



Examining the Practicality of Ethernet for Mobile Backhaul Through Interoperability Testing

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EANTC Introduction

Providing independent network quality assurance
since 1991



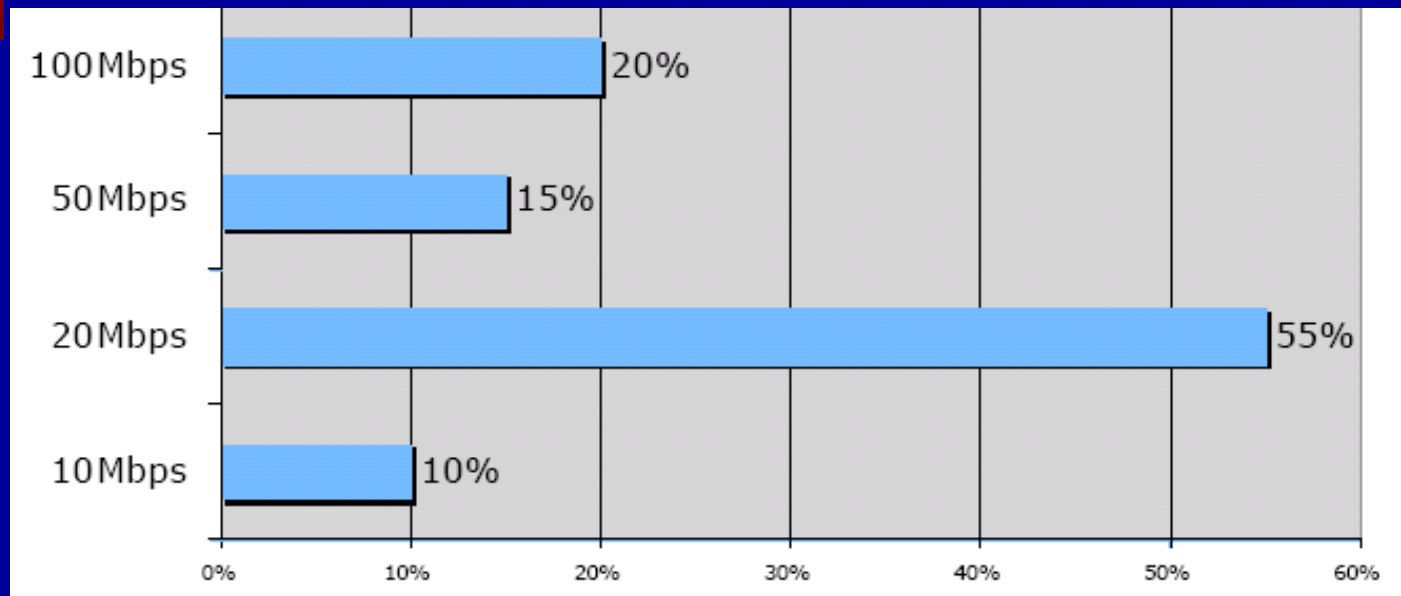
EANTC Berlin, Germany

- Test and certification of network components for manufacturers
- Network design consultancy and proof of concept tests for service providers
- Request for Proposal (RFP) support and life cycle testing for large enterprises and government organizations

Agenda

- Opportunities and challenges
- Gauging the state of the art
- Mobile backhaul relevant interop test areas
 - ATM pseudowires, TDM circuit emulation
 - Clock synchronization – packet- and network-based
 - Inter-carrier connectivity
 - IPv6 VPNs
- Outlook

Mobile Backhaul Migration to MPLS and Carrier Ethernet – Why?



