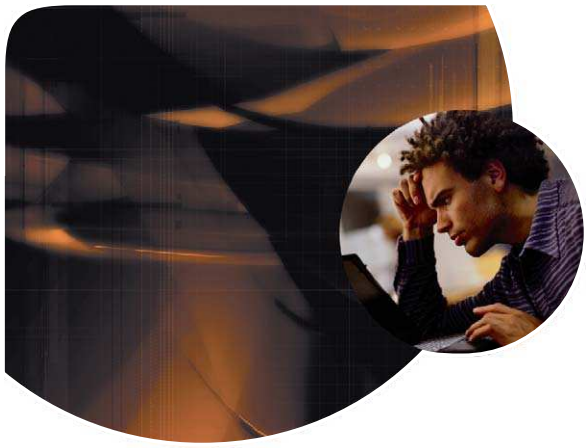


Agilent N2X

Synchronous Ethernet ESMC Protocol Emulation Software

N5566A

Technical Data Sheet

The most comprehensive solution for verifying the Ethernet Synchronization Message Channel (ESMC) protocol, generating and analyzing Synchronization Status Message (SSM) PDUs, and interactively testing the impact of clock Quality Level (QL) changes.

Rapidly test the operation, performance, and scalability of Synchronous Ethernet clock management, selection, distribution, traceability, and failover.

Agilent Technologies

Key Features

- **Verify Synchronous Ethernet ESMC implementations to G.8264/Y.1364, G.8261/Y.1361 & G.781**
- **Emulate ESMC protocol to validate clock management, distribution and traceability**
- **Test clock source selection, switching, and flapping to ensure network stability**
- **Provoke and quantify clock failover performance**
- **Generate and analyze SSM messages on multiple ports with mixed Quality Level (QL) codes**
- **Verify clock-distribution paths: intra-PHY, inter-PHY, inter-line card, inter-chassis**
- **Stress 10pps limit, and mix with CFM and other slow protocols**
- **Combine with Agilent scopes, generators and analyzers to evaluate clock transfer quality**

Product Overview

Agilent N2X is the industry's most comprehensive test solution for testing the development and deployment of network services for converging network infrastructures. Service providers, network equipment manufacturers (NEMs), and component manufacturers can verify service attributes of entire networks end-to-end, while also isolating problems down to individual networking devices and subsystems. Agilent N2X delivers unparalleled test realism to verify the ultimate performance, scalability and resilience of carrier grade services and infrastructure.

The N5566A Synchronous Ethernet ESMC Protocol Emulation software is one component of the N2X Carrier Ethernet test solution, which includes emulation and conformance testing of technologies such as CFM, Y.1731, Link OAM, LACP, STP, RSTP, MSTP, BFD, L2oMPLS, VLANs, MEF 9, MEF 14 and MEF 21.

The N5566A application enables interactive testing of the ESMC SSM protocol that underpins Synchronous Ethernet clock management, distribution, traceability, and failover in applications such as wireless backhaul where distribution of a frequency-locked reference clock is vital. N2X enables flexible simulation of peer Ethernet devices advertising SSM Quality Level (QL) codes to fully stress and characterize behaviors such as clock selection, switching, and failover.

Verify Synchronous Ethernet ESMC implementations to ITU-T and IEEE standards

The N5566A emulation facilitates rapid and easy testing of the key specifications relevant to Synchronous Ethernet:

- Verify ESMC message encapsulation (G.8264/Y.1364 11.3, G.781, G.812, and G.813)
- Check encoding of SSM Quality Level (QL) codes (G.8264/Y.1364 11.3.1)
- Test the handling of proprietary ESMC extensions (G.8264/Y.1364 11.4)
- Verify best reference port selection (G.8264/Y.1364 11.3.2 and G.781)
- Provoke and measure reference port switching (G.8264/Y.1364 11.3.2 and Annex A)
- Stress clock selection/distribution with reference port flapping (G.8264/Y.1364 11.3.1 and IEEE 802.3 Annex 43)
- Characterize slow protocol interaction and uncover unwanted behaviors (G.8264/Y.1364 11.3.2 and IEEE 802.3-2005)
- Perform "negative tests" using badly formed PDUs (G.8264/Y.1364 11.3 and 11.4)
- Load the system with maximum and over-specification SSM message floods (G.8264/Y.1364 11.2.1 and IEEE 802.3 Annex 43)
- Validate failover, with initiation and response to the 5-second rule (G.8264/Y.1364 11.3 failure behavior, and 11.3.2.2 QL reception)
- Inject line-rate traffic to saturate SSM egress ports and verify message prioritization (implied in G.8264/Y.1364)
- Measure SSM PDU rates against specification (G.8264/Y.1364 11.3.2.2 QL rate)
- Check that egress QL codes match configured QL (G.8264/Y.1364 11.2 SSM codes, and Annex A.2 inputs)

