

Delivering Ethernet Services to the Research & Education Community

ADVANCE

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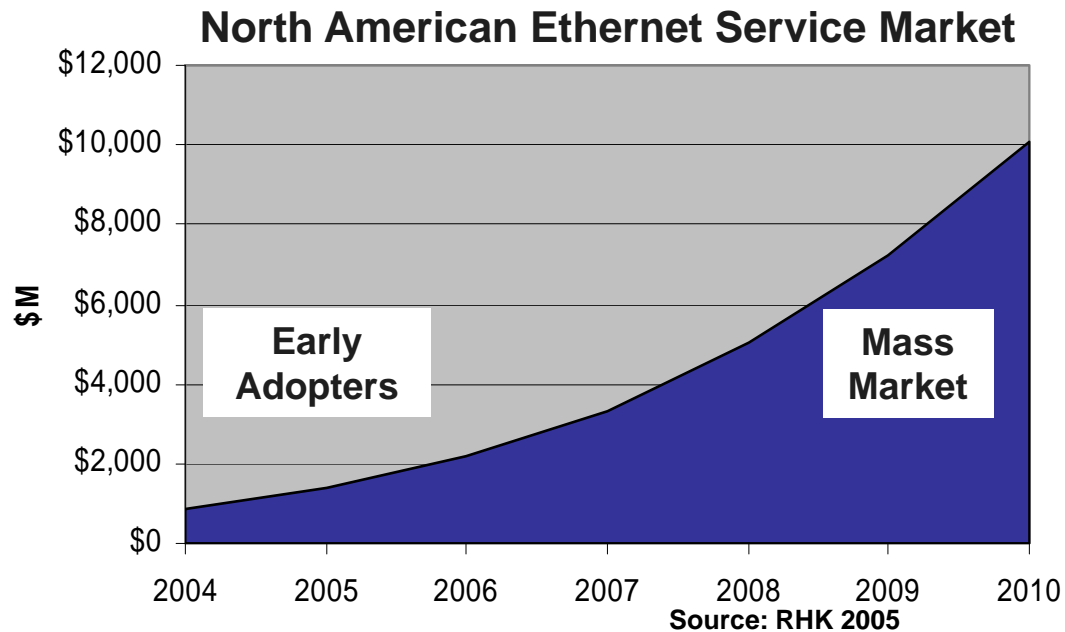


Agenda

- ▶ Introduction
- ▶ Advances in Operations, Administration & Maintenance (OAM) standards
- ▶ OAM, Ethernet access and demarcation



Ethernet Service Evolution



- **Carrier-grade Ethernet is driving a mass market shift to Ethernet**
- **OAM is a critical part of a carrier-grade Ethernet offering, without it, many users will stick with their current WAN technologies**









Poll Question

- ▶ What is holding back WAN Ethernet deployments in your network?
 - A. Availability of backbone Ethernet capacity
 - B. Availability of regional Ethernet capacity (or fiber)
 - C. Ability to manage Ethernet in WAN
 - D. Preference for another protocol



Ethernet OAM Standards Overview

| Standards Body | Ethernet OAM |
|---|--|
|   <p>IEEE</p> | <ul style="list-style-type: none"> ▶ 802.3ah – EFM OAM ▶ 802.1ag – CFM ▶ 802.1aj - TPMR ▶ 802.1AB – Discovery ▶ 802.1ap – VLAN MIB |
|  <p>METRO Ethernet Forum</p> | <ul style="list-style-type: none"> ▶ MEF 7– EMS-NMS Info Model ▶ MEF 15– NE Management Req ▶ MEF 17 - OAM Req & Framework ▶ MEF 16 – Ethernet Local Management Interface ▶ Performance Monitoring |
|  <p>ITU</p> | <ul style="list-style-type: none"> ▶ Y.1730 – Ethernet OAM Req ▶ Y.1731 – OAM Mechanisms ▶ G.8031 – Protection ▶ Y.17ethqos – QoS ▶ Y.ethperf - Performance |
|  <p>IETF</p> | <ul style="list-style-type: none"> ▶ RFC-2544 – Benchmarking Methodology for Network Interconnect Devices ▶ RFC-2819 – Remote Monitoring (RMON Etherstats) |
|  <p>TMF TeleManagement FORUM</p> | <ul style="list-style-type: none"> ▶ TMF814 – EMS to NMS Model |



Ethernet OAM Standards



MEF &
ITU Y.1731

Service Layer OAM (UNI to UNI)

IEEE 802.1ag,
MEF & ITU Y.1731

Connectivity Layer OAM

IEEE 802.3ah

Access Link OAM

Access Link OAM



Ethernet OAM Standards

| Services and Performance <i>(ITU Y.1731/MEF)</i> | Basic Connectivity <i>(IEEE 802.1ag,ITU)</i> | Transport/Link <i>(802.3ah EFM)</i> |
|--|---|--|
| Discovery Continuity check (keep alive) Loopback (non-intrusive and intrusive) AIS/RDI/Test Link Trace Performance management | Discovery Continuity check Loopback Link Trace | Discovery Remote failure indication: Dying gasp, link fault & critical event Remote, local loopback Fault isolation Performance monitoring with threshold alarms Status monitoring |

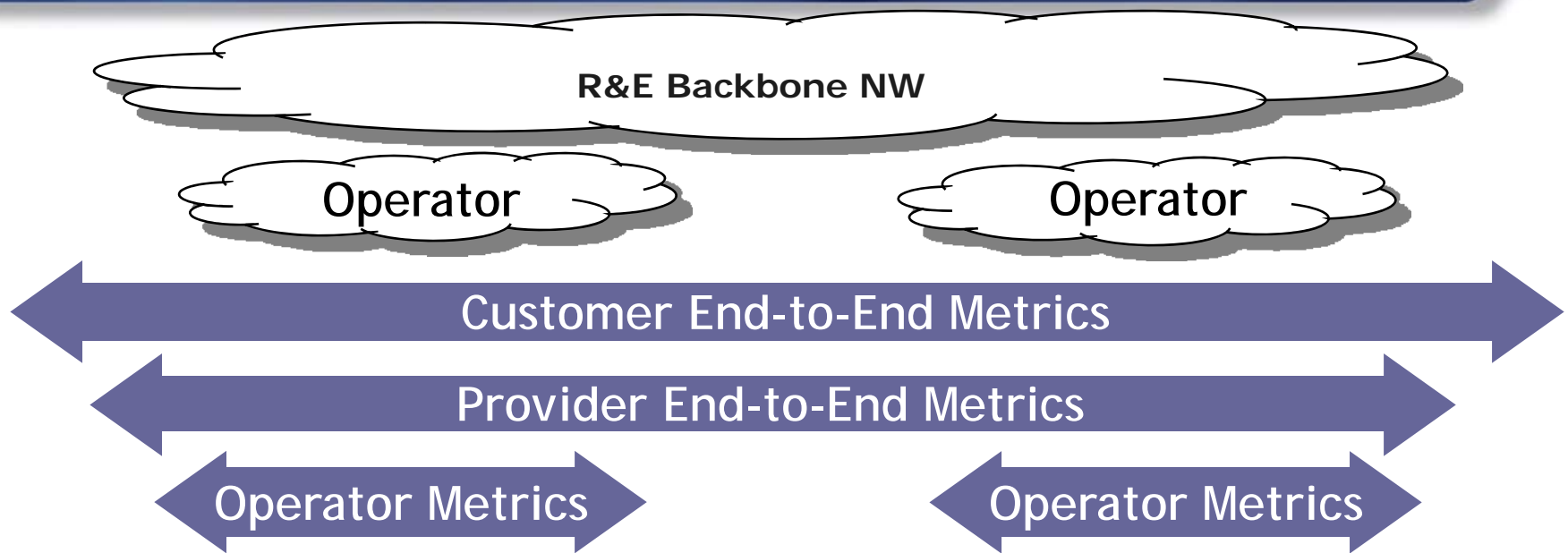


IEEE 802.3ah Ethernet in First Mile

- ▶ EFM standard completed in mid 2004
 - ▶ First Ethernet OAM standard completed
- ▶ Focused on point to point Ethernet link OAM
 - ▶ Does not propagate beyond the link
- ▶ Discovery
- ▶ Remote failure indication
 - ▶ Dying gasp, link fault & critical event
- ▶ Remote loopback
- ▶ Performance monitoring and threshold crossing alarms
- ▶ Ethernet OAM shares BW with data payload
 - ▶ Utilizes a “slow” protocol limited to 10 packets per second
 - ▶ OAMPDUs identified by MAC address and Ethernet Length/Type/subtype field
 - ▶ Uses a protocol sub layer between physical and Data link layers