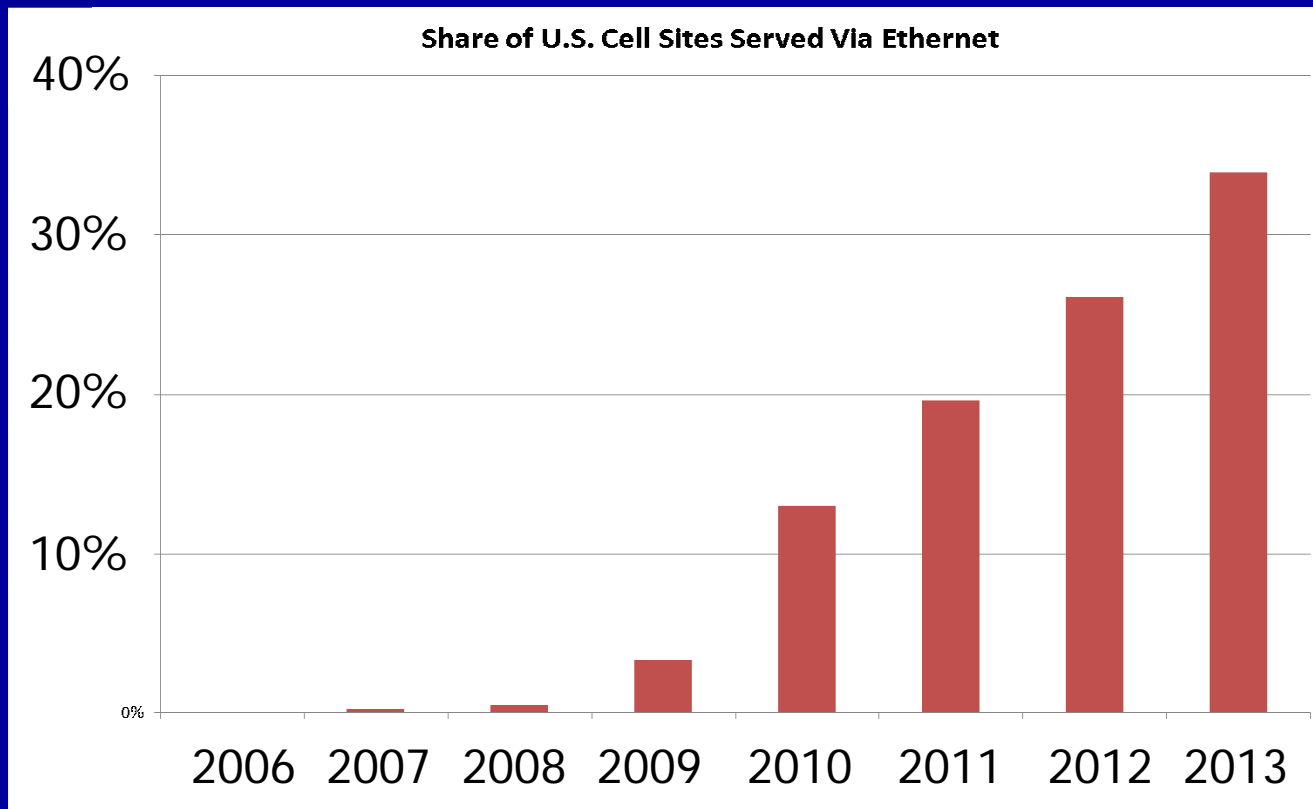
MEF
Mobile
Backhaul
Market
Survey
2008

“Average cell site traffic will be 25 Mbit/s by 2012 ... legacy technology can’t scale”



*Michael Howard,
principal analyst
at Infonetics
Research*

Projected Cell Site Migration Towards Ethernet



Source: New Paradigm Resources Group

The Converged Network Vision

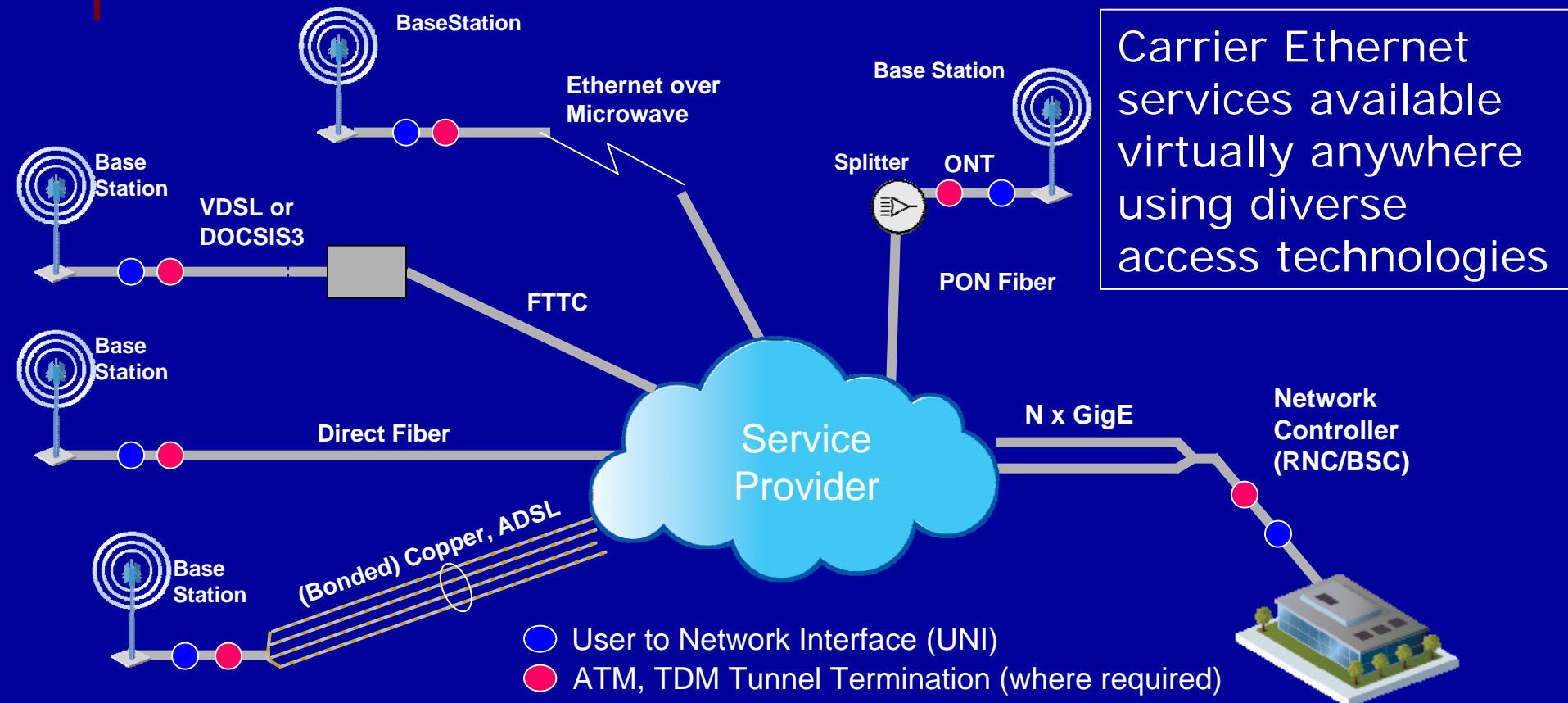
Consumer triple play
+ business services
+ mobile backhaul

Across a single,
converged network

Additional revenue
opportunity for fixed
network operators (?) (!)



