A Report on MPLS Interoperability

The MPLS/FR Alliance

An industry-wide association of networking and telecommunication companies focused on advancing the deployment of multi-vendor Multi-Service Label-switching networks and associated applications.

MPLS Interoperability & Scalability Showcase
MPLS World Congress, Paris, February 2003

- **Organized by:**
  MPLS Forum Interoperability Committee & European Advanced Network Test Center (EANTC)
- **in cooperation with:**
  ETSI Interoperability Service
- **hosted by:**
  Upperside

The Event

- **Areas Covered:**
  - ✓ **Layer 3 VPN scalability and interoperability**
  - ✓ **Layer 2 Transport scalability and interoperability**
  - ✓ **Fast Reroute interoperability**
- **Protocols Covered:**
  - ✓ **RSVP-TE**
  - ✓ **LDP (also tunneled in RSVP-TE)**
  - ✓ **MP-iBGP**
  - ✓ **RSVP-TE tunnels protected by Fast Rerouting**

    [OSPF-TE used as routing protocol]

The Participants

Agilent Technologies	RouterTester
Alcatel	7770 OBX
Avici Systems	QSR SSR
Cisco Systems	7206VXR 12404
Data Connection	DC-MPLS, DC-BGP, DC-OSPF, DC-VPN Manager
IXIA	1600T

NetPlane	Powercode OPTIRoute LTCS
Nortel Networks	Shasta 5000 BSN
Quallaby	Proviso
RAD Data Communications	IPmux-1
Redback	SmartEdge 800
Riverstone Networks	RS8000
Spirent	AX4000