- Check that egress QL codes match ingress QL code (G.8264/Y.1364 11.2 SSM codes, and Annex A.6 SSM selection)
- Gauge the duration and impact of Quality Level (QL) change propagation (G.8264/Y.1364 11.3.2.1 QL change)
- Test on a large number of ports simultaneously to verify system behavior under real-world and extreme loads

Emulate ESMC protocol to validate clock management, distribution and traceability

The N5566A product is designed to facilitate user workflow of the above-described scenarios, from test definition through configuration to obtaining results & statistics. This approach minimizes the user learning curve and is consistent with the use model of the complementary N2X Carrier Ethernet emulations, providing multiprotocol color-coded real-time system state at-a-glance.

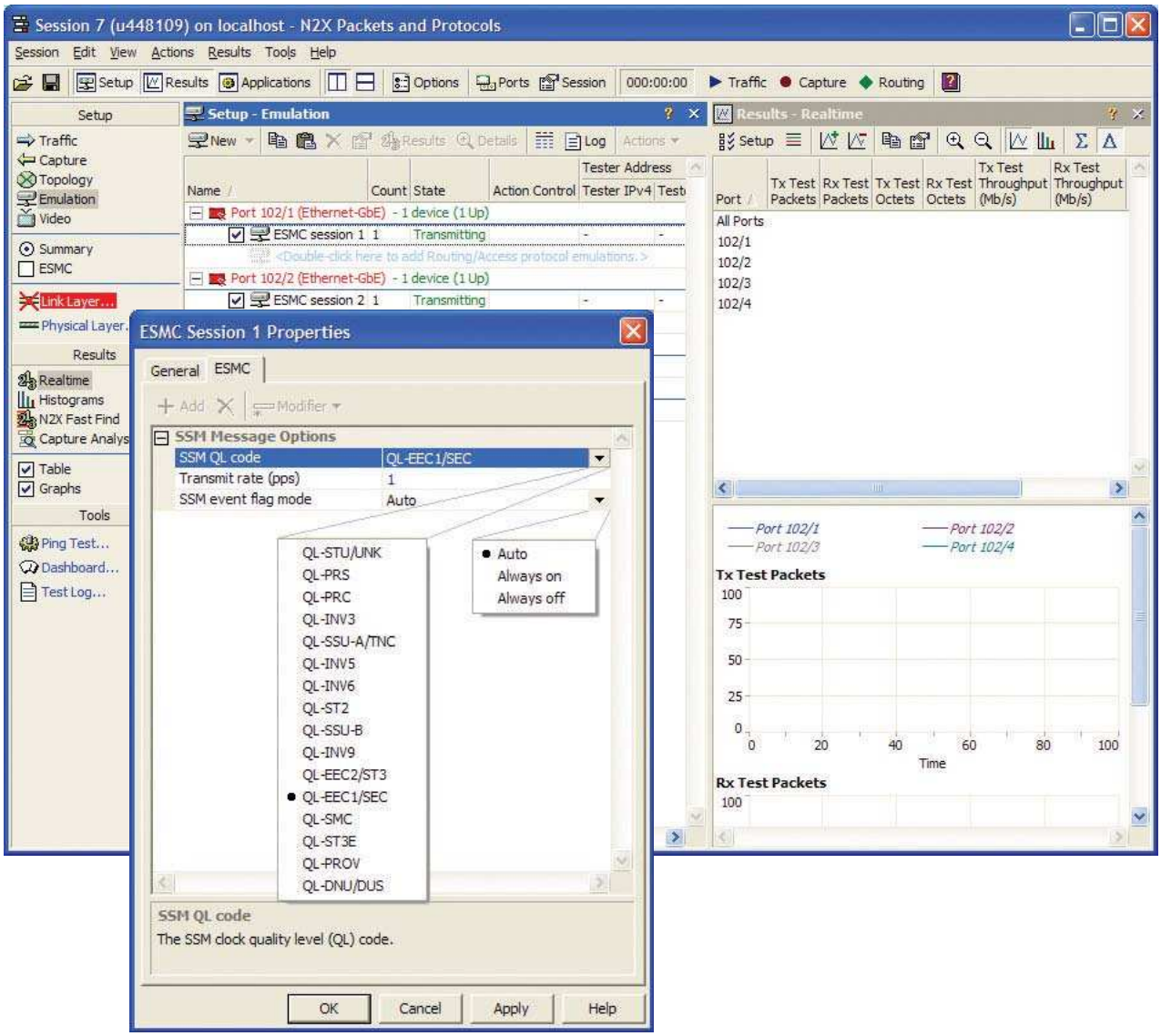


Figure 1 : Comprehensively test Synchronous Ethernet devices with normal and abnormal emulation parameters

Full control of the ESMC protocol enables comprehensive functional, performance and scalability testing of Synchronous Ethernet devices. Because this functionality is built into the Agilent-patented N2X Generic Protocol Framework (GPF) as a full emulation rather than just the traffic generator, you can:

- Interactively change any parameter (such as QL codes and message transmit rates) while the test is running;
- Independently use the traffic generator on the same port to load the data plane of the system-under-test (SUT) without fear of unwanted interactions;
- Track ESMC state and statistics in real time (like all N2X emulations) without having to setup complicated capture filters or manually examine ESMC PDUs in the capture buffer;
- Emulate Quality Level (QL code) changes with full adherence to ITU-T G.8264/Y.1364 specifications, such that the first ESMC PDU following a QL change is sent asynchronously with the event flag set, and all other ESMC PDUs are sent at the correct intervals without the event flag set. Without an emulation, this critical test scenario would otherwise require complex scripting.

Negative testing is built into the ESMC emulation, enabling simulation of misbehaving peer devices, and testing of the SUT with out-of-specification conditions:

- Send ESMC PDUs at abnormal message rates other than one packet-per-second, with different rates on every port;
- Emulate PDUs containing unused or unexpected QL codes;
- Verify system behavior with an incorrectly used event flag. Normally, the event flag should only be set within the first ESMC PDU after the QL code changes.

Test clock source selection, switching, and flapping to ensure network stability

Synchronous Ethernet employs the ESMC protocol to communicate clock quality, allowing a device to select the best clock from its ingress port clock sources and from the device's internal or directly connected clock.

By emulating ESMC on multiple ports and interactively changing simulated quality level (QL) codes within N2X ESMC PDUs, you can use N2X to test clock source selection.