Mobile Backhaul Migration to MPLS and Carrier Ethernet – Coverage



Ethernet Backhaul Challenges

Operational experience

- Can I rapidly isolate a fault?

Clock Synchronization

- How do I accurately time my Radio interface?
- How do I ensure seamless call handover?

Reliability and availability

- Are the network controller connections highly available?

Support for legacy and future generations

- How will I support multiple generations of radio technology?

Ethernet Backhaul Test Areas

Operational experience

- Ethernet OAM (IEEE 802.1ag, 802.3ah; ITU-T Y.1731)

Clock Synchronization

- Packet-based sync (adaptive clock, IEEE 1588, NTP?)
- Network-based sync (Sync Ethernet, NTR, microwave)

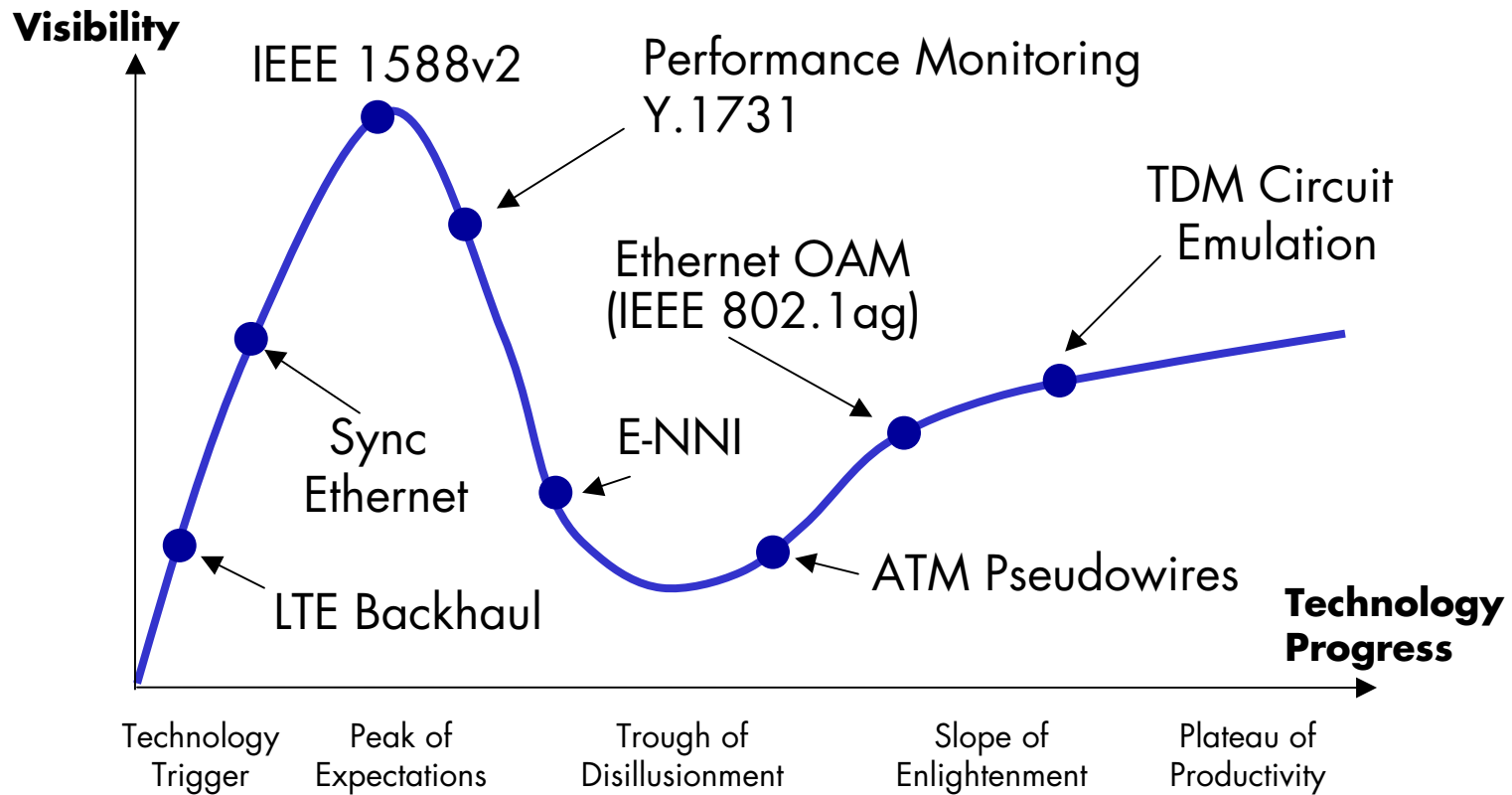
Reliability and availability

- Global protection using backup paths; MPLS fast reroute

Support for legacy and future generations

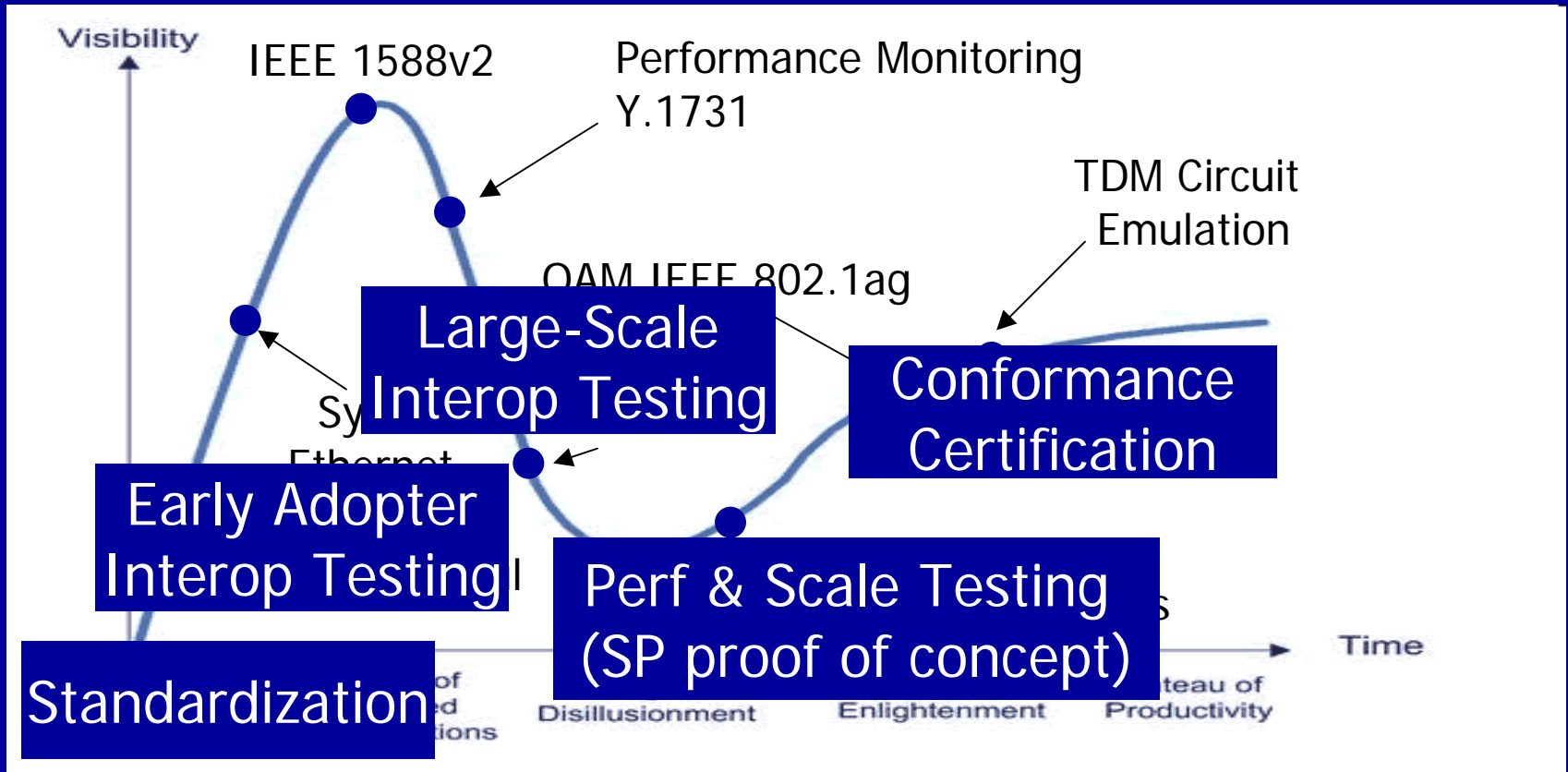
- ATM pseudowires, TDM circuit emulation (legacy)
- E-Line (pseudowires), E-Tree (VPLS) (future backhaul)

State of the Art in Packet-based Mobile Backhaul Technologies – Personal View



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Hype Cycle model (five stages) © Gartner 1995