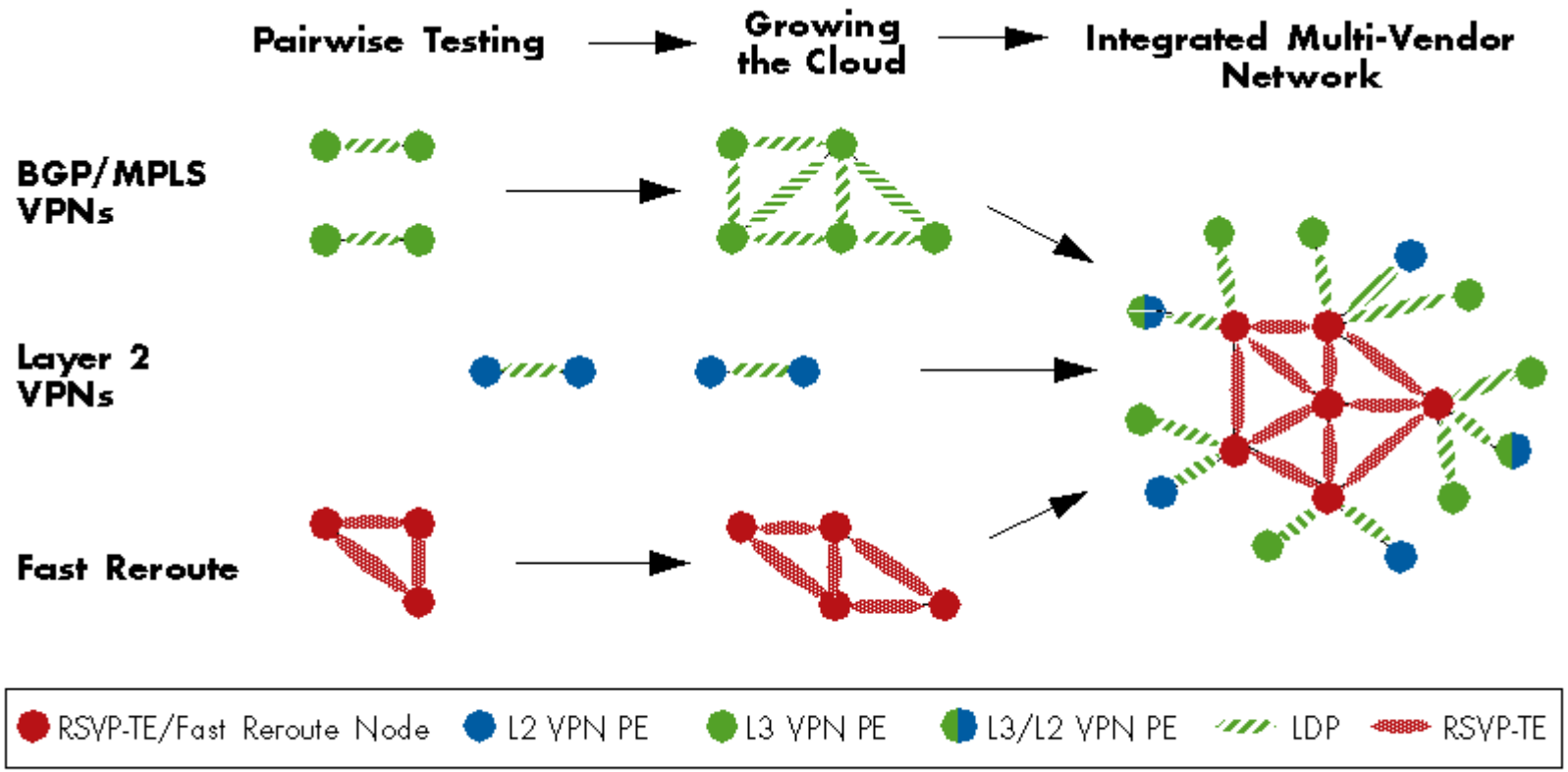
The Test Plan

- **Based on experiences of the interop event at Supercom, June 2002**
  - ✓ **Extended the test plan to cover new new areas**
    - **BGP/MPLS VPN +** scalability
    - **Ethernet/VLAN over MPLS +** scalability
    - Detour and Facility backup (Reroute)
- **Designed by the Interoperability Working Group of the MPLS Forum**