IEEE 802.1ag Connectivity Fault Management (CFM)



- ▶ Partitions network into hierarchical administrative domains
 - ▶ Basic connectivity checking and troubleshooting across any domain, and across multiple domains at the same time
- ▶ Continuity checks – proactive service verification
- ▶ Loopbacks – layer 2 version similar to IP Ping
- ▶ Link trace – layer 2 version similar to Traceroute
- ▶ Recently completed standard



ITU Y.1731 EthOAM – Service Level OAM

- ▶ Builds on 802.1ag
- ▶ Discovery
- ▶ Continuity check (keep alive)
- ▶ Loopback (non-intrusive and intrusive)
 - ▶ Defect detection/localization
 - ▶ Performance verification
- ▶ Link trace
- ▶ AIS/RDI/Test – out of service verification
- ▶ Performance management for SLA verification
 - ▶ Frame loss
 - ▶ Frame delay
 - ▶ Frame delay variation
 - ▶ Others (errored frame seconds, service status (up/down), frame throughput, etc.)
- ▶ Also recently completed



Test/Monitoring Standards

- ▶ Metro Ethernet Forum (MEF)
 - ▶ Recommended key parameters for SLAs – MEF 10
 - ▶ Service availability, frames lost, frame delay, frame jitter
 - ▶ Defined the “what”, not the “how”
- ▶ RFC-2544
 - ▶ Out of service testing – followed by most test sets, some demarc devices
 - ▶ Frame loss, latency, throughput, back to back, reset
- ▶ Y.1731
 - ▶ Focused on end to end service (WAN)
- ▶ RFC-2819 - RMON Etherstats
 - ▶ Monitoring of local performance (e.g. node or LAN)



Remote Monitoring (RMON) RFC-2819

- ▶ Remote monitoring (RMON) provides a frame work of related standards for performance monitoring
- ▶ Introduces concept of “probe” or “monitor”
 - ▶ Initially stand-alone, now integrated into many devices
 - ▶ Completed 2000
- ▶ RMON-1 (RFC-2819) is focused on link layer (layer 2) monitoring
- ▶ Local performance monitoring (vs. end to end)
- ▶ Collected on port and EVC (VLAN) basis
- ▶ Includes parameters such as: Packet counts, multi-cast pkts, CRC errors, pkt size, collisions, jabber, etc.
- ▶ RMON designed for enterprise LAN applications



RFC-2544 Testing

Benchmarking Methodology for Network Interconnect Devices

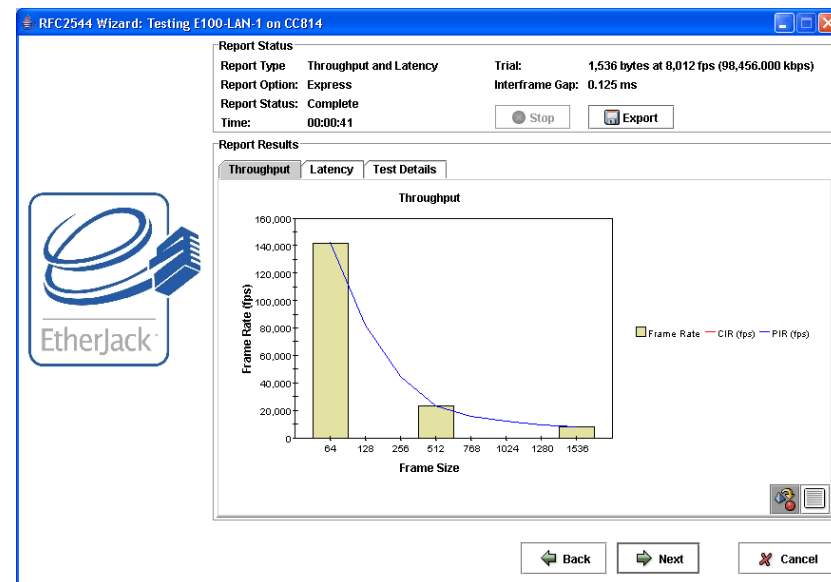
- ▶ Suite of tests for verifying Ethernet equipment
 - ▶ Now being used for Ethernet services

- ▶ Test suite is made up of:

- ▶ Throughput
- ▶ Latency
- ▶ Frame loss
- ▶ Back to back
- ▶ Reset

} **MEF SLA parameters**

- ▶ Results generally presented in graphical form
 - ▶ Each test is performed multiple times with different frame sizes

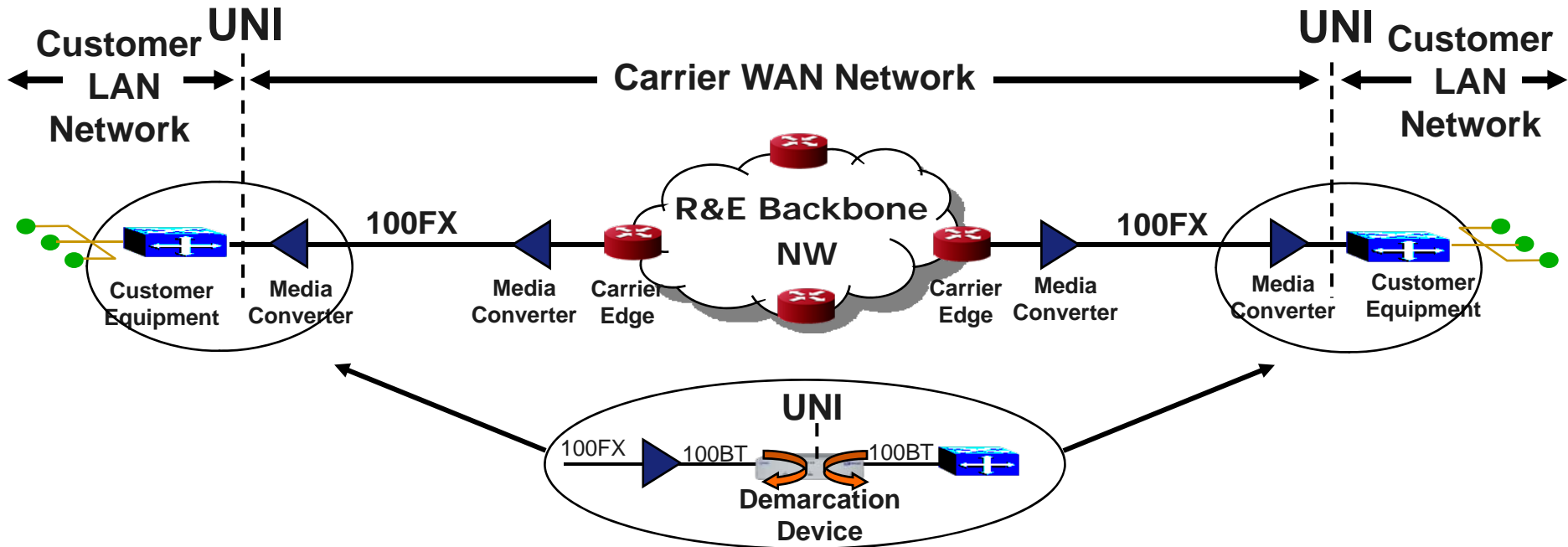


Poll Question

- ▶ Which test/management protocol do you currently use to manage Ethernet in WAN?
- A. RFC-2544 – Benchmarking Testing
- B. RFC-2819 – RMON
- C. 802.1ag/Y.1731 – CFM/EthOAM
- D. 802.3ah – EFM
- E. Other



What is Ethernet Demarcation?