EANTC Testing Cycle



MPLS and Ethernet World 2009 Interop Event: Participating Vendors

Alcatel-Lucent 

 Corrigent
SYSTEMS

 SPIRENT®
Communications


BROCADE

ERICSSON 

 Telco
Systems
A BATM Company


HUAWEI

 RAD

data communications


Calnex Solutions

 IXIA®

NEC

celtro 

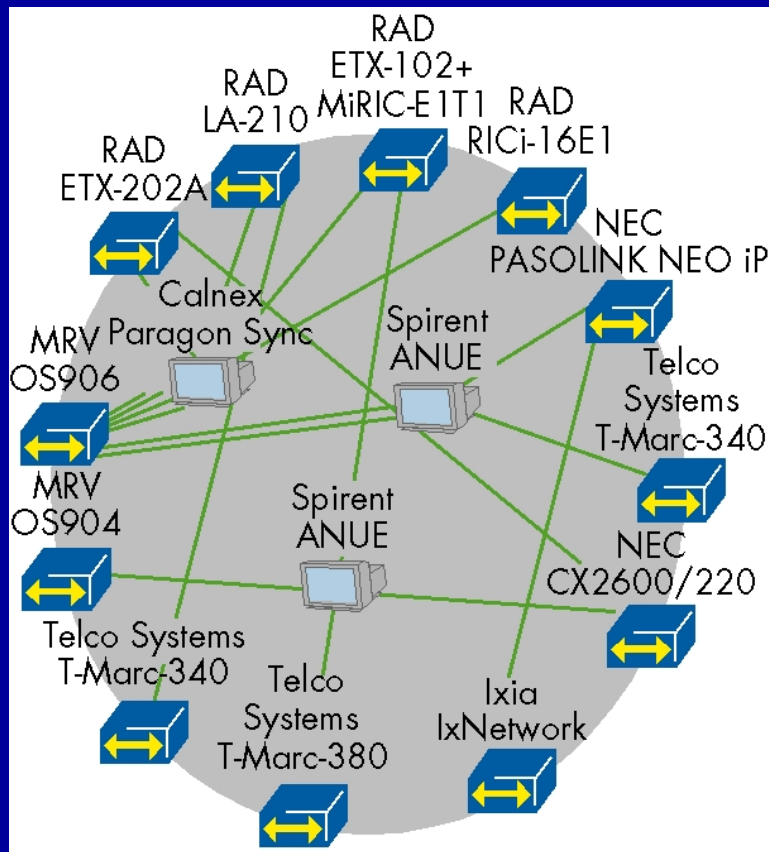
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NETWORKS
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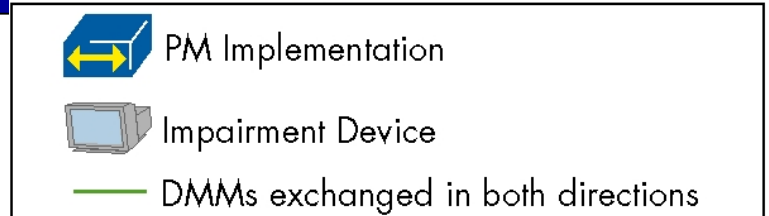
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Y.1731 Performance Monitoring Tests at MPLS World Congress 2009



- Important when outsourcing the mobile backhaul network; validates SLAs
- Growing number of implementations (10 tested)
- Artificial loss, delay, delay variation inserted by impairment generators
- Generally, high degree of accuracy – much improved since last test



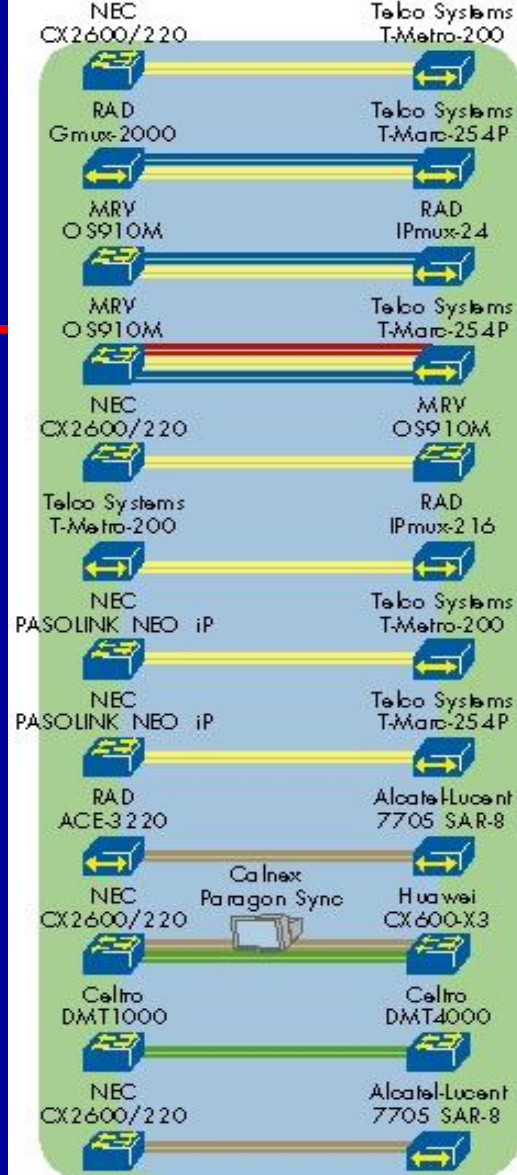
Test Area: Mobile Backhaul – TDM Circuit Emulation

Used for E1 connections between GSM base stations and controllers

Five alternative solutions tested:

1. IETF MPLS SAToP (4 vendors)
2. IETF IP SAToP (2 vendors)
3. MEF 8 Structure Agnostic (4 vendors)
4. MEF 8 Structure Aware (3 vendors)
5. IETF MPLS Structure Aware (3 vendors)

