



Ethernet Services Commissioning

The adoption of GigE is under way. Integration of much of the infrastructure is in progress and many datacomm and telecomm services are being moved from circuit and connection orientated networks to packet orientated networks

José M. Caballero + John McDermott

Testing the World's Digital Networks



Trend**Communications**

GIGABIT ETHERNET MIGRATION

Today GigE and IP are very attractive to network providers, and are ready to compete with many legacy networks based on PDH and xDSL. The adoption of MPLS technology can add connection oriented features. For those services and fault tolerant architectures designed to deliver mission critical services, RPR (Resilience Protection Ring) can improve resilience to a level where it is close to SDH.

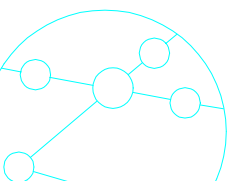


Lower capital expenditure (capex) and easy integration into the enterprise are well known aspects of GigE that will speed up its widespread adoption. While this is true, it is not enough, we need to consider the operational side of designing, installing, and maintaining the new networks. This can account for around 50% of the service cost.

Most of the Ethernet services lack a class of service system to prioritise traffic making it just a best-effort service. Often it is necessary to use a high-bandwidth backbone in order to guarantee a SLA that specifies that there are no delays in traffic throughput. The problem is that this policy leads to wasted resources and is not a complete guarantee that the service will be achieved all of the time.

THE TESTING CHALLENGE

The use of Ethernet beyond the LAN provides a further challenge of ensuring that the provided service is deployed correctly and is reliable. This is especially true as these type of services are typically provided as an expensive lease contract with a service provider, and are rarely totally under the control of the end user. A range of test scenarios and test methods must be developed to allow the operator and end user to prove that a service is providing the required quality of service, and to assist the investigation and resolution of faults or disputes.