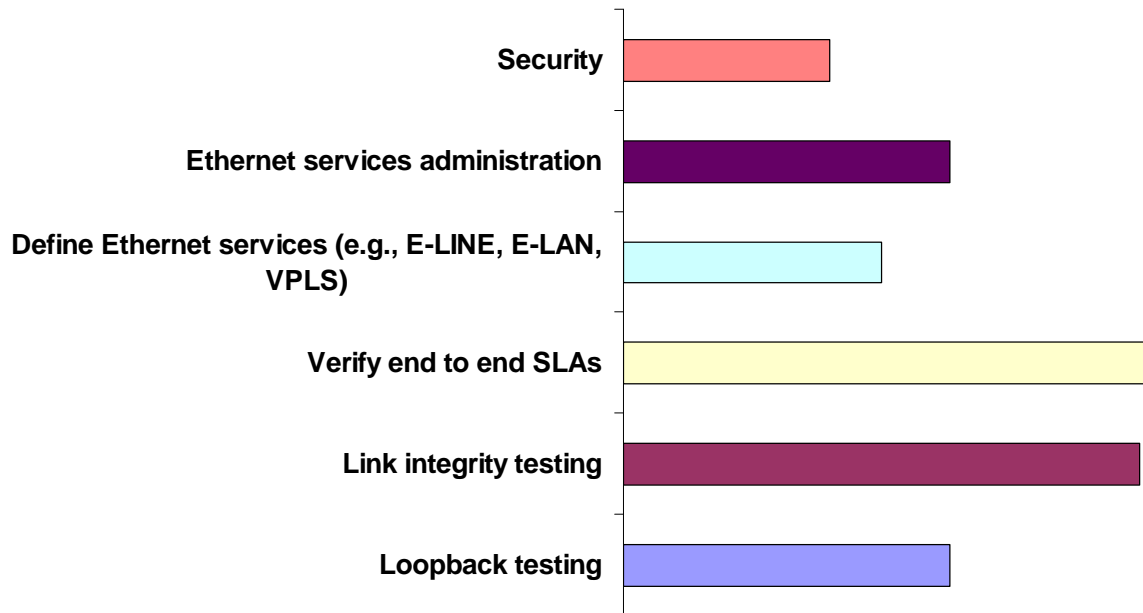
Ethernet Demarcation

- ▶ Necessary at carrier to customer interface (UNI)
- ▶ Provides separation between carrier WAN and enterprise LAN
- ▶ Enables testing and monitoring of both LAN and WAN
- ▶ Incorporates service UNI for traffic shaping & NID/NIU for OAM



Demarcation Device Usage

“For service providers in the audience, what are the three most important uses for Ethernet demarc points in your networks?”

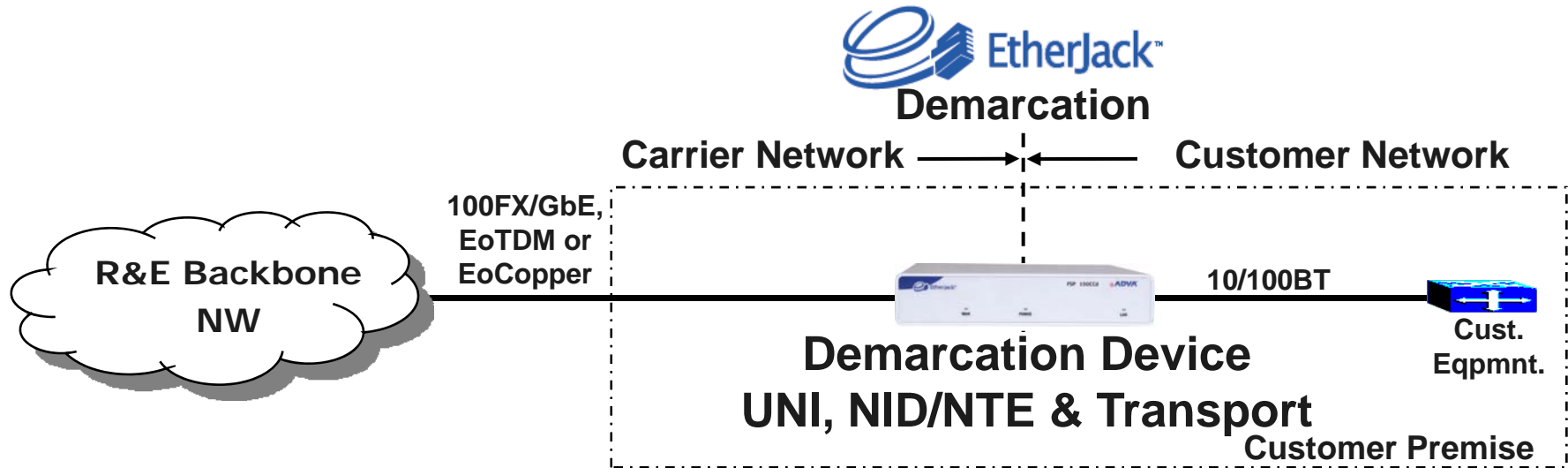


Light Reading Webinar 8/2006

Demarcation devices used by more than 50% of Ethernet carriers



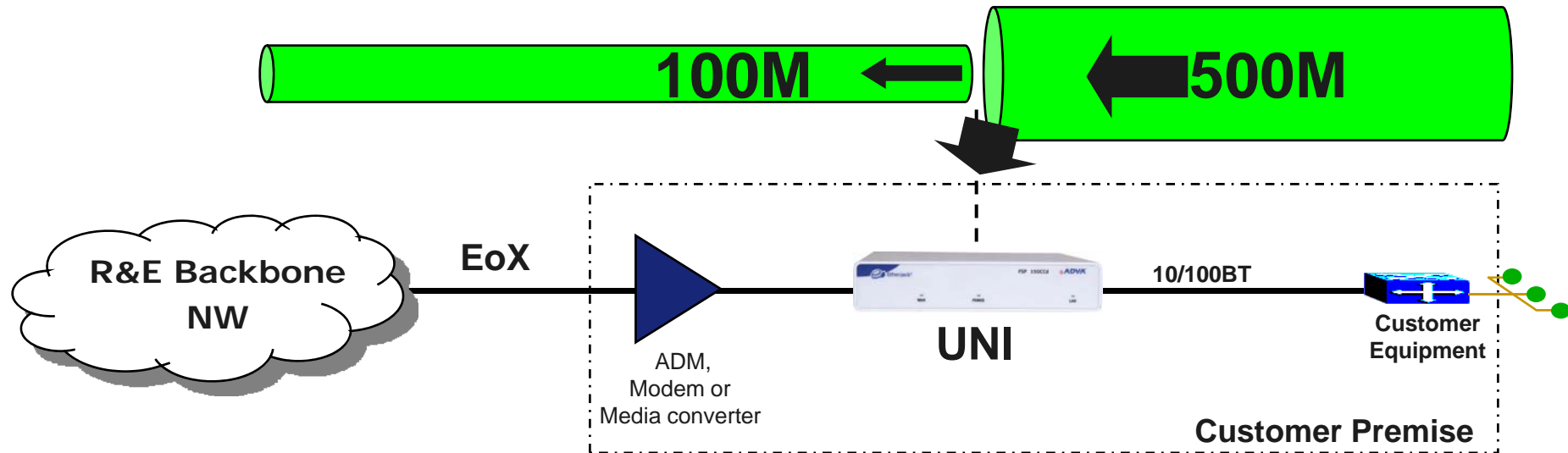
Ethernet Demarcation Device Functionality



- ▶ **Three key functions for Ethernet demarcation**
 - ▶ **Ethernet NID (Network Interface Device) or Network Termination Equipment (NTE)**
 - ▶ Link/Service layer Ethernet OAM – 802.3ah/802.1ag
 - ▶ **Ethernet Service UNI (User Network Interface)**
 - ▶ Service layer policing and definition – MEF/ITU
 - ▶ **Integrated first mile transport**
 - ▶ Extend Ethernet reach over Fiber (GbE/100FX), EoTDM (OC-n/STM-n, DS3/E3 or DS1/E1) or copper (EoDSL)



