Error Testing of Ethernet Link and MAC Layers

The initial steps of OAM testing

Over the past several years, the success of Ethernet service applications in Local Area Networks (LANs) has gained momentum as the capabilities of the Ethernet network have broadened substantially. Starting with a transmission speed of 10 Mb/s in the early days of Ethernet, transmission speeds quickly increased to 100 Mb/s and then to 1 Gb/s. Today, transmission speeds of 10 Gb/s are getting common in interswitch communication.

In Wide Area Networks (WANs), Ethernet service applications have recently commenced their triumphal procession, hoping to follow in the footsteps of the success of LAN Ethernet. This technology is still in the beginning stages of development. In the case of WAN Ethernet, the whole network is not Ethernet based. Instead, the customer interfaces are Ethernet-focused, starting with the lower transmission speeds of 10/100/1000 Mb/s which are supported by the ONT family.

In today's changing telecommunications market, customers are specifying that their network technology matches the technology at the demarcation point of their service provider. This new requirement has significantly impacted Ethernet technology development. Ethernet has effectively extended from a simple, cheap, plug-and-play technology to a measurable service application that can guarantee service level agreements (SLA) for both customers and service providers. The need to guarantee SLAs as well as the push toward massive network scaling has been instrumental in prompting an influx of interest in developing carrier-grade Ethernet equipment. Carrier-grade Ethernet equipment is capable of producing the same reliability as traditional voice equipment for Ethernet service applications.

The development of carrier-grade Ethernet equipment has introduced many new features and functions to Ethernet technology. Some of these improvements are defined in the network management protocol. Others are defined in the higher layers protocols of Ethernet/IP, and still others are defined in the lower layer of the link and MAC layers. Link and MAC layer error performance is getting more and more attention as the environment of the equipment extends from the traditional office setting to field and outdoor environments. The verification of these new challenges are tasks for the laboratories and the system verification testing (SVT) for equipment manufacturers and approval testing for service providers, which are the target applications for the ONT-50/506/512. The field test requirement for the lower layers stay untouched.

For example, in cases of finger-pointing issues, a service provider needs the assurance that the interface will detect impairments and trace all of the events, providing clear and concise information in order to identify the party responsible for fixing network problems.

Currently, the main testing topology (Figure 1) requires end-to-end service testing. Since end-to-end testing is related to switching and forwarding of the device under test (DUT), the configuration of the physical layer is changed slightly. Interface testing involves using the tester as the source of the impairment and the element manager as the display of the impairment. In principle, this is the same testing mechanism that has been used for SDH/SONET testing for a long period of time.

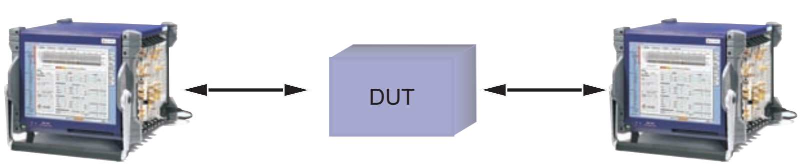


Figure 1: End-to-end service testing

The example below assumes an optical 1 Gigabit Ethernet (GigE) interface, which can be tested using the ONT family of test instruments (Figure 2). The procedure is in the same way applicable to test copper Ethernet.

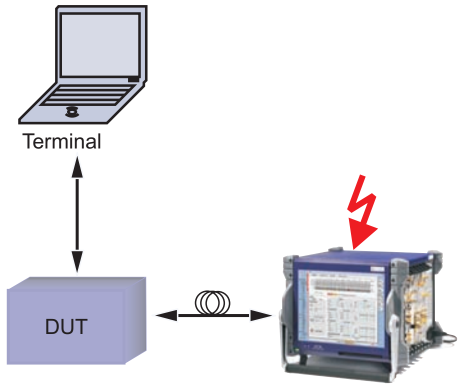


Figure 2: Interface testing

Impairments on the link layer depend on the physical transport media, optical or copper. In addition, if copper is the physical transport media, then impairments will also depend on whether the media is point-to-point or shared. On the MAC layer, the type of physical transport media has no effect on impairments.

The following errors and events can be generated with an optical GigE interface.