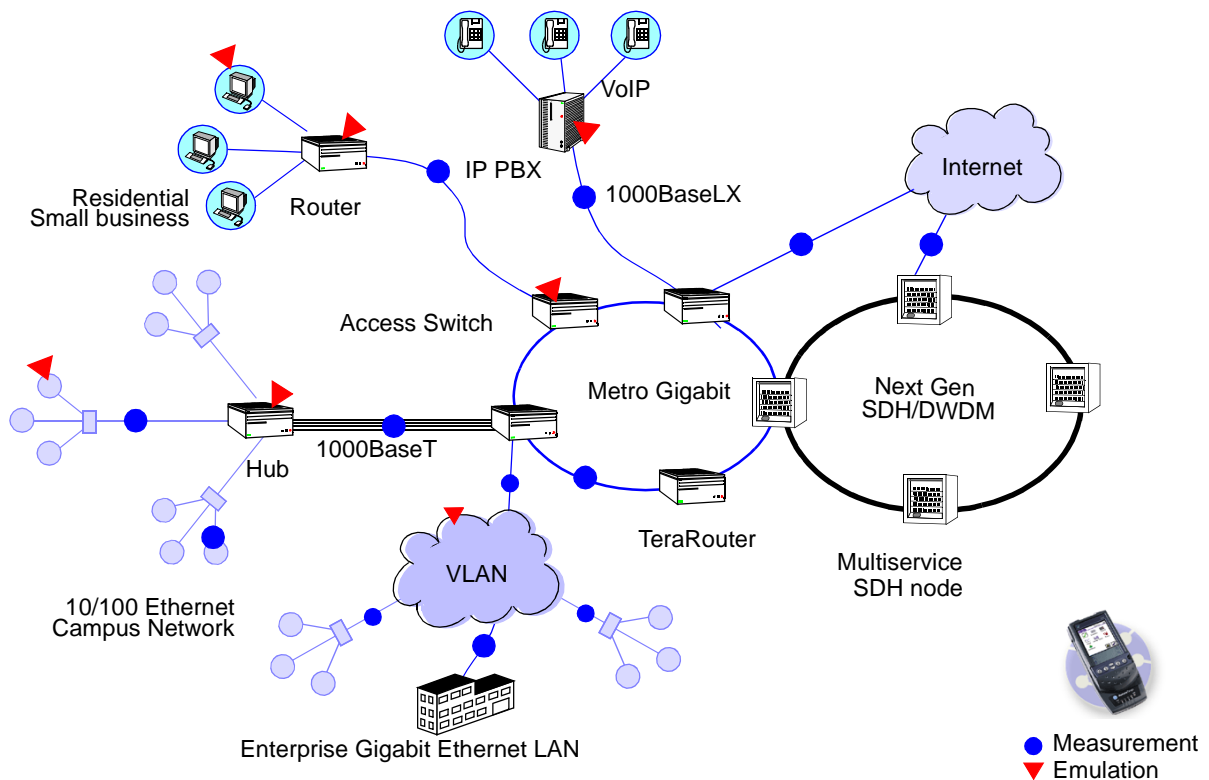


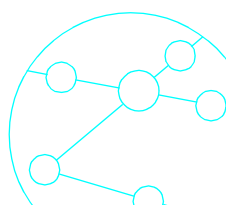
Figure 1

Ethernet topology and Aurora Tango Gigabit Ethernet testing points.

Frame-oriented vs. bit-oriented

Ethernet is a frame-oriented technology, which means that information is put into frames and then sent to its destination. In contrast, bit-oriented technologies, like GSM, PDH, or SDH, constantly transmit a stream of bits in a predictable TDM (time domain multiplexing) sequence. As a result of this BER end-to-end tests do not have the same meaning when comparing to Ethernet. With Ethernet, stations drop entire frames as soon as a single bit causes a FCS (Frame Check Sequence) error. This means that if an errored frame of 1,500 bytes is dropped because it had one bit error, then 12,000 bits are lost.

This does not mean that BER tests should not be used, as there are still many valuable tests that can be performed. In particular for transparent link-to-link Ethernet connections, or even in Metro Ethernet, a BER test is useful whenever the traffic does not cross nodes that can drop frames. IEEE802.3 Annex 36A contains descriptions of relevant test patterns that are used for stressing transmit and receive devices to ensure best performance in relation to Jitter, and according to each definition these may be used in a framed mode, or unframed mode. In addition operators familiar with BERT may specify use of Pseudo Random Bit Sequences (PRBS) though the applicability of these is



BERT measurements because the procedure typically demands that a single piece of test equipment is responsible for test pattern generation and analysis.

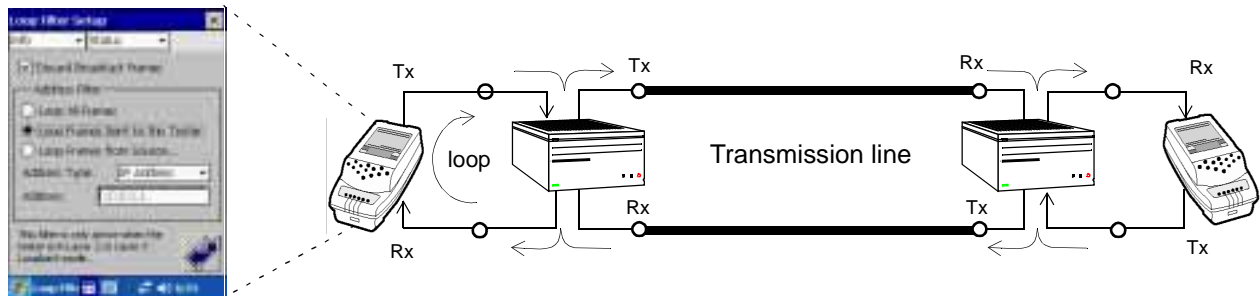


Figure 4 Loop-back mode for optical and electrical interfaces

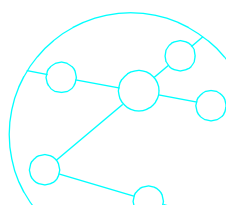
The far end unit provides an intelligent loopback at Layer 3, the IP address layer. It is necessary for the tester to provide Address Resolution Protocol for discovering the network route. It is also advantageous that filters are provided so that broadcast traffic, and any other IP address that is not relevant to the test procedure, does not undergo the loopback process. This will control the amount of extra traffic on the network, to prevent possible overload.