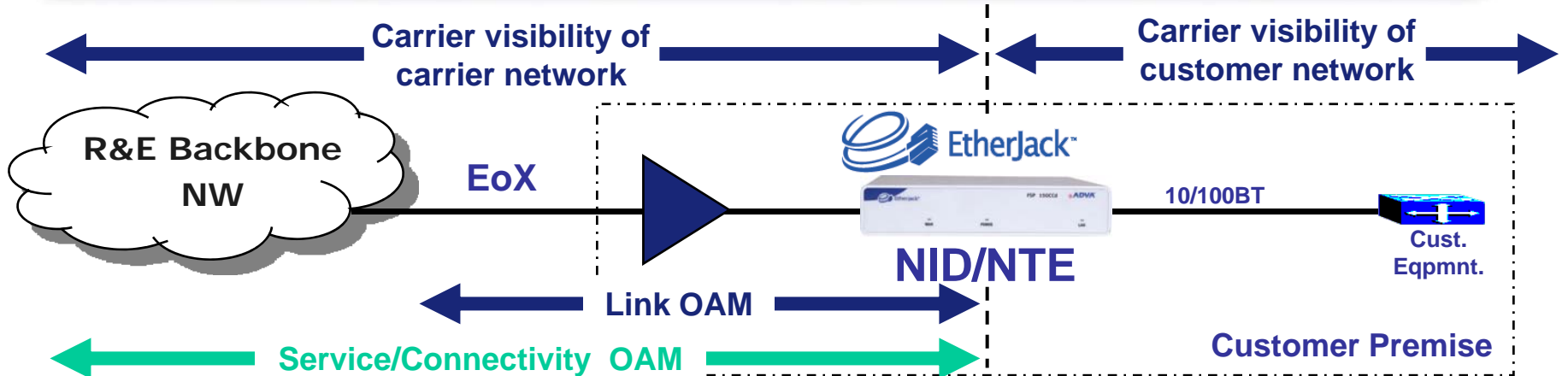
User Network Interface (UNI)



- ▶ **Required anytime rate limiting is performed**
 - ▶ Eg EoTDM, shared uplinks, multiple services, etc.
- ▶ **MEF based bandwidth profile on port/VLAN/Ethernet Virtual Circuit (EVC) basis**
 - ▶ CIR/EIR – Committed/Excess Information Rate
 - ▶ CBS/EBS – Committed/Excess Burst Size
- ▶ **Traffic classification/priority based on TOS/DSCP/802.1P/802.1Q/etc.**
 - ▶ Low latency handling of VoIP/video services
 - ▶ Ethernet Virtual Circuit (EVC) or VLAN support
 - ▶ 802.1Q & Q-in-Q - Add, remove, swap and stacking of VLAN tags



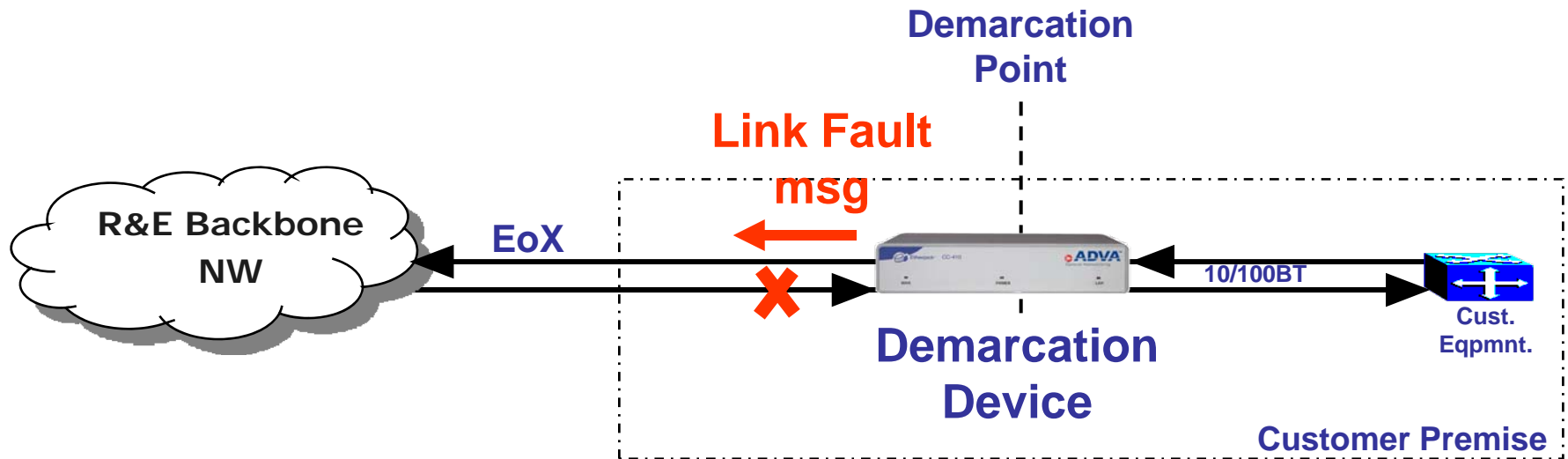
Network Interface Device (NID)



- ▶ **NID or NTE required at customer handoff for OAM**
 - ▶ Analogous to smartjack, CSU/DSU or NTE for frame relay
- ▶ **Link OAM (EFM - IEEE 802.3ah) is necessary but not sufficient**
 - ▶ Performance monitoring and threshold crossing alarms
 - ▶ Remote failure indication - Dying gasp, link fault & critical event
 - ▶ Remote loopback (Port)
- ▶ **Services OAM (ITU Y.1731) /Connectivity OAM (CFM IEEE 802.1ag)**
 - ▶ SLA Monitoring/Performance monitoring
 - ▶ Continuity verification
 - ▶ Service level loopback
 - ▶ AIS/RDI or fault propagation
 - ▶ Test head to generate test suites (RFC-2544)
 - ▶ Cable integrity test for customer premise



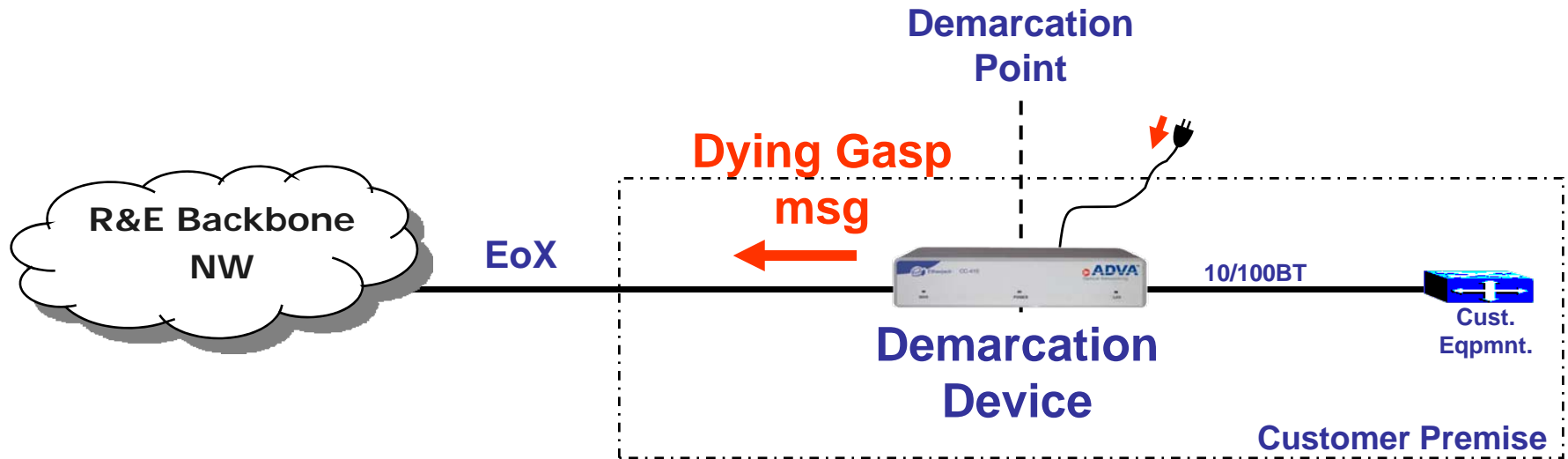
Remote Failure – Link Fault/Critical Event



- ▶ **Link Fault** – eg Loss of signal is detected by the receiver
 - ▶ Sent once per second
- ▶ **Critical Event** – Manufacturer specified failure eg hardware or software alarm
 - ▶ Sent immediately and continuously