Building the Network

- Testing was started in protocol-specific groups of 2 or 3 vendors.
- Once one-on-one interoperability issues were resolved, the groups were connected to construct the network.
- Scalability tests started already in small groups.

Network Evolution



Evolution Of Test Stages

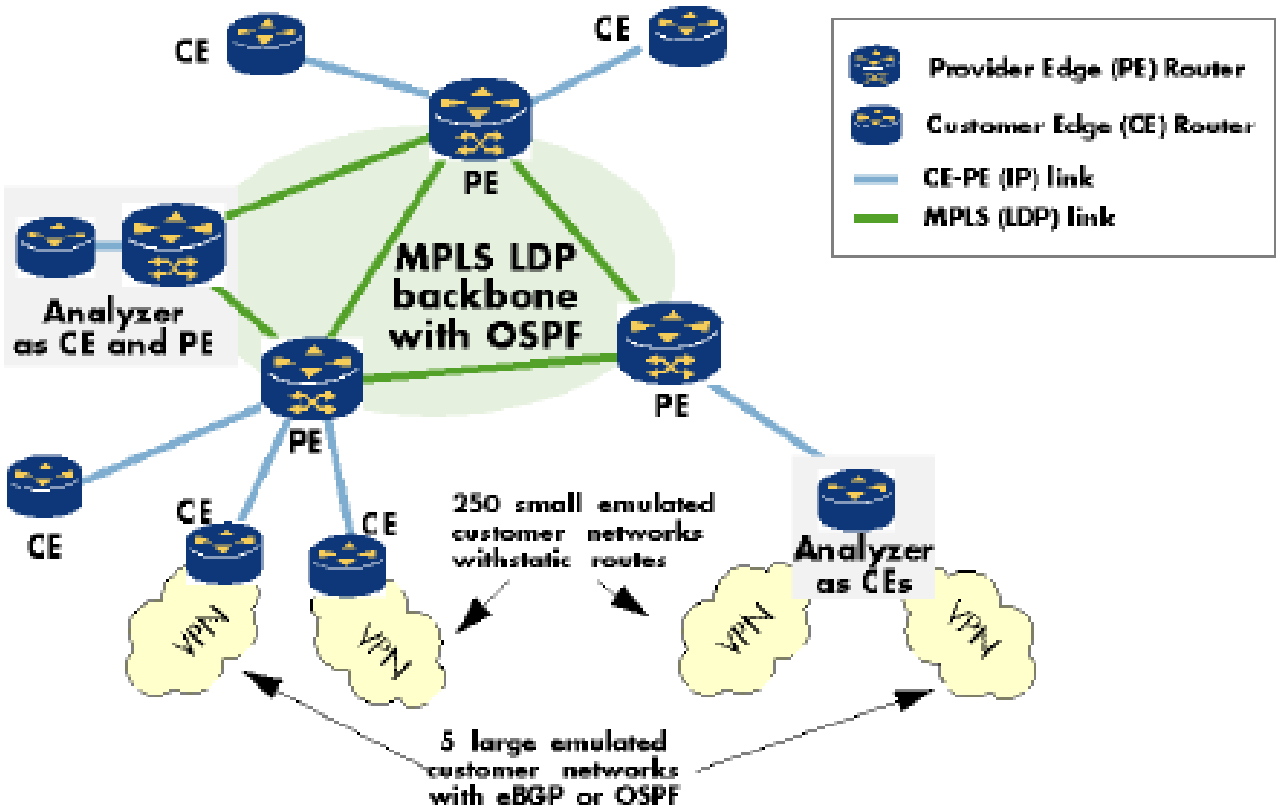
What is Scalability?