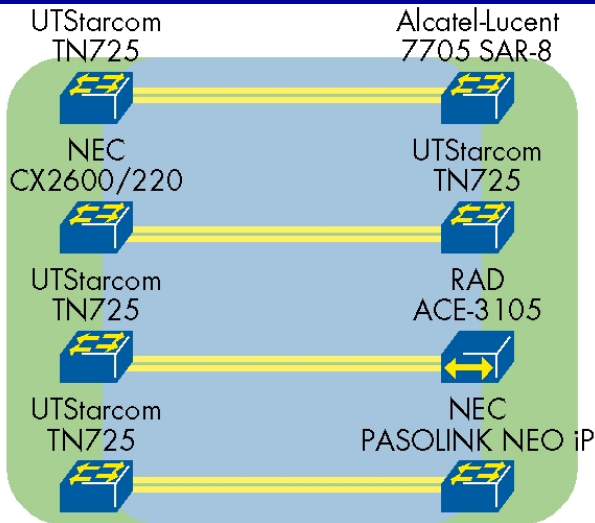
Adaptive clock synchronization tested
(one combination under emulated network conditions, back-to-back otherwise)



Test Area: Mobile Backhaul – ATM Pseudowires

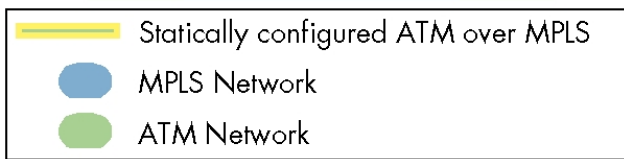
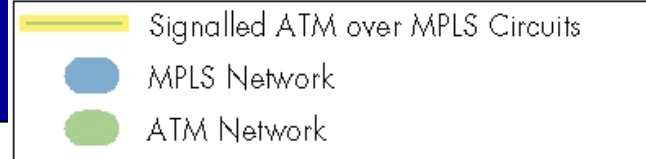
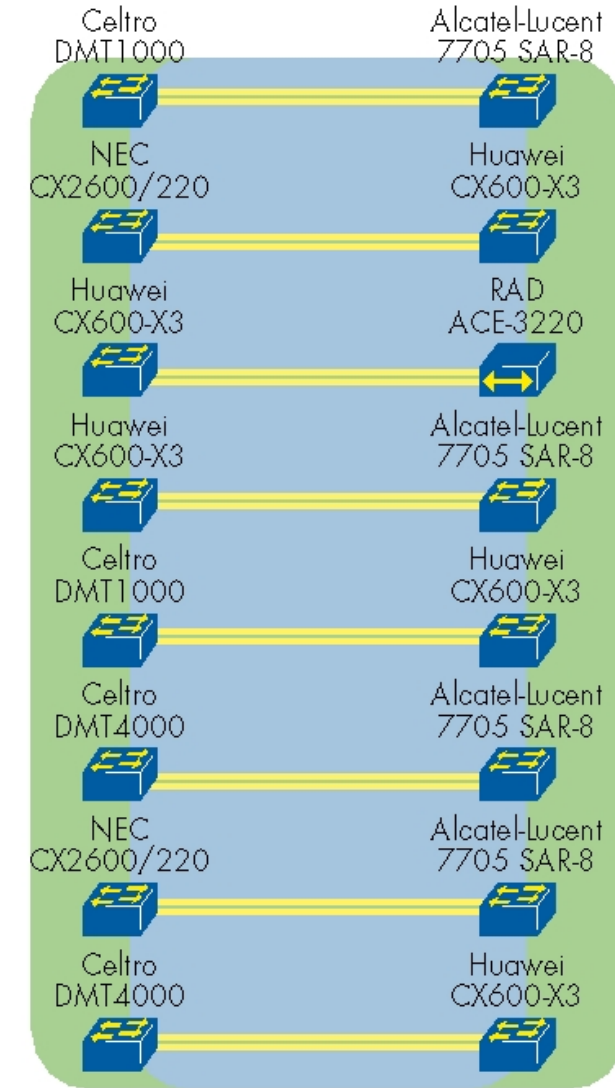
Used for E1 connections between 3G base stations and network controllers

- ATM transport over MPLS (**RFC 4717**)
- Clock sync external (**IEEE 1588v2**)



Signalled ->

← Static



Test Area: Mobile Backhaul

– ATM Pseudowires

Findings:

- Twelve multi-vendor test combinations
- Standard defines a number of options; some interop issues in option support:
 - Cell concatenation mode (multiple cells per PDU)
 - “N-to-1” mapping of ATM channels into a single pseudowire
 - Penultimate Hop Popping (PHP, one MPLS label)
- 100% interoperability successfully achieved on minimum subset support level

State of the art and challenges of clock synchronization over Carrier Ethernet

Packet based solutions:

- Multiple technologies (adaptive clocking, IEEE 1588v2) developed – extensive lab testing activities going on
- Performance threat: Network delay and delay variation at the same order of magnitude as clock wander and jitter
- Control end-to-end packet network QoS - finally use differentiated quality for clock, voice, data