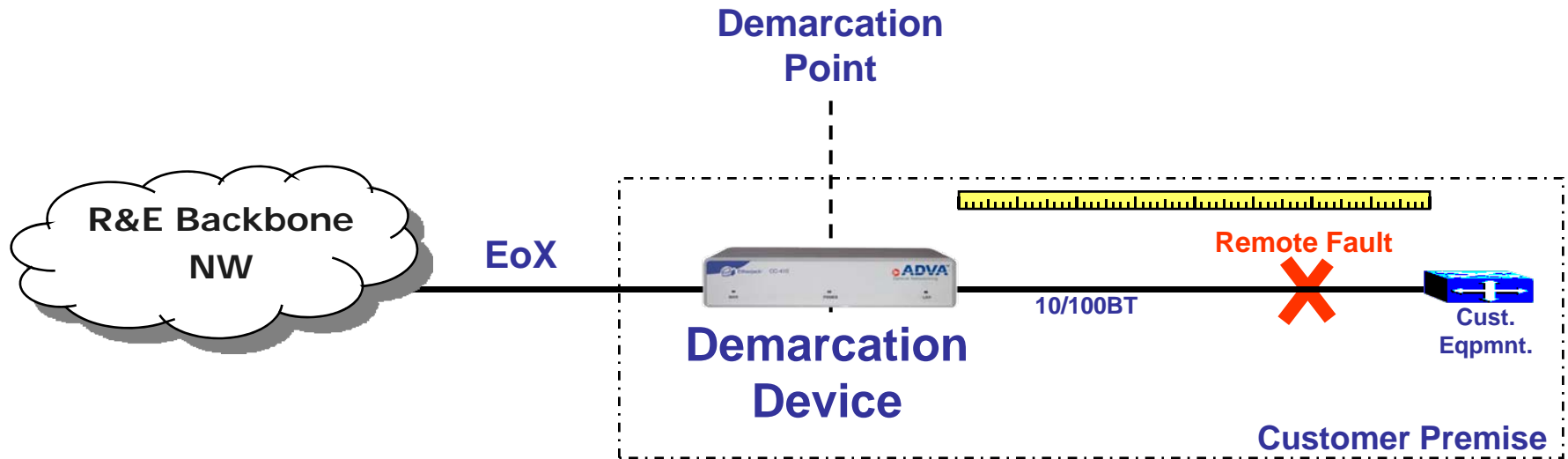
Remote Failure - Dying Gasp



- ▶ Signals carrier that an unrecoverable local fault (e.g. power failure) has occurred
- ▶ Sent immediately and continuously
- ▶ Critical for both AC and DC powered customer premise located equipment



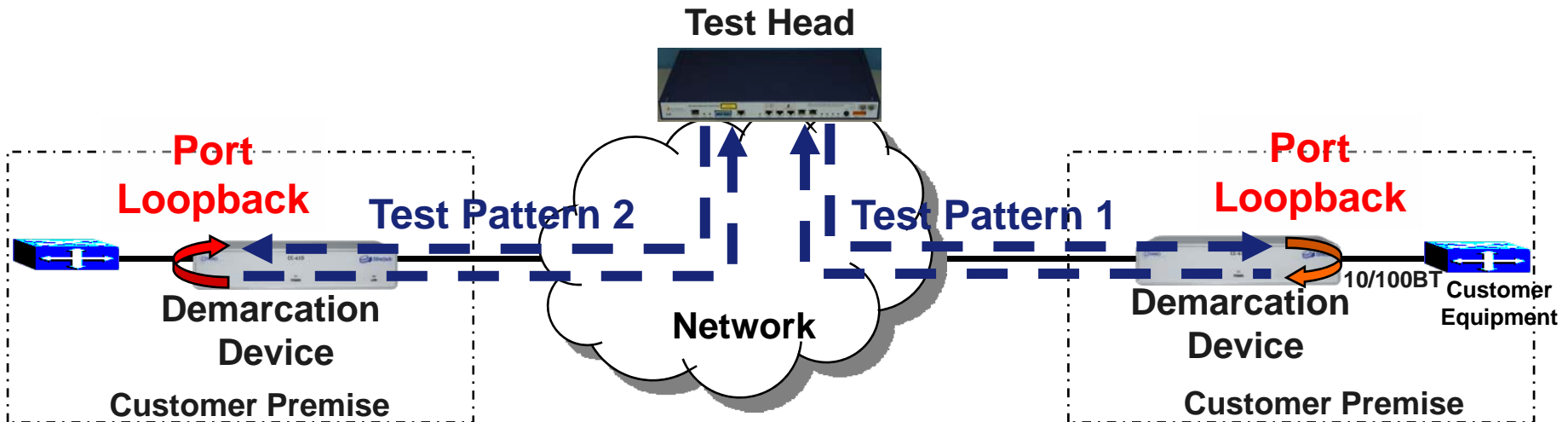
Cable Integrity Testing



- ▶ Identifies opens, shorts and impedance problems with CAT-5 cable on customer premise
- ▶ Measures distance to cable fault
- ▶ Addresses large percent of customer induced issues



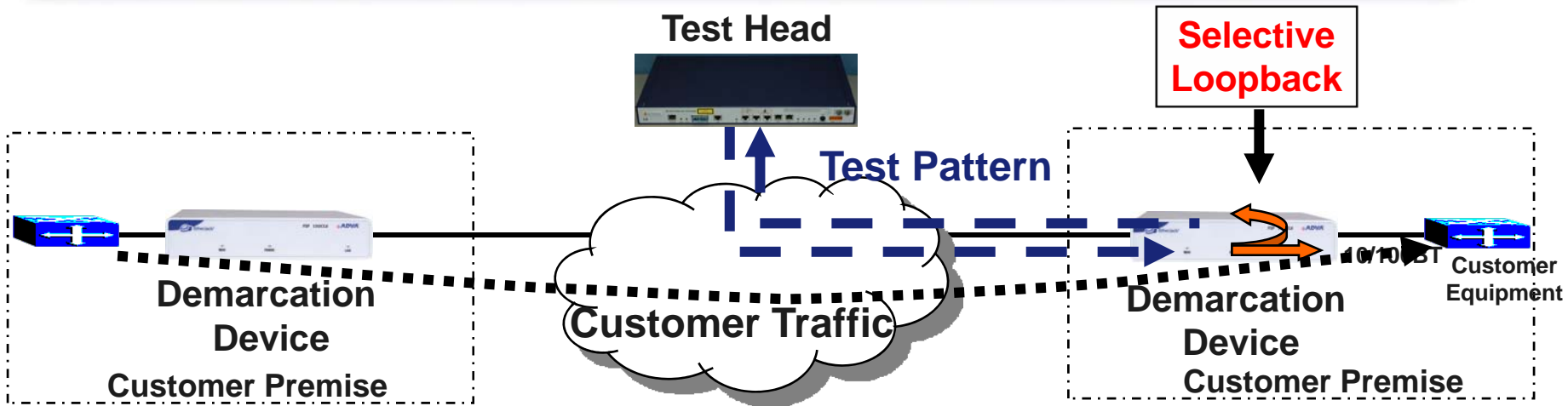
Port Loopback



- ▶ Port level (intrusive) testing is ideal for turn up and commissioning
 - ▶ Eliminates truck rolls
- ▶ Works with central test head to perform RFC-2544 tests
 - ▶ Measures performance (delay, dropped packets, throughput, etc.)