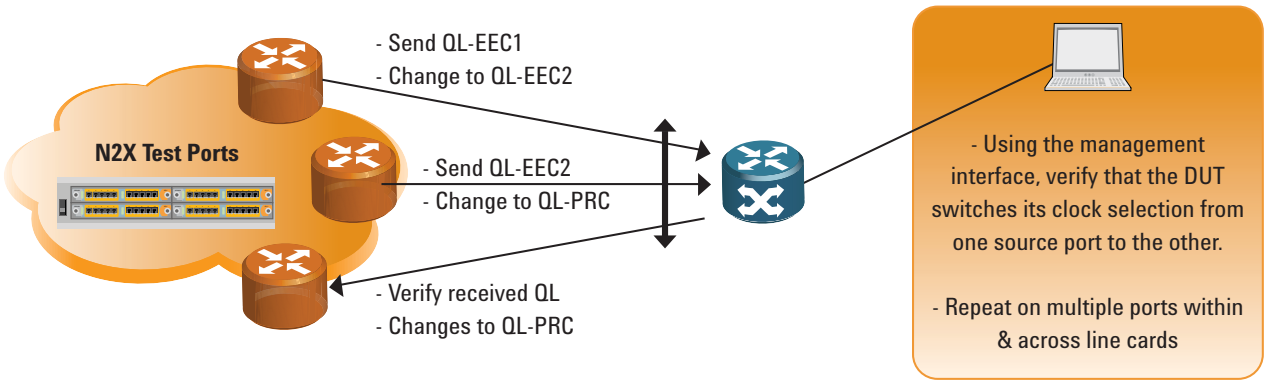


Figure 2 : Interactively change QL codes to verify clock selection

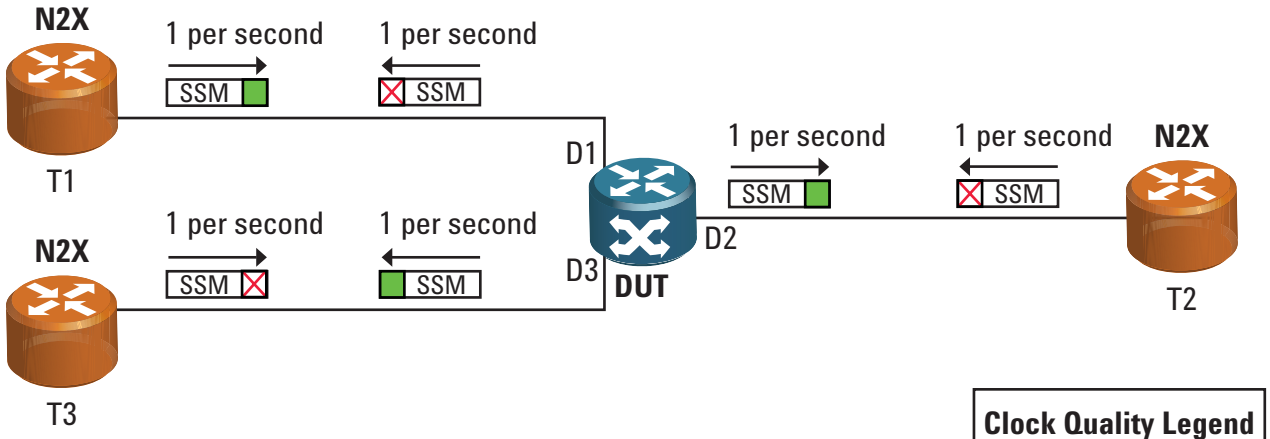
Provoke and quantify clock failover performance

N2X can test a wide range of clock failover scenarios to verify that a Synchronous Ethernet device correctly and rapidly selects a new clock source – for example,

- when a peer device fails;
- when a link fails;
- when a network is reconfigured;
- when an upstream clock fails; or
- when a peer device is restarted.

For example, standards specify that when no ESMC SSM message is received on the clock ingress port for five seconds, the device must "failover" and use the next best available clock source. You can use the N2X ESMC emulation to send SSM messages with different QL codes to multiple DUT ports, and then disable transmission of SSM messages from the port advertising the best QL.