RFC 2544 OR PERFORMANCE TEST

Many GigE test solutions have adopted the guidelines of the Internet Engineering Task Force recommendation RFC-2544, which was originally designed for verifying the performance of LAN devices at the MAC layer. RFC 2544 describes a set of procedures for measuring the performance of Ethernet equipment but it is also used for the overall network.

Procedures to measure performance are:

- **Throughput**, defined as the number of bits transmitted per second through the DUT or the network without losing data or dropping frames.
- **Latency**, measures the average time that elapses between sending traffic and receiving it. Measurement can be end-to-end or round trip delay.
- **Frame loss**, measures the offered load as a percentage of the Maximum Line Rate at which no frames are lost.



- **Burstability or back-to-back**, defined as the maximum number of frames that can be sent in a fixed period of time without frames being dropped.
- **Recovery**, characterizes how quickly the network recovers from an overload condition.
- **Reset**, or the time at which a network or station recovers from a reset.

These tests are performed individually or in sequence for frame sizes in the range 64 - 1518 bytes.

RFC2544 is a useful procedure for assessing the performance of equipment in laboratory conditions, however there are practical limitations for applying to network commissioning. Firstly, the procedure does not offer a constant load to the network, and therefore may not provide repeatable results. Secondly, the test duration is determined by the network performance during the test runtime and cannot be specified by the operator, and hence may run for an undesirable long time. Thirdly, the data rate is offered at line rate and may therefore be overloading the network to an extent that could be undesirable. Fourthly, the procedure is defined to discover the equipment performance at which *there is no frame loss*, this may be an impractical test on real networks where frame loss is expected normal behaviour.

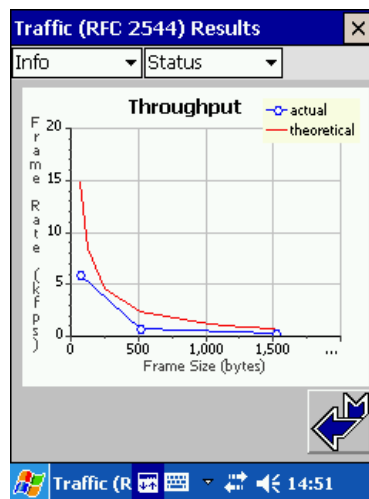
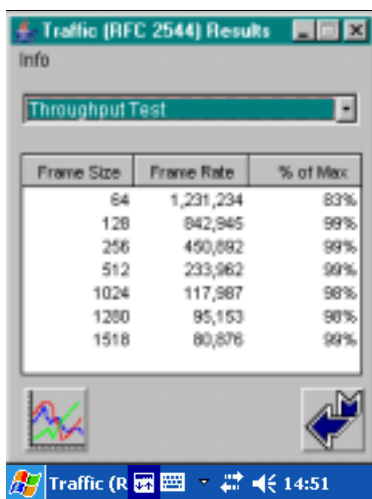
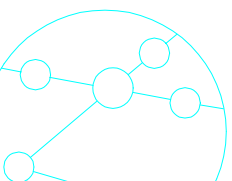


Figure 5

RFC-2544 throughput results on Aurora Tango Gigabit Ethernet

The RFC2544 implementation by Trend allows for the the 2nd question regarding test duration to be controlled by the user with editing of the test parameters. In this case the tester provides an estimate of the minimum and maximum expected test duration. The 3rd and 4th



questions above can be controlled by the user, such that a specified bandwidth can be tested, and that an allowed frame loss may occur such that the procedure can provide a successful measurement.

PERFORMANCE MEASUREMENTS

The aim of *Performance Measurements* is to provide operators and users with information on the bit errors that occur on their digital links. For this, there is a series of ITU-T recommendations on the performance of digital links, including international connections.