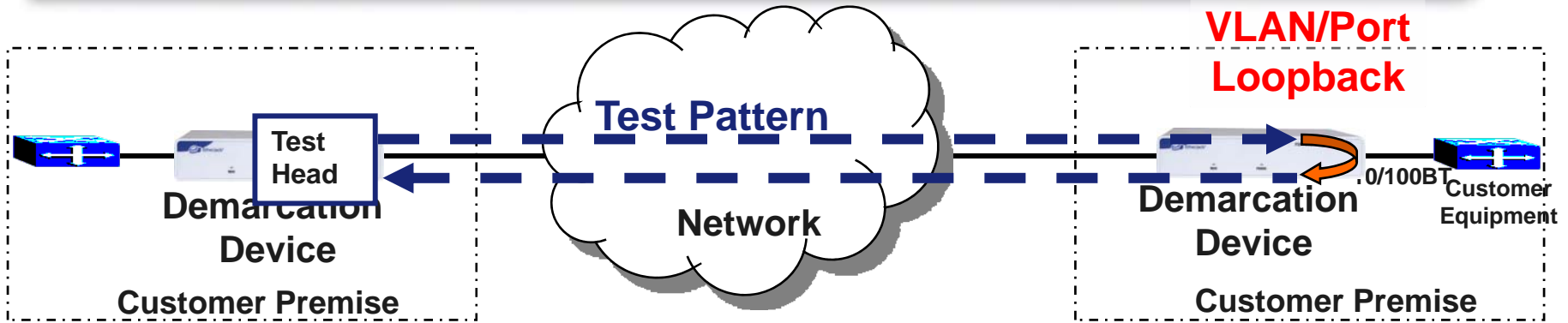
Selective (Non-Intrusive) Loopback



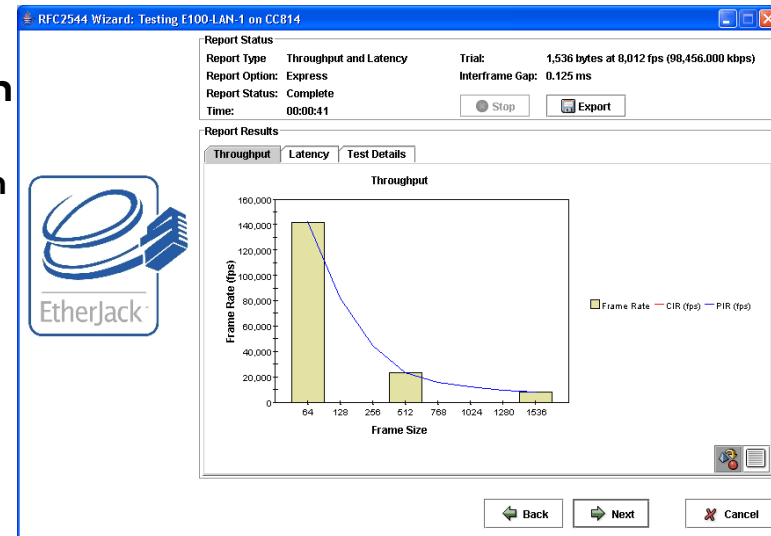
- ▶ Selective loopback performed on VLAN or specific OAM frames (e.g. opcode: ETH_LB)
- ▶ Test an individual EVC (VLAN) while remaining EVC's are in-service
- ▶ Also used for continuity check and service assurance
 - ▶ Far-end test head executes test periodically on non-service affecting VLAN or OAM frame to verify end to end connectivity through entire network – similar to ping
 - ▶ Can measure delay, throughput, dropped frames of end-to-end service – follows actual data path (LSP, etc.) of customer traffic



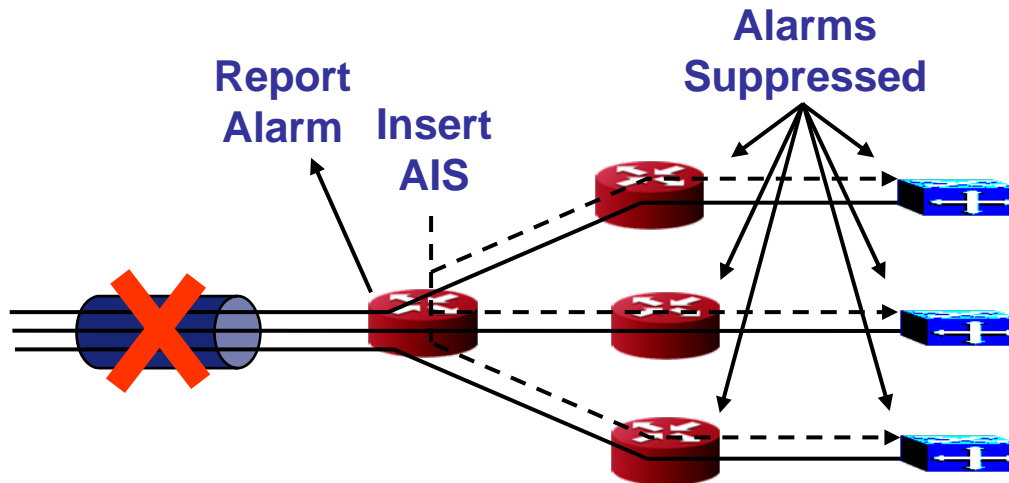
Ethernet Test Head



- ▶ Demarc device provides an embedded test generation function
 - ▶ EVC (VLAN) or port based test patterns
- ▶ Tests end to end data path over actual data path
 - ▶ Eliminates truck rolls to end user site
 - ▶ Works with far-end port/VLAN loopback to perform end to end testing for turn-up or fault isolation
- ▶ Executes RFC-2544 test suites to measure:
 - ▶ Number of frames received
 - ▶ Proper frame sequence and headers
 - ▶ Received traffic rate
 - ▶ Transmission delay
- ▶ Supports 4 key SLA parameters:
 - ▶ Availability, delay, delay variation, dropped traffic



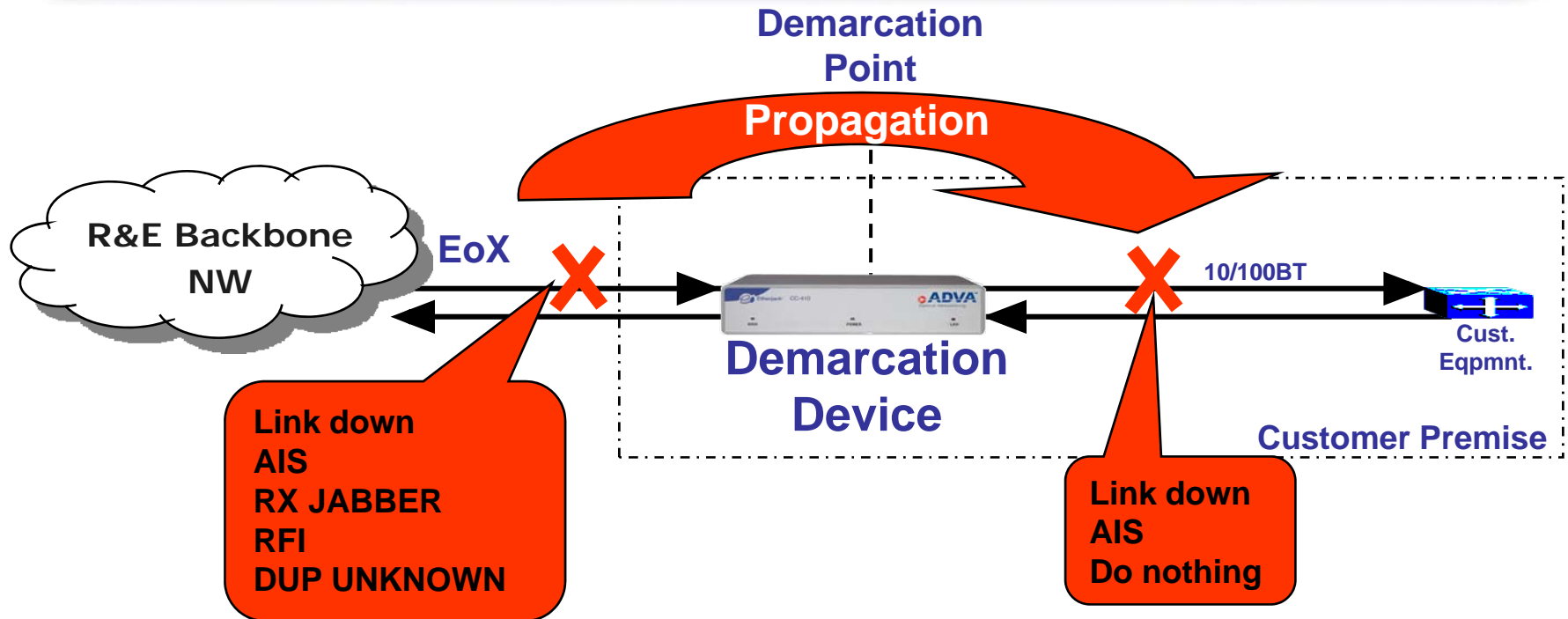
Ethernet AIS/RDI – Y.1731



- ▶ Used to suppress downstream alarms and eliminate alarm storms from a single failure
- ▶ Commonly used in legacy services like SONET, TDM, frame relay, etc.