- **Goals**
  - ✓ **Define a typical service provider scenario.**
  - ✓ **Have a realistic number of VPNs and routes per VPN at each PE.**
  - ✓ **Tunnel VPN traffic through the backbone (LDP over RSVP-TE)**
- **Non-Goals**
  - ✓ **Performance Tests**
    - **Achieve the maximum number of VPNs/routes**

VPN Scalability - a first!

- **BGP/MPLS VPNs**
  - ✓ **255 VPNs**
  - ✓ **1000 routes per VPN in 10 VPNs, plus 10 routes per VPN in 245 VPNs**
  - ✓ **Distribution considered for HQ and remote sites**
- **Ethernet VLAN “Martini” Transport tunnels**
  - ✓ **200 of 802.1q “pseudo-wires” per PE**

VPN Scalability Test Scenarios



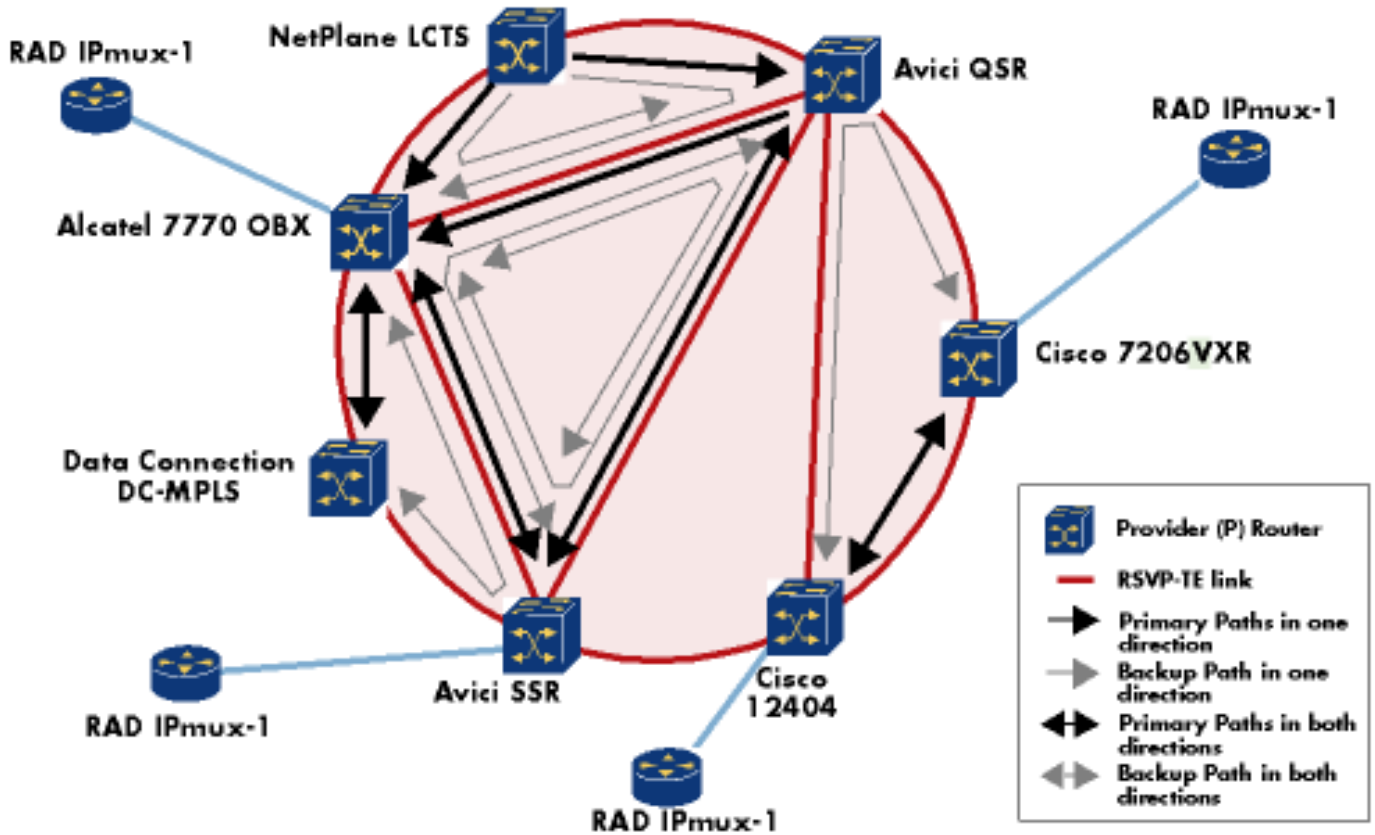
Topology for MPLS/BGP VPN Tests

Fast Reroute Interoperability

- IETF's Fast Reroute draft
- Two options
  - ✓ Facility (Bypass)
  - ✓ Detour
- Reroute to backup LSP due to primary failure