Generally, monitoring on transport networks can be carried out in an end-to-end or in a segmented way. Measurements on paths give information to the user about the overall QoS. Measurements on lines and sections are performed during repair, installation, and maintenance, to make sure that transmission performance objectives established previously are met. The main ITU-T recommendations concerning quality and performance measurements are G.821, and G.826.

Physical layers test using G.821

ITU-T Rec. G.821 was originally defined to measure errors on an international digital connection at $n \times 64$ Kbit/s.. The scope of this recommendation is currently limited to simple digital links, however it can be used on Ethernet networks to measure the quality of the physical medium for each local section.

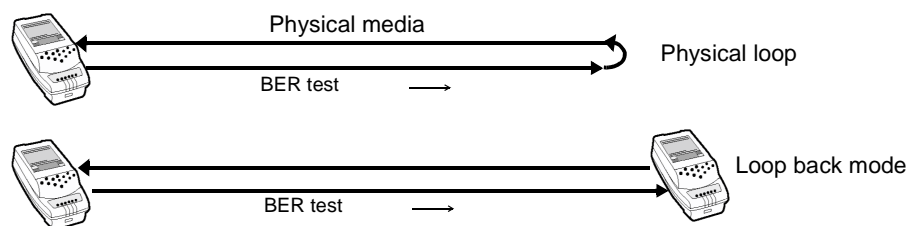
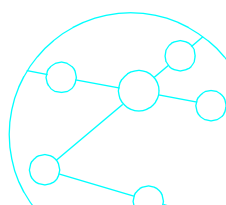


Figure 6

Physical layer continuity and BER test using G.821

G.821 is always an Out of Service Measurement (OOSM) and the test equipment generates a signal containing a known pattern, PRBS or user defined, that can be analysed at the far-end by another tester. Alternatively, the far-end can be physically looped if attenuation or other physical parameters are not a limiting factor.