Fault Propagation

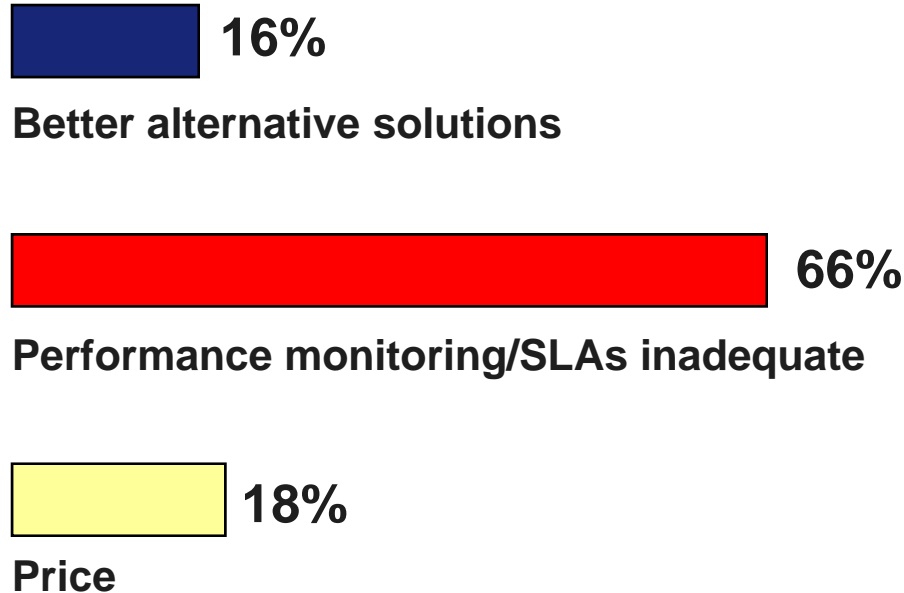


- ▶ **Fault Propagation allows upstream link issues to propagate downstream**
- ▶ **Critical for end user applications that need visibility of network issues**
 - ▶ **Eg Redundant routing protocols (HSRP)**



Carrier Ethernet Challenges

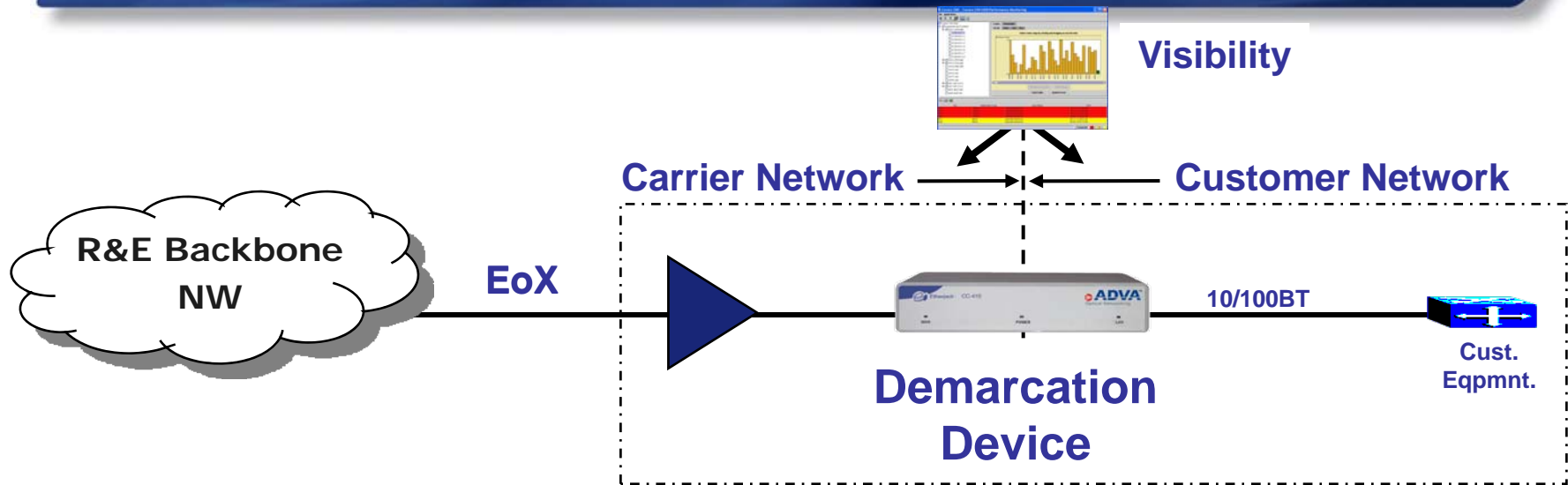
What is holding service providers back from deploying Ethernet more aggressively?



Source: Light Reading Webinar 2006



RMON RFC-2819

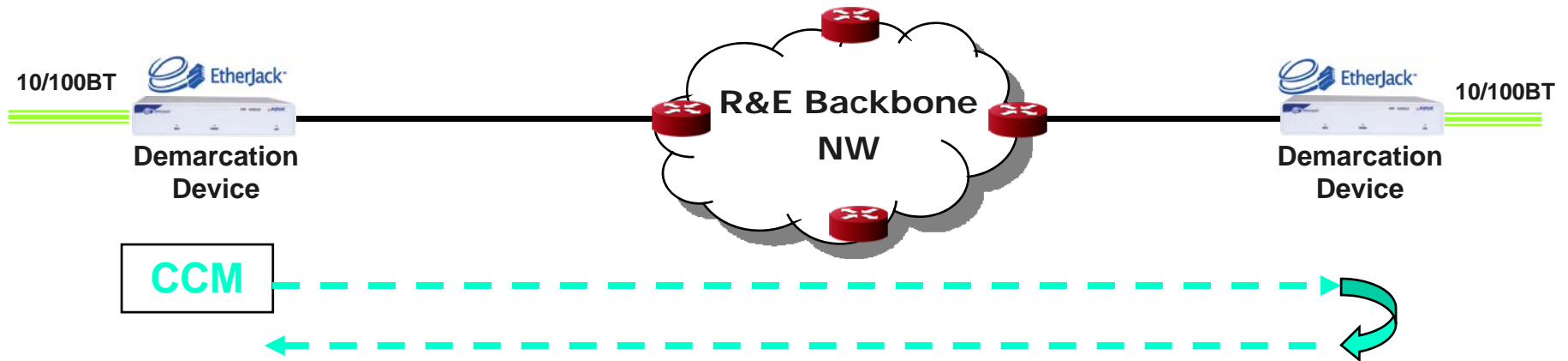


- ▶ Local performance monitoring
- ▶ Collected on port and EVC (VLAN) basis
 - ▶ From both sides of demarcation point
 - ▶ Includes parameters such as: Packet counts, multi-cast pkts, CRC errors, pkt size, collisions, jabber, etc.
- ▶ RMON designed for enterprise LAN applications – also need:
 - ▶ Discarded packets (out of SLA), average bit rate parameters, ingress vs. egress BW, etc.