N2X records the time of received and transmitted QL code changes on every port, so you can easily and quickly verify that the DUT responds in a timely manner and accurately selects the next best clock source from the available ingress port clock sources and any directly connected or internal clocks.



Five seconds after the N2X Test Port 1 (T1) stops sending SSM messages the DUT should switch to its internal reference and notify all ports of the change.

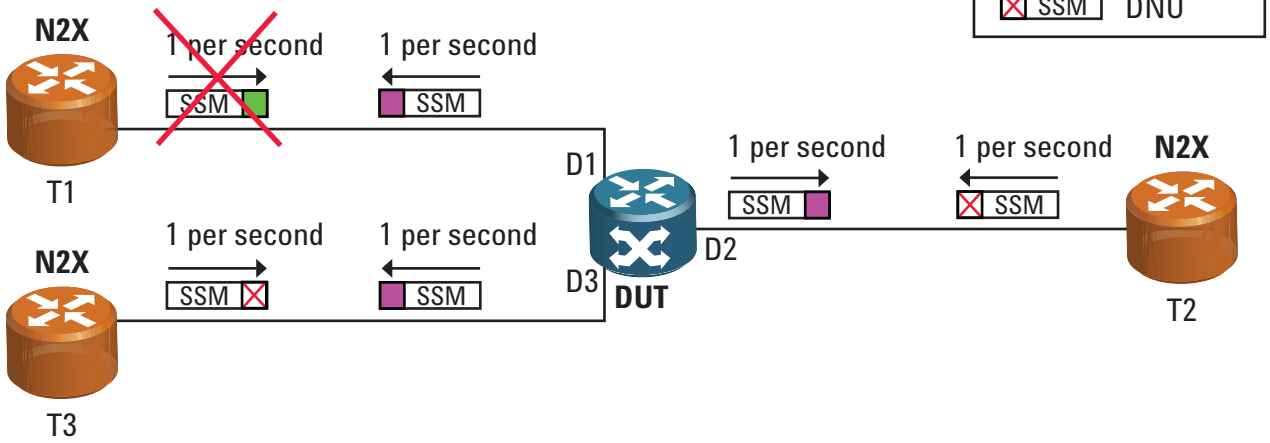


Figure 3 : N2X tests clock failover and verifies the ESMC 5-second rule

Generate and analyze SSM messages on multiple ports with mixed Quality Level (QL) codes

N2X interprets Synchronous Ethernet Quality Level (QL) Codes correctly, for both decodes and encodes, as per ITU-T G.8264/Y.1364, enabling testing of clock reference port switching and distribution.