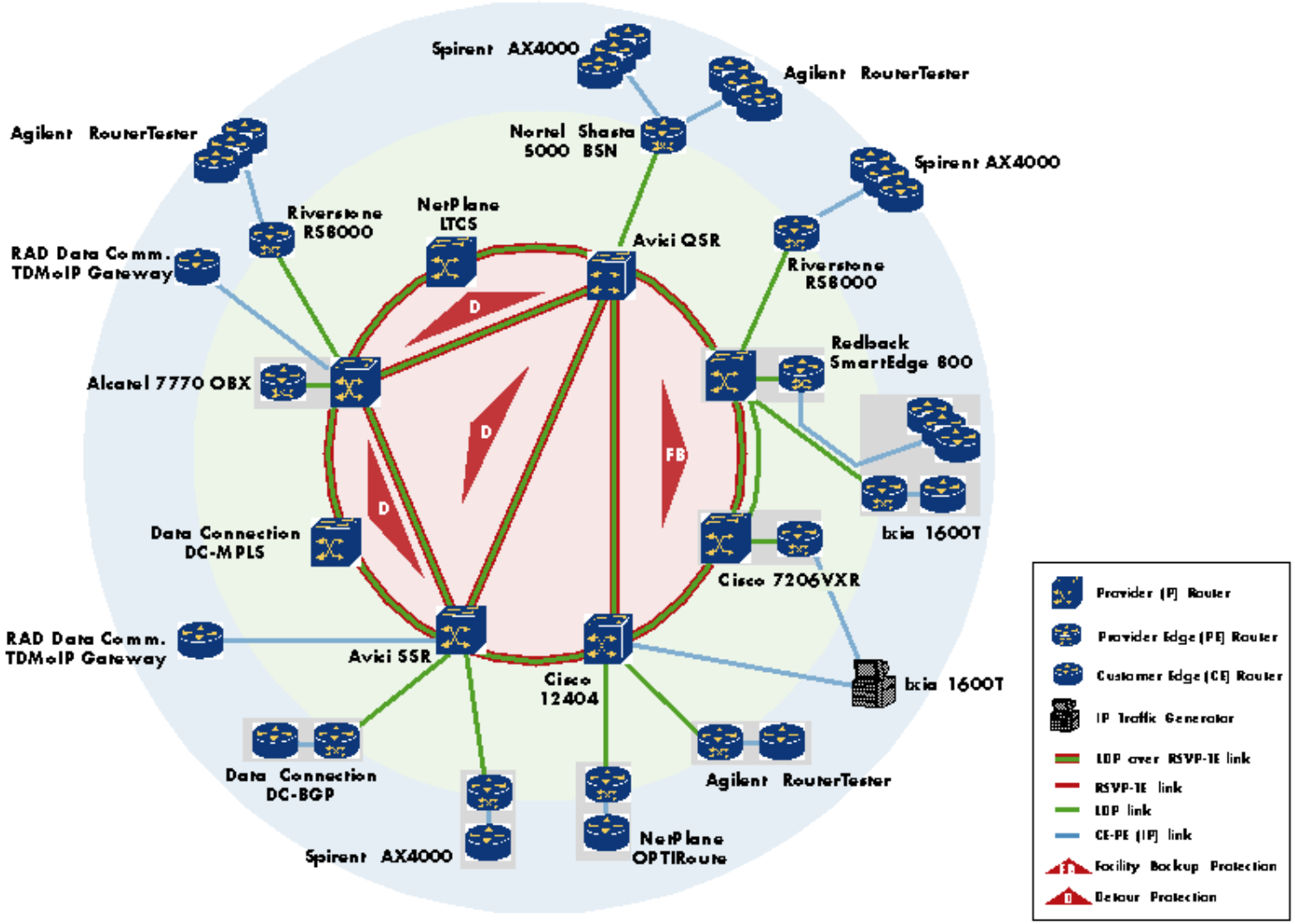
➢ Used TDM over IP application and load generators to verify the fast reroute time is indeed sub 50 ms

Fast Reroute Test Topology



Topology for Fast Rerouting Tests

The Final Network



Test Results

Key Features Tested		Results
L2 VPNs	Interoperability Ethernet VLANs	OK
	Scalability 200 Ethernet VLANs	OK
	Data Transfer	OK
L3 VPNs	Interoperability LDP	Most combinations interoperable
	Interoperability MP-BGP	OK
	Scalability 255 VPNs	All implementations reached 255 VPNs
	Scalability 10–1000 routes per provider edge	All implementations reached 10 VPNs x 1000 routes (BGP/OSPF routing) plus 245 VPNs x 10 routes (static routing)
	Data Transfer through VPNs	A few combinations tested; no issues found
Fast Reroute Interoperability Detour and Facility Backup		Backup tunnels established in most cases, switch-over verified (< 50 ms, SDH grade resiliency)
LDP over RSVP-TE Tunnel Interoperability		Unresolved configuration issues in a couple of cases

Protocol Issues

- **There were issues with RSVP-TE signaling and OSPF-TE**
  - ✓ **All devices need to provide support for OSPF-TE.**
- **There were issues with LDP signaling.**
  - ✓ **There should be agreement to the label ranges that are used over Ethernet links.**
  - ✓ **There should be agreement on the label range on each device vs. label range per interface.**

Fast Reroute Issues

- **Detour Backup**
  - ✓ **Current Fast Reroute draft has no recommendation for backward compatibility of class types in FRR object (between different draft versions)**
- **Facility Backup**
  - ✓ **Merge Point LSRs not aware that they are on a protected path in case of interface-specific label space, hence doesn't merge paths till failure – this is a possible signaling issue?**