CFM SLA Monitoring Techniques

- ▶ Based on Continuity Check Messages (CCM) in 802.1ag (CFM) and Y.1731
 - ▶ Sent 1/Second – Fault Management
 - ▶ Sent 10/Second – Performance Monitoring
 - ▶ Sent 300/Second – Protection Switching

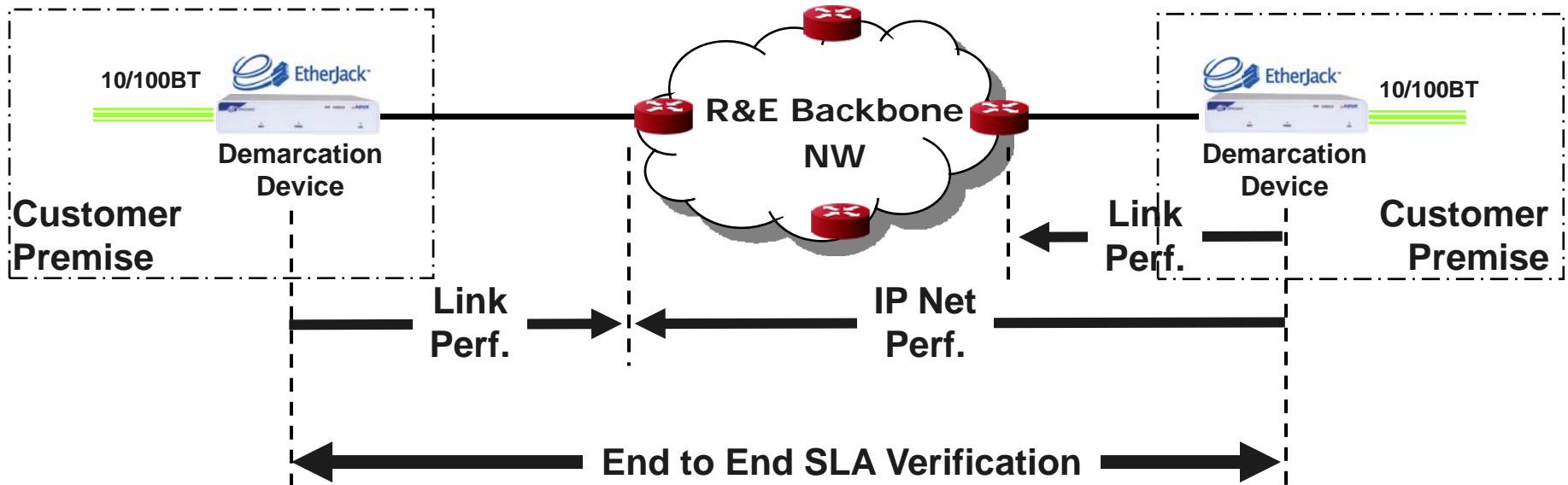


Frame Delay, Delay Variation, Frames Lost, Service Availability



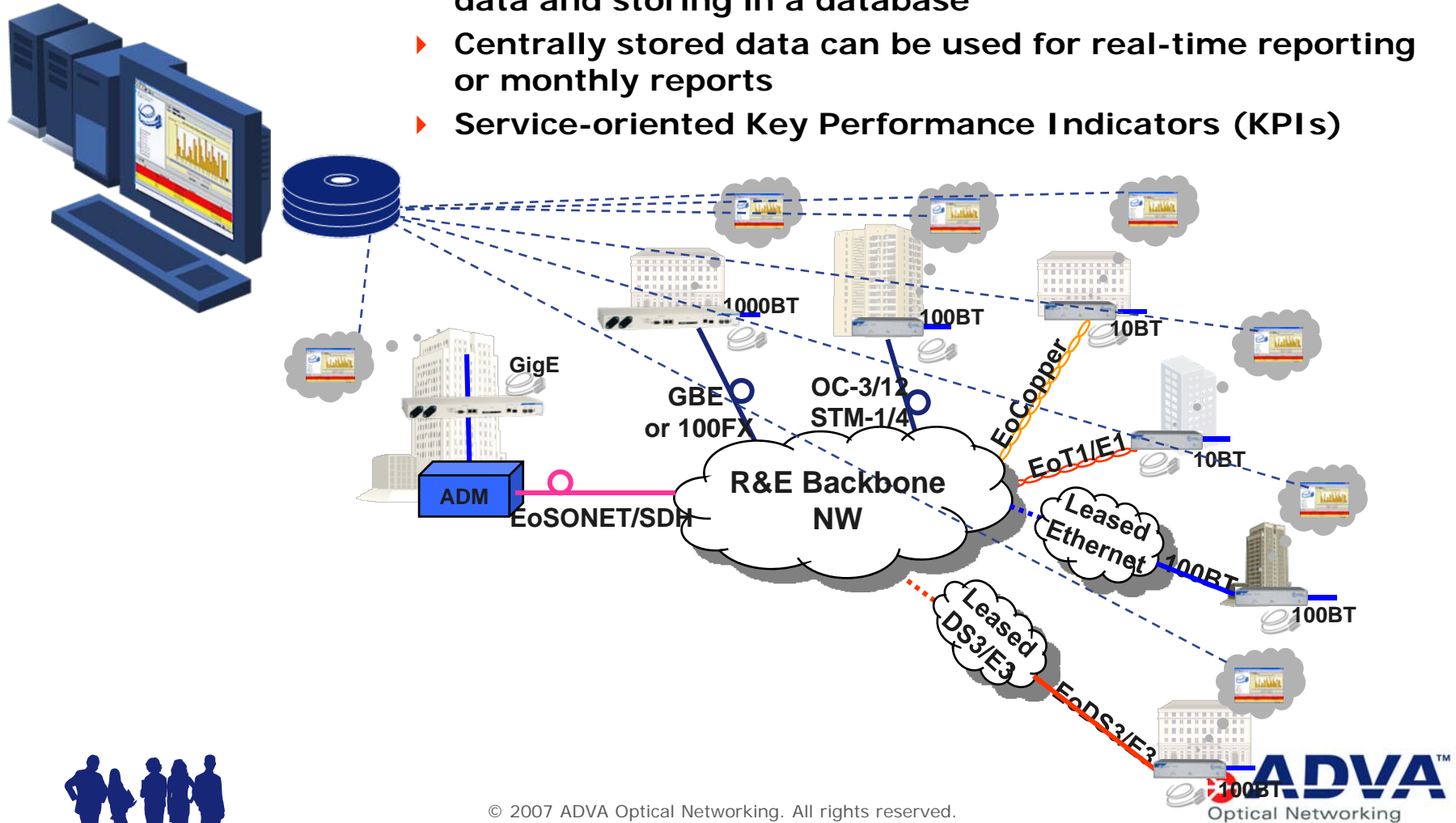
SLA Verification

- ▶ End to end SLAs are critical for carrier grade Ethernet services
 - ▶ Service availability, frame delay, frame jitter and dropped frames
 - ▶ Both round trip and 1 way basis
- ▶ Standards provide tools for SLA measurement – 802.1ag, ITU Y.1731
- ▶ Emerging technology – Ethernet demarcation devices required to measure end to end SLAs



Performance Management OS

- ▶ Complements SLA measurement by demarcation devices
- ▶ Centralized tool for collecting performance monitoring data and storing in a database
- ▶ Centrally stored data can be used for real-time reporting or monthly reports
- ▶ Service-oriented Key Performance Indicators (KPIs)



Summary

- ▶ OAM standards for Ethernet in the WAN have come a long ways to support Ethernet in the WAN
- ▶ Remotely located demarcation devices are key to implementing these new standards
- ▶ With a full suite of OAM, Ethernet becomes a much more intelligent service



Questions???



Thank You

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FSP 150 Ethernet access solution

Key applications

- ▶ Demarcation: Differentiated, dedicated or shared Ethernet services
- ▶ Extension: Ubiquitous Ethernet service delivery over any media
- ▶ Aggregation: Secure carrier-class Ethernet transport access network with up to 1:1000 aggregation ratio

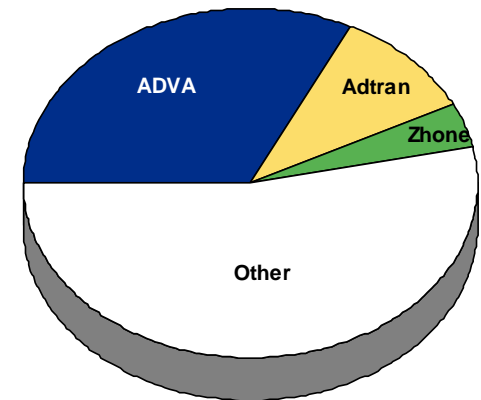
Key benefits

- ▶ **Intelligent Ethernet:** differentiated service delivery with full end-to-end SLA monitoring for mission critical applications
- ▶ **Ubiquitous Ethernet:** Support for a variety of fiber and copper transport standards allows service to be delivered in region and out of region

ADVA is the largest Ethernet access vendor in the world (>100K deployed fiber demarcation devices)



Worldwide Total Ethernet Access Device Revenue Market Share



Source: Infonetics 2007