N2X also interprets non-Ethernet QL Codes to support the three synchronization philosophies known in ITU-T G.781 as Options I, II and III. This enables testing of Synchronous Ethernet devices that may be used in networks interconnected with non-Ethernet networks (such as SONET/SDH networks). In particular, it enables testing of the prioritization of clocks from Ethernet and non-Ethernet networks, to ensure that the best or most appropriate clock source is selected when multiple clock sources are available on different ingress ports from multiple sources.

QL Codes that are not used in any of the Synchronization Philosophies are interpreted as Invalid, and labeled as per the G.781 convention (QL-INV3, QL-INV5, etc).

Support for Quality Level Code "QL-DNU/QL-DUS" (decimal value 15), known as "Do Not Use", enables verification of failure/failover scenarios in which the SUT fails to receive an SSM message with a valid QL Code for more than 5 seconds.

Verify clock-distribution paths: intra-PHY, inter-PHY, inter-line card, inter-chassis

Within a system that supports Synchronous Ethernet, there are multiple clock-distribution paths that N2X can test:

- Intra-PHY: Test the path between multiple ports on the same PHY device within each line card;
- Inter-PHY: Test the path between ports across multiple PHY devices within each line card;
- Inter-card: Test the path between ports across different line cards in each shelf, chassis, or rack;
- Intra-chassis: Test the path between ports across two or more shelves, chassis, or racks;
- Intra-device: Test the path between multiple independent Ethernet switches, possibly from different vendors.

In addition, by emulating ESMC on multiple ports simultaneously, an entire system can be tested for the correctness of its clock selection and distribution, its conformance to specifications, and its stability under extreme ESMC load conditions.

SSM QL Code			QL Code interpretation for Synchronous Ethernet G.8274, and each G.781 Synchronization Philosophy				N2X Label for decodes/encodes
Dec	Bin	Hex	G.8274	Option I	Option II	Option III	
0	0000	00	-	QL-INV0	QL-STU	QL-UNK	QL-STU/UNK
1	0001	01	-	QL-INV1	QL-PRS	QL-INV1	QL-PRS
2	0010	02	-	QL-PRC	QL-INV2	QL-INV2	QL-PRC
3	0011	03	-	QL-INV3	QL-INV3	QL-INV3	QL-INV3
4	0100	04	-	QL-SSU-A	QL-TNC	QL-INV4	QL-SSU-A/TNC
5	0101	05	-	QL-INV5	QL-INV5	QL-INV5	QL-INV5
6	0110	06	-	QL-INV6	QL-INV6	QL-INV6	QL-INV6
7	0111	07	-	QL-INV7	QL-ST2	QL-INV7	QL-ST2
8	1000	08	-	QL-SSU-B	QL-INV8	QL-INV8	QL-SSU-B
9	1001	09	-	QL-INV9	QL-INV9	QL-INV9	QL-INV9
10	1010	0A	QL-EEC2	QL-INV10	QL-ST3	QL-INV10	QL-EEC2/ST3
11	1011	0B	QL-EEC1	QL-SEC	QL-INV11	QL-SEC	QL-EEC1/SEC
12	1100	0C	-	QL-INV12	QL-SMC	QL-INV12	QL-SMC
13	1101	0D	-	QL-INV13	QL-ST3E	QL-INV13	QL-ST3E
14	1110	0E	-	QL-INV14	QL-PROV	QL-INV14	QL-PROV
15	1111	0F	-	QL-DNU	QL-DUS	QL-INV15	QL-DNU/DUS

Figure 4 : N2X interprets QL Codes correctly, for decodes and encodes, as per G.8264 and G.781 options I, II & III

Stress 10pps limit, and mix with CFM and other slow protocols

Synchronous Ethernet Standards specify that no more than ten ESMC PDUs should be sent in any one-second period by a device. This applies to all Organization Specific Slow Protocol (OSSP), per port, individually for each and every OSSP. N2X enables you to:

- Stress the ESMC packet rate limit by exceeding the ten packets-per-second transmit rate – a defect was found in one vendor's implementation using this scenario;
- Mix ESMC PDUs with PDUs of other Slow Protocols, such as Link Aggregation Control Protocol (LACP), Link Aggregation Market Protocol (LAMP), and Ethernet OAM (IEEE CFM, ITU-T Y.1731) to test interactions and ensure that the SUT correctly applies the 10pps packet rate limit on a per-protocol basis and to verify that the other slow protocol messages do not interfere with ESMC;
- Repeat the stress test on multiple ports within and across multiple SUT line cards to verify that the 10pps packet rate limit is correctly observed at a system level, and that the system performs as expected when the rate is exceeded on multiple ports;
- Ensure that system-wide clock switching and distribution is stable under all conditions, regardless of ESMC and other OSSP packet rates.

Combine with Agilent scopes, generators and analyzers to evaluate clock transfer quality

By adding Agilent scopes, signal generators and analyzers to your testbed, you can extend the range of measurements and test scenarios possible:

- Generate clock input signals with different frequencies and phases;
- Compare the frequency and phase of recovered clock signals (if available from the SUT) with the original clock signal to verify correct clock selection and distribution;
- Evaluate the physical quality of recovered clock signals (if available from the SUT) to measure clock quality degradation and clock transfer impairments by the SUT.

The following Agilent application notes may be useful (available at the time of writing at these URLs):

- Measuring Jitter in Digital Systems: http://cp.literature.agilent.com/litweb/pdf/5988-9109EN.pdf
- Using Clock Jitter Analysis to Reduce BER in Serial Data Applications: http://cp.literature.agilent.com/litweb/pdf/5989-5718EN.pdf
- Network Synchronization: http://cp.literature.agilent.com/litweb/pdf/5988-0360EN.pdf

Please contact your local Agilent representative or visit http://www.agilent.com to learn about the latest Agilent test equipment to complement your N2X testbed.

Comprehensive results and statistics

Extensive ESMC protocol results and statistics enable rigorous functional testing, both interactively from the GUI and via the N2X API. Measurements can be displayed in tabular form, graphed, and logged to a file for import to a spreadsheet or analysis tool.

- Monitor the current received QL code on one or more downstream ports while interactively changing simulated QL codes, to quickly ensure correct QL code propagation;
- Watch the incrementing of QL code message counts to quickly ensure that no incorrect or unexpected QL codes are received;
- Observe received ESMC PDU message rates to compare with the 1 packet-per-second or expected rate and verify against the 10 pps upper limit;
- Inspect ESMC PDU inter-arrival times to check behavior during QL code changes and failover scenarios;
- Compare "last QL change" timestamps between clock ingress and clock egress ports to estimate reported clock switchover or clock quality change propagation times, and compare against manufacturer specifications.