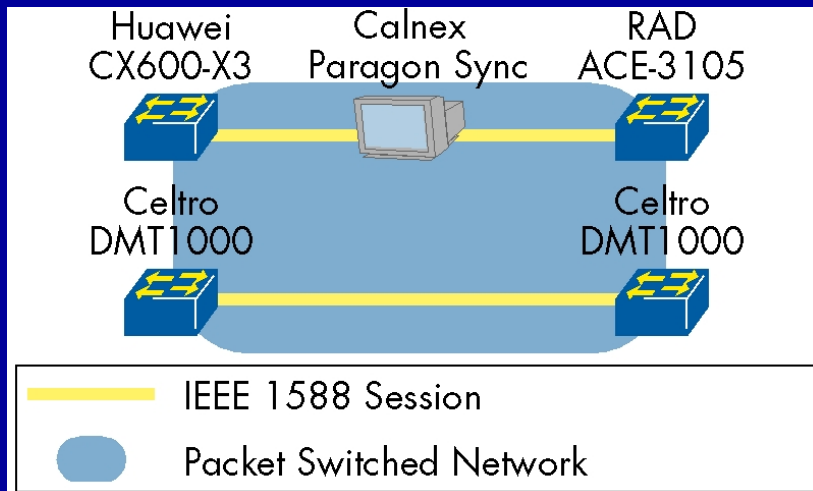
Network synchronous solutions:

- Synchronous Ethernet support slowly growing
- Not influenced by network load conditions
- Hop-by-hop support required

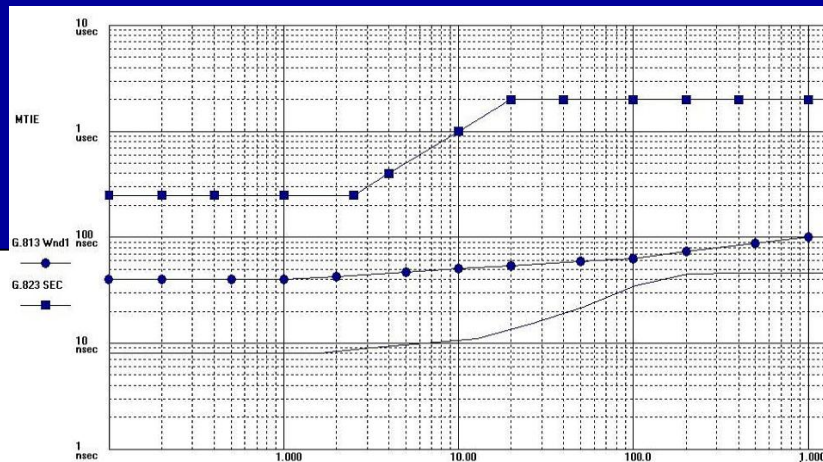
Combination of methods expected in the future, using transparent boundary clocks

Test Area: Clock Synchronization (Precision Time Protocol IEEE 1588-2008)

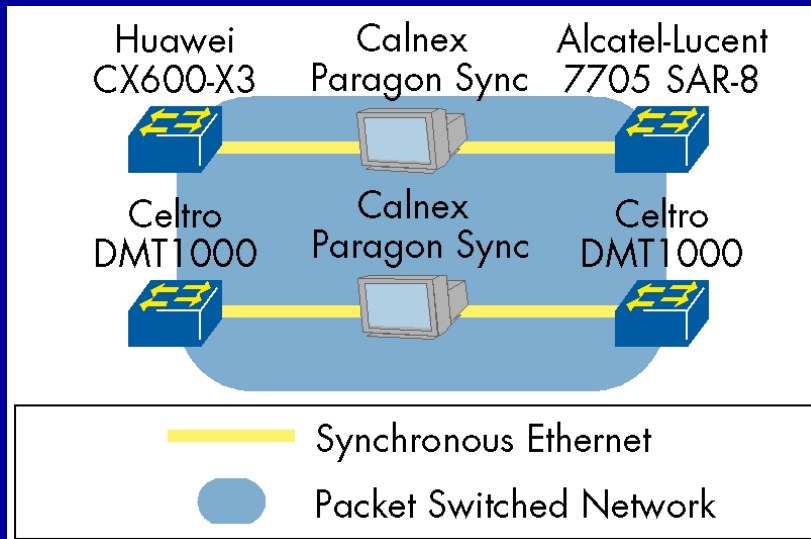
Several implementations – option support varies:



- Some vendors support multicast, some unicast transport of clock messages
- Two clock options: one-step and two-step
- Sync messages rate range support varied: 1-32, 32-128, 100-1000 per second
- Limited interoperability already achieved in our early tests