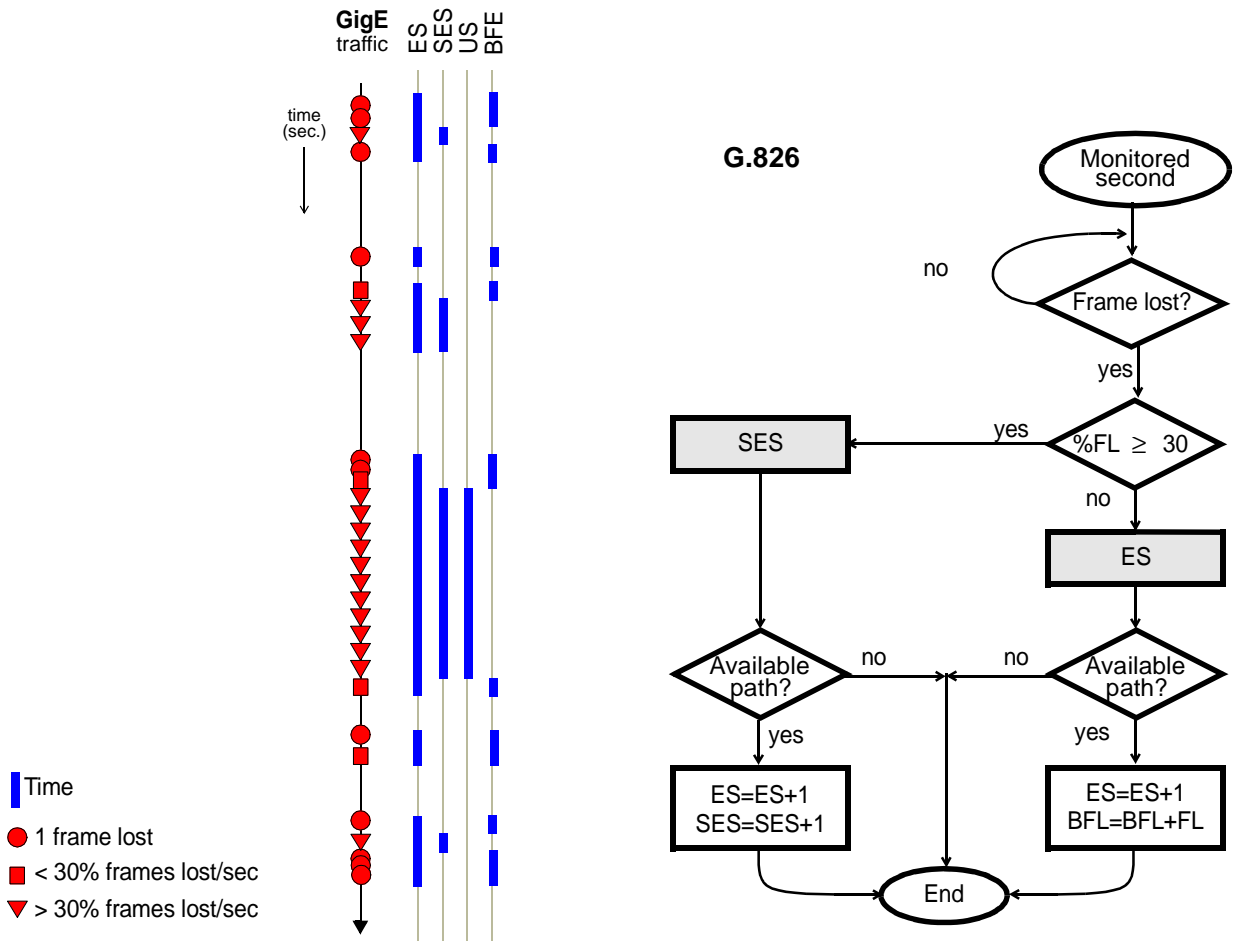


Figure 7

G.826-like test for defects, errored blocks, ES, SES, US and BFE recognition.

Performance measurements with G.826

ITU-T Rec. G.826 was defined to complement, improve, and substitute for G.821 providing to ISM and OOS measurements. It is based on the concept of errored blocks. The recommendation originally specified the events and parameters that define the performance of the carrier network paths such as PDH, SDH/SONET, Frame Relay, or ATM, over metallic cables, fibre optics and wireless.

More recently G.826 has been used by Trend Communications to create a G.826-like test to measure the performance of Gigabit Ethernet, matching blocks to Ethernet frames. This G.826-like measurement generates the Ethernet frames and uses the FCS to bit errors that may occur. In addition, the network latency is measured. This technique has the advantage to the operator of providing a defined

bandwidth test for a specified duration. As many engineers installing GigE are trained in a telecom environment where BERT procedures are commonplace, it is advantageous that considerable familiarity is provided by this method.

- **US: Unavailable Seconds**, starts when 10 consecutive severely errored seconds have been detected. These 10 seconds are part of the US. Availability starts again after 10 consecutive non-SES seconds have passed. If a bidirectional path is considered, the US is if one or both directions are unavailable.
- **BFL: Background Frame Error**, an errored frame not occurring as a part of an SES or and US period.
- **Error performance parameters**, these parameters should only be evaluated while the path is available:
- **ESR: Errored Second Ratio**, the ratio of ES to total seconds in the available time during a fixed measurement interval.
- **SESR: Severely Errored Second Ratio**, the ratio of SES to total seconds in available time during a fixed measurement interval.
- **USR: Unavailable Seconds Ratio**, the ratio of US to available seconds (AS).

Further information on this topic can be found at:
www.trendcomms.com/training.



TrendCommunications

Trend Communications Ltd
Whitebrook Park
Lower Cookham Rd
Maidenhead Berkshire
SL6 8XY, UK

Trend Communications SL
Pujades, 60
08005 Barcelona
(Spain)

International: ...+44 1628 503500
Deutschland: 089 32 30 09 11
España: 93 300 3313
France: 01 69 35 54 70
India: 22 8597 463/4
UK: 0 1628 503500
US: 256 461 0790

www.trendcomms.com
info@trendcomms.com