Link Layer:

- Invalid code group
- Running disparity
- Bit error on the physical link
- Line errored frame
- False carrier
- Loss of signal
- Loss of synchronization

MAC Layer:

- Runt
- Oversized
- FCS
- Jabber

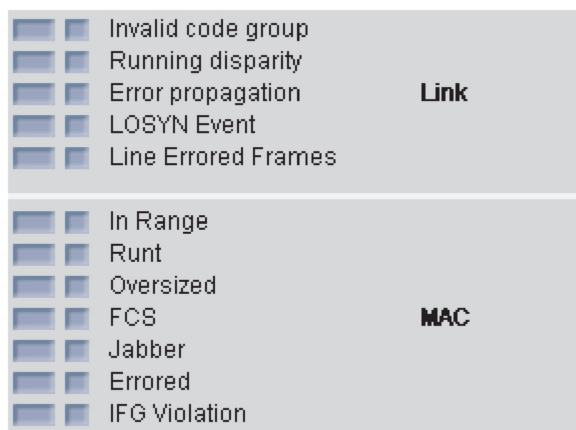
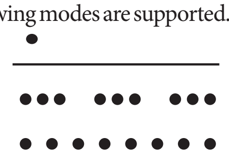


Figure 3: Display of the received error

Although this class of errors can be detected by higher layer Ethernet testers, generating these events is typically not supported. In order to verify how the network elements react to them, a physical layer tester like the ONT-506 out of the ONT family is required. In end-to-end testing, on the other hand, these events are merely seen as no traffic or as a loss of frames.

To simplify this testing, each of these events can be generated with the press of one button. It is also possible, though, to generate the events in different modes. The following modes are supported.

- Single
- Continuous
- Burst
- Rates
- Combinations of the above modes



Not all modes are applicable to all events. For example, a rate for loss of signal isn't appropriate, but a continuous loss of signal event or a burst of loss of signal events makes sense. In some cases, the basis for a burst event is time (ms), for example loss of signal. In the case of bit error, the basis for a burst event is a bit .

Figure 3 shows an example where loss of signal events are inserted in a burst sequence of 2 ms of loss of signal followed by 5 s of an available signal. In addition, the detection on the ONT receiver side is shown in a graphical view with loss of signal and loss of performance assessment capability (LPAC). Verification on the DUT has now to be done by analysing the network element status of the related interface.

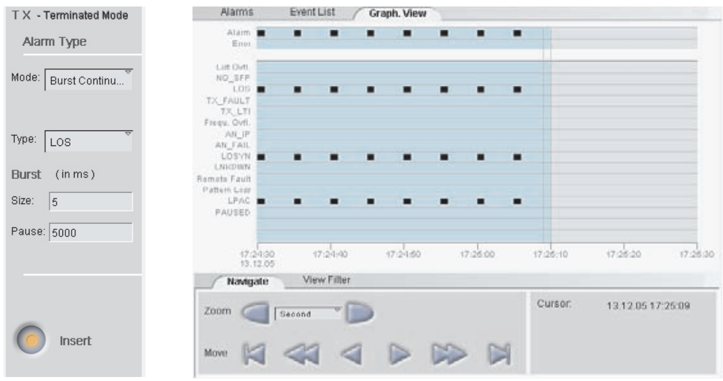


Figure 3: Generation and analysis at the ONT

This example can also be extended to the MAC layer. In this case, an FCS error, which can be inserted very easily by the press of one button, or can be generated in the above mentioned different modes.

In addition, verification of the clocking tolerance is also possible using a physical layer-oriented tester. The current standard allows for a tolerance of ± 100 ppm. The ONT family-based Ethernet interfaces are capable of varying this value up to the boundary of the standard and beyond.

Conclusion

The tests discussed in this document reflect the first steps in verifying the carrier-grade behavior of the physical interfaces during development and SVT for equipment manufacturers and approval testing for service providers. Subsequent steps in this area will be defined as the OAM activities within the standards organizations, such as the IEEE and ITU-T, are finalized. Additional features will then be integrated to the network elements, requiring new features in the testers of the ONT family. The testing features discussed in this document will play an integral role in this expanded testing.

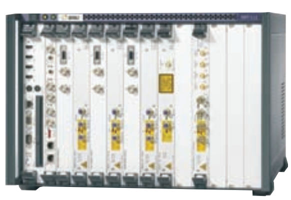
Related products

ONT-503 Optical Network Tester

The versatile ONT-503 allows to integrate all modules available for the ONT-5xx family. Its form-factor and the breadth of demanding test applications for e.g. 40/43G, Carrier Ethernet and Multichannel makes it the test set of choice for system verification groups and early deployers at Network Manufacturers' as well as Providers' companies.

ONT-506 Optical Network Tester

Desktop solution for testing of design and conformance of Next Generation transport networks. SDH, SONET, Multi-channel, OTN, Jitter, NewGen, Ethernet. Multiple users can run multiple applications simultaneously and independently. Linux operating system. High resolution 15" colored touch-screen, 6 slots.



ONT-512 Optical Network Tester

Rack-mount solution for testing of design and conformance of Next Generation transport networks. Same applications as ONT-506. Easy integration into automated environments with Linux operating system and Tcl/Tk and LabWindows libraries. Built-in controller, 12 slots.

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