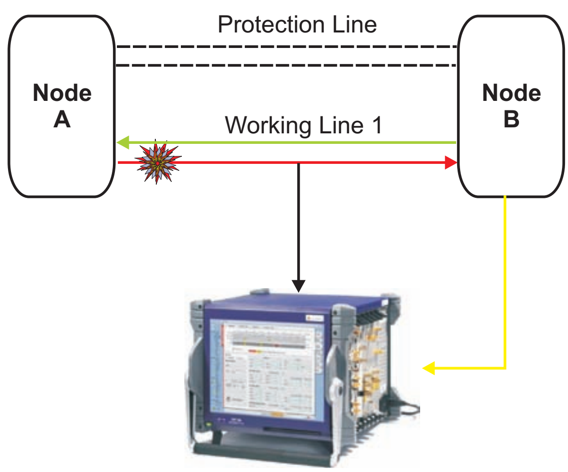


Figure 14: An interoperability test to determine the line side to client side detection and response time

Example 3

Step 1:

An error or alarm is generated on the line from Node A to Node B, which causes a service disruption on the client interface.

Step 2:

The ONT detects all errors /alarms received from the client interface and logs them as events with timestamps. The ONT measures and records the service disruption time and declares a "pass" or "fail" based on user-selected filters.

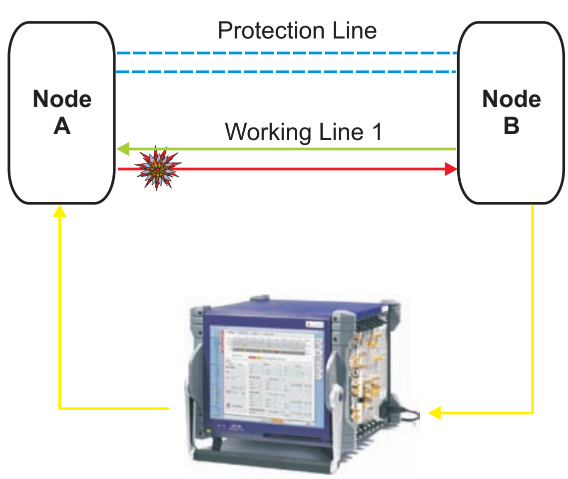


Figure 15: A network test to determine service disruption time.

Conclusion

The evolution of current and legacy transmission networks into the agile optical networks of the future is driving the need for more powerful and flexible test solutions. Test laboratories are looking to invest in solutions that support multiple technologies and many users, are scalable and are easy-to-use, have state-of-the-art accuracy, and can be easily upgraded to support the technologies of the future. The ONT was developed as a foundation of this testing paradigm and is JDSU's flagship laboratory test platform.

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