Summary of the event

- ✓ **Presented that MPLS VPN technology is interoperable and scalable**
- ✓ **Demonstrated the two fast reroute modes in a common backbone**
- ✓ **Verified the fast reroute times (below 50ms on POS).**

Provided further reassurance in MPLS networking technology

Supercomm, Atlanta, June 2003

Enabling a Multi-Service Future: **From Vision to Value**

- **Organized by:**
  MPLS Forum Interoperability Committee
- **Staged by:**
  Interoperability Laboratory, University of New Hampshire (IOL-UNH)

SUPERDemo 2003

- **Focus on demonstrating multivendor interoperability in the following areas:**
  - ✓ **Frame Relay over MPLS**
  - ✓ **ATM over MPLS**
  - ✓ **Ethernet/VLAN over MPLS**
  - ✓ **BGP/MPLS VPN**
  - ✓ **Virtual Private LAN Services (VPLS)**
  - ✓ **MPLS Fast Reroute (FRR)**
- **New interoperable, scalable Services while offering Service Guarantee**

19 Participating Products

- Alcatel 7670 Routing Switch Platform (RSP)
- Alcatel 7770 Optical Broadband Exchange (OBX)
- Agilent RT900
- Agilent Network Ananlyzer
- Cisco GSR 12404
- Cisco GSR 12406
- Ixia 400Tand 1600T
- Juniper M40e
- Juniper ERX 1440
- Laurel ST200
- Marconi BXR-48000
- Marconi ASX-4000
- Nortel Passport 15000
- Nortel Shasta 5000 Broadband Service Node (BSN)
- RAD IPmux
- Riverstone RS 8000
- TiMetra SR-Series Service Router
- Vivace Viva1050

Test Scenarios

- Fast Reroute was tested in the Core
- Three MPLS service scenarios tested in isolation and then implemented across a core MPLS network:
- Layer 2 point to point Transport services:
  - ✓ ATM (Cell and AAL5 modes)
  - ✓ Frame Relay (Transport mode)
  - ✓ Ethernet (Port and VLAN modes)
- Virtual Private LAN service (VPLS)
- BGP/MPLS VPN service

Test Plan Preparation

- Agilent Technologies
- Avici Systems
- European Advanced Network Testing Center (EANTC)
- Laurel Networks
- Metanoia
- Netplane Systems
- Tenor Networks
- TiMetra
- University of New Hampshire Interoperability Lab

Core Participants

- Alcatel 7770 OBX
- Cisco GSR 12406
- Juniper M40e
- Marconi ASX-4000
- Marconi BXR-48000

Fast Reroute

Detour Fast Reroute

- Alcatel 7770 OBX
- Juniper M40e
- Marconi BXR-48000

Bypass Fast Reroute

- Cisco 12404
- Alcatel 7770 OBX
- Cisco 12406

Transport Services

Service	Participant List
FR over MPLS	Agilent RT900, Cisco GSR 12404, Ixia 400T, Juniper ERX 1440, Laurel Networks ST200, Vivace Viva1050
ATM over MPLS	Agilent RT900, Cisco GSR 12404, Ixia 400T, Juniper M40e, Laurel ST200, Vivace Viva1050
Ethernet VLAN over MPLS	Agilent RT900, Cisco GSR 12404, Ixia 400T, Juniper Networks M40e, Juniper ERX 1440, Laurel ST200, Riverstone RS 8000, Vivace Viva1050

VPN Services

Service	Participant List
BGP/MPLS VPN	Alcatel 7770, Alcatel 7670, Agilent RT900, Cisco GSR 12404, Ixia 400T, Juniper M40e, Juniper ERX 1440, Laurel ST200, Nortel Passport 15000, Nortel Shasta 5000 BSN, Riverstone RS 8000
VPLS	Agilent RT900, Ixia 400T, Riverstone RS8000, Timetra SR-Series Service Router

Scalability Results

Service Type	Scalability Number achieved per PE	Participating companies
BGP/MPLS VPN	250	11
FR over MPLS Transport	500	6
ATM over MPLS Transport	500	6
Ethernet/VLAN over MPLS Transport	700	8
VPLS	1	4