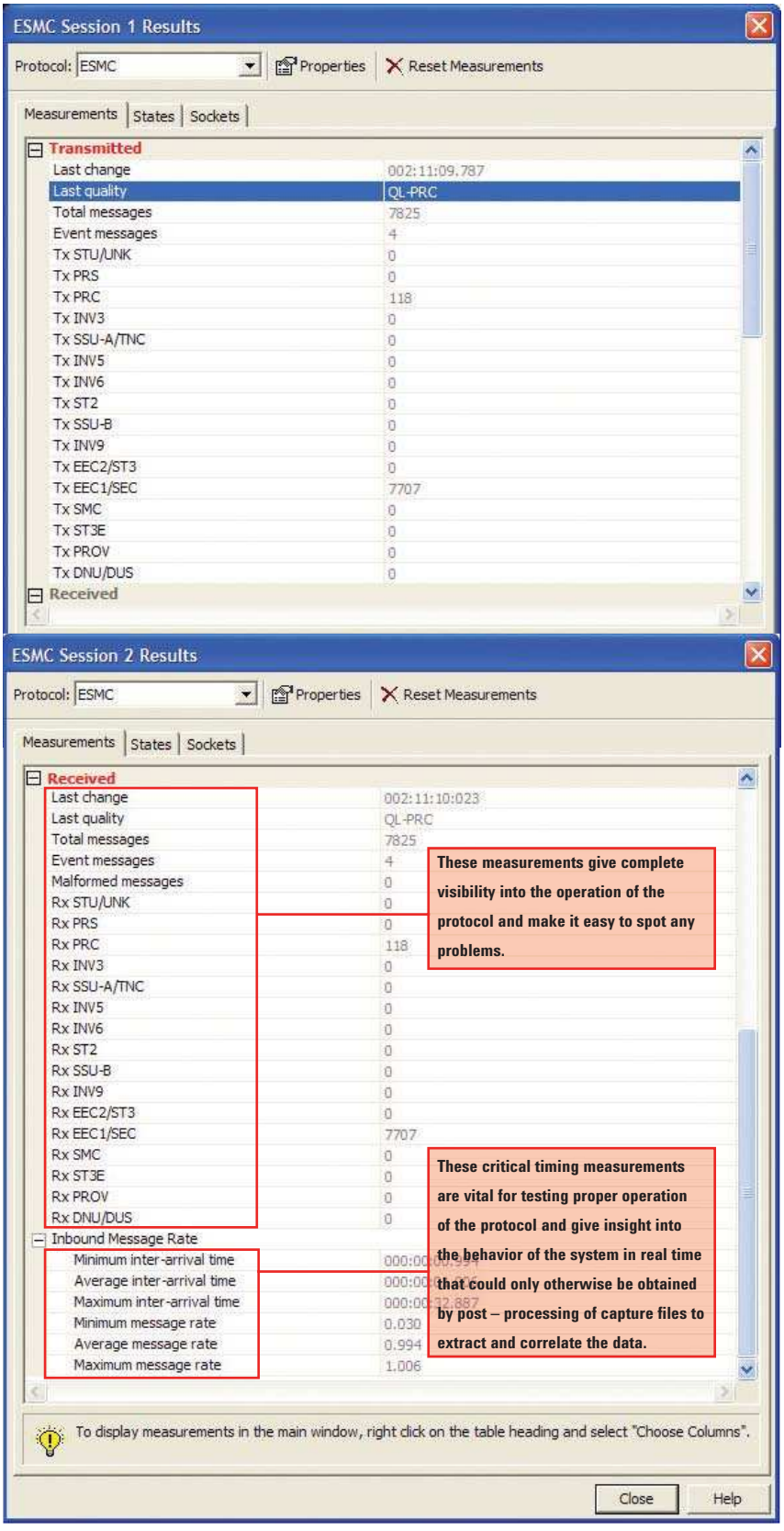


Figure 5 : Real-time statistics enable critical measurements such as QL change propagation time

Perform Negative Testing via flexible XML PDU builder

Essential to interoperability testing is the establishment of DUT behavior in the event of an unexpected or malformed PDU. N2X's flexible XML-based PDU builder allows you to easily create and transmit (via the GUI or API) a non-conforming ESMC PDU. For example, you can change the version number or reserved bits in the flags.

To stress the SUT with rapidly varying QL codes or other PDU fields, you can use the N2X Field Modifiers to:

- count (step) through available field values;
- randomize field values.

In addition, you can edit or extend the N2X XML files using a simple text editor to create non-standard ESMC PDU definitions with additional TLVs. This can also be useful for tracing a message through a system.

These capabilities complement the ESMC emulation's own negative-test functionality, described earlier.

Capture and Analyze ESMC PDUs

The N2X XML-based flexible decoder allows Synchronous Ethernet ESMC PDUs to be displayed and analyzed.

- Verify every protocol field and sub-field in detail, to confirm proper DUT encapsulation (e.g., ITU-T OUI & Subtype);
- Filter for specific messages (for example, ensure that Information PDUs have their Event flag set to 0);
- Analyze reported Quality Levels (display QL-EEC1, QL-EEC2, and other QL codes from non-Ethernet clock sources);
- Accurately compare ESMC PDU arrival timestamps across multiple ports to identify and solve timing problems that might otherwise take many hours to find.

Applicable Standards

- ITU-T G.8264/Y.1364 Distribution of timing through packet networks (ESMC SSM protocol & message formats for Synchronous Ethernet)
- ITU-T G.8261/Y.1631 Timing and Synchronization aspects in Packet Networks (Annex A: SSM processing and clock selection/ distribution)
- ITU-T G.781 Synchronization layer functions (Section 5: Synchronization philosophies and Quality Level codes)

Configuration and Ordering Details

Hardware

To use the N5566A Synchronous Ethernet ESMC Emulation software, the following Agilent N2X hardware and software are required.