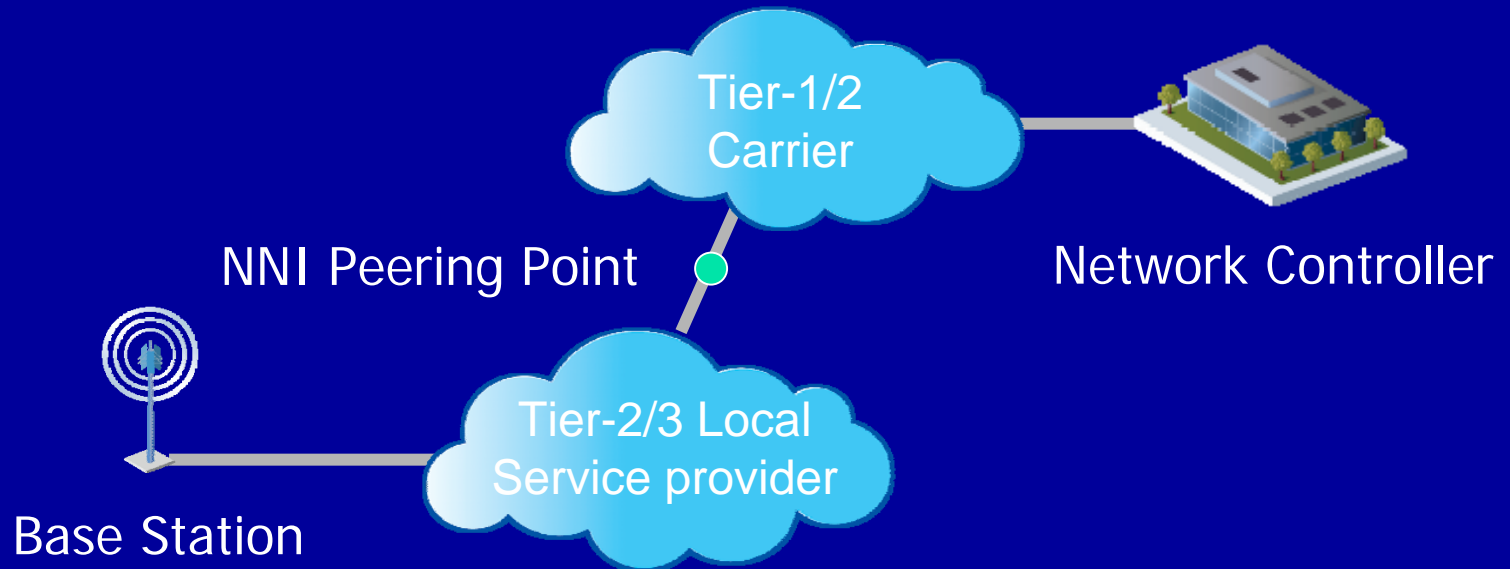


Test Area: Synchronous Ethernet



- First time successful public multi-vendor testing at this year's interop event
- Test system measured wander of sync messages
- Requirements for frequency synchronization quality met by all vendors

Inter-Provider Peering Solutions – Important For Mobile Backhaul?



- Base station to network controller connections are regional!
- NNI will improve coverage, open market to small local SPs
- Mobile operators benefit by centralizing services

Inter-Provider Peering Solutions

State of the art:

- Carrier Ethernet E-NNI stuck in standardization
- Provider Bridging-based interconnection ("Q-in-Q") are standard today

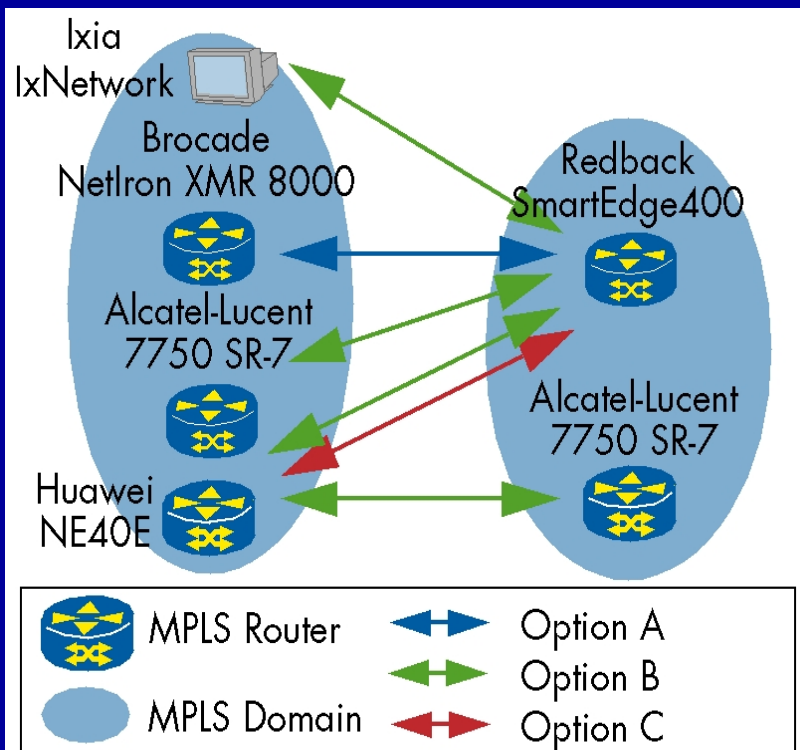
Growing SP interest in advanced MPLS interconnections, improving service and reducing provisioning effort

- Multi-segment pseudowires
- End-to-end MPLS pseudowires
- Mutual understanding of level of trust required!

QoS awareness required

- Service Level Agreements across service providers

Test Area: Inter-Carrier MPLS Interconnectivity



Three standardized alternatives tested:

- Option A – Treat opposite carrier like a customer
- Option B – Build separate service segment between providers, stitch three segments together
- Option C – Single, dynamic end-to-end service
- From A to C: Operational efficiency increases, privacy decreases
- Lab facilitated end-to-end testing

Summary

Interoperability testing helps to:

- Validate new protocols, create confidence
- Improve quality of individual implementations
(Majority of SP networks are multi-vendor today)

Outlook

- EANTC will focus interop testing for LTE backhaul and increase coverage of clock sync at CEWC 2009
- Individual performance & scalability PoC tests (vendor- and service provider-driven) upcoming

Thank you!

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