Multi-Vendor Interoperability in Evolved 3G/LTE Backhaul Networks

European Advanced Networking Test Center
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About the European Advanced Networking Test Center

- Vendor independent network quality assurance since 1991
- Unique technical expertise of network design and testing in latest technology areas
- 20-year testing experience matches highest quality standards

Business Areas

- Test and certification of network components for manufacturers
- Network design consultancy and proof of concept testing for service providers
- Request for Proposal (RfP) support, acceptance testing and network audits for large enterprises and government organizations
- Vendor neutral technology seminars
Recent Multi-Vendor Interoperability Test Events

10th Public MPLS Interoperability Test, Paris, Feb 2012

7th Public Carrier Ethernet Interoperability Event, Amsterdam/Singapore, 4Q/2011
Technologies Covered In Recent Interop Events & In The Future

- Carrier Ethernet Services
- 3G/LTE Backhaul
- IPv6 Migration
- IP/MPLS, MPLS-TP, Microwave Transport
- Service Activation Test Methods
- Fault Management (OAM)
- Service Assurance/Performance Monitoring
- Wholesale Operators
- LTE Advanced
- Small Cells
Recent Carrier Ethernet Interoperability Tests: Participating Vendors
Physical Topology
Packet Backhaul Technology Status Q1/2012

Visibility

Y.1564
Service Activation

IEEE 1588:2008

MPLS-TP

Performance Monitoring
Y.1731

Technology Progress

SyncE

ERPS

Ethernet Microwave

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Hype Cycle model (five stages) © Gartner 1995

Green Circle: Good Progress
Yellow Circle: Less Progress
Black Circle: Stable
Network Clock Synchronization Reference Architecture

- Synchronous Ethernet
- Suitable for Frequency synchronization
  - Requires hop-by-hop Ethernet transport network
Synchronous Ethernet Protocol Test Results

SyncE with ESMC tested successfully with 10 implementations

Automated choice of best clock worked great

SyncE over Ethernet Link Aggregation successfully tested with 5 implementations

Clock signal exchange works fine even when multiple links are involved

Figure 21: SyncE Over LAG
Packet Clock Synchronization Reference Topology

- IEEE 1588v2 Precision Time Protocol (PTP)
- Master Clock and PTP Client (Slave Clock) mandatory
- Optional:
  - Transparent Clocks for asymmetry correction
  - Boundary Clocks for segmentation
IEEE 1588:2008 Slave and Transparent Clock Tests

IEEE 1588:2008 testing of transparent clocks

IEEE 1588:2008 testing of slave clocks with frequency and phase synchronization
IEEE 1588:2008 testing of boundary clocks
Complex test setup – passed G.823 15ppb mask
Ethernet microwave solutions are advancing

- Bridging functions
- Clock synchronization support
- Ethernet OAM support
- Prioritization and queuing functions

EANTC tested six implementations of two product classes

- 256..1024-QAM with 28 MHz channel bandwidth
- 64-QAM with 500 MHz channel bandwidth (millimeter wave)
Microwave Class of Service Support

- Adaptive modulation triggered by weather conditions
- Changes total link capacity
- Requiring queuing and prioritization support in the microwave node
- Multiple pairs of microwave transport may be in the path
- 11 combinations successfully tested
How to Transport Clock Sync Across Microwave Links?

- Microwave links introduce delay and delay variation
- Legacy systems were based on PDH
- Modern microwave solutions are based on Ethernet without inherent clocking support
- Synchronous Ethernet is required
- Active SyncE Support confirmed with all six implementations under test
Service Activation Testing (ITU Y.1564)

- Validate committed service levels at service activation time
  - Bandwidth Profile Configuration Test
  - Frame Loss
  - Delay
  - Delay Variation
  - Availability
- Three vendors participated – configuration challenge
- First public interoperability test of Y.1564 worldwide
Ethernet Performance Monitoring

- More than 25 vendor pairs tested
- Delay/delay variation tests successful and accurate
- Loss tests supported occasionally as well
- Including tests with Ethernet encryption devices
- Differentiation: On-demand or scheduled monitoring (scalability question)
Resiliency Across Protocol Domains

- MPLS uses Fast Reroute
- MPLS-TP uses Global Protection
- Ethernet uses Ethernet Ring Protection
- ... how do these work together at the boundaries of network domains?
Interoperability of Redundant ERPS/MPLS connections

Successfully tested

- Resilient interconnection of MPLS-TP and ERPS
- Redundant connections of IP/MPLS and ERPS networks

![Diagram of network connections involving Cisco, Ericsson, Hitachi, and Telco Systems with labels for open Ethernet ring, R-APS channel, IP/MPLS domain, MPLS-TP domain, Ethernet Access Network, traffic flow: protection path, traffic flow: working path, and port blocking.]

Figure 13: ERPS and IP/MPLS VPLS or ERPS and MPLS-TP VPLS Interworking
IPv6 Transition Technologies: The Big Picture

IPv4 Core
IPv4 Access Network
IPv4 Rapid Deployment
Subscriber Network
Carrier Grade NAT

IPv4 Internet
IPv6 Internet

Dual Stack Core
6rd BR
v6 over v4
6rd L2TP

Dual Stack Core
LNS

Dual Stack Core
NAT
AFTR
v4 over v6

Dual Stack Core
PE

IPv6 Access Network
IPv6-Only Access Network
IPv6-Only Subscriber

Native IPv6
IPv6 Rapid Deployment
IPv6
IPv6 Only Network
IPv6 Only Subscriber

EANTC
Outlook: Upcoming Interoperability Events

Validating service requirements of

- LTE / LTE-Advanced Synchronization support, focusing boundary/transparent clocks and multiple clock domains
- Resiliency
- Backhaul design considerations for small cells
- Wholesale Access Operators: ENNI/E-Access services
- Efficient Manageability and service activation
Further Information

Interoperability white papers available at
- http://www.eantc.de/cewc2011

Commissioned Test Articles available at
- http://www.lightreading.com/ciscoseries