A N2X system is required with:

- System controller
- Chassis
- One or more Ethernet Test Cards

The N5566A software is supported on all N2X Ethernet test cards except the N2X XP or XP-2 test cards, which do not support protocol emulations.

Software

Required software packages:

- Packets and Protocols Application Software (E7881B)

Optional complementary software packages:

- Spanning Tree Protocol (STP, RSTP & MSTP) Emulation Software (N5580A)

Please contact your local Agilent representative to help configure and order an N2X test system.

Online Help

An extensive online help system provides complete descriptions and detailed usage instructions for every component of N2X. Dialog-level, context-sensitive help provides rapid access to the relevant sections of the online help.

Technical Specifications.

This section lists the protocol-specific parameters that are configurable through the GUI or the Tcl scripting environment.

Configuration Parameters

SSM Message Options

SSM QL Code	• QL-PRS • QL-PRC • QL-INV3 • QL-SSU-A/TNC • QL-INV5 • QL-INV6 • QL-ST2 • QL-SSU-B • QL-INV9 • QL-EEC2/ST3 • QL-EEC1/SEC • QL-SMC • QL-ST3E • QL-PROV • QL-DNU/DUS
Transmit rate (msg/s)	• 0 to 100
Event flag mode	• Auto, Always On, Always Off

Results and Statistics

Transmit state

Last QL change timestamp	• hhh:mm:ss.sss
Last QL code	• QL-xxx

Transmitted message counts

Total messages	• Count
Event messages	• Count
Tx STU/UNK	• Count
Tx PRS	• Count
Tx PRC	• Count
Tx INV3	• Count
Tx SSU-A/TNC	• Count
Tx INV5	• Count
Tx INV6	• Count
Tx ST2	• Count
Tx SSU-8	• Count
Tx INV9	• Count
Tx EEC2/ST2	• Count
Tx EEC1/SEC	• Count
Tx SMC	• Count
Tx ST3E	• Count
Tx PROV	• Count
Tx DNU/DUS	• Count

Receive state

Last QL change timestamp	• hhh:mm:ss.sss
Last QL code	• QL-xxx

Received message counts

Total messages	• Count
Event messages	• Count
Malformed messages	• Count
Rx STU/UNK	• Count
Rx PRS	• Count
Rx PRC	• Count
Rx INV3	• Count
Rx SSU-A/TNC	• Count
Rx INV5	• Count
Rx INV6	• Count
Rx ST2	• Count
Rx SSU-8	• Count
Rx INV9	• Count
Rx EEC2/ST2	• Count
Rx EEC1/SEC	• Count
Rx SMC	• Count
Rx ST3E	• Count
Rx PROV	• Count
Rx DNU/DUS	• Count

Inbound message Rate

Minimum inter-arrival time	• hhh:mm:ss.sss
Average inter-arrival time	• hhh:mm:ss.sss
Maximum inter-arrival time	• hhh:mm:ss.sss
Minimum message rate	• Messages/s
Average message rate	• Messages/s
Maximum message rate	• Messages/s

Emulation Status (per-instance = per-port)

Emulation	• Enabled, Disabled
Emulation state	• Idle, Stopped, Transmitting

www.agilent.com/find/n2x

Agilent N2X

Agilent's N2X multi-service tester combines leading-edge services with carrier grade infrastructure testing and emulation. The N2X solution set allows network equipment manufacturers and service providers to more comprehensively test new services end-to-end, resulting in higher quality of service and lower network operating costs.

Software and Support Agreement

To protect your investment in the Agilent N2X, every new system includes an initial 12-month comprehensive system-based warranty and Software and Support Agreement (SSA).

Renewing Agilent support services ensures uninterrupted technical support and software upgrades, giving you confidence in N2X throughout the life of your system.

The N2X technical support portion of your SSA includes assistance with product operation and measurements, and verification that the N2X equipment is in correct working order.

Warranty and Support

Hardware Warranty

All N2X hardware is warranted against defects in materials and workmanship for a period of 1 year from the date of shipment.

Software Warranty

All N2X software is warranted for a period of 90 days. The applications are warranted to execute and install properly from the media provided.

This warranty only covers physical defects in the media, whereby the media is replaced at no charge during the warranty period.

Ordering Information

To order and configure the test system, consult your local Agilent field engineer.

Sales, Service and Support

N2X must be serviced by an approved Agilent Technologies service centre, please contact us for more information.

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P.O. Box 4026
Englewood, CO 80155-4026

1-800-829-4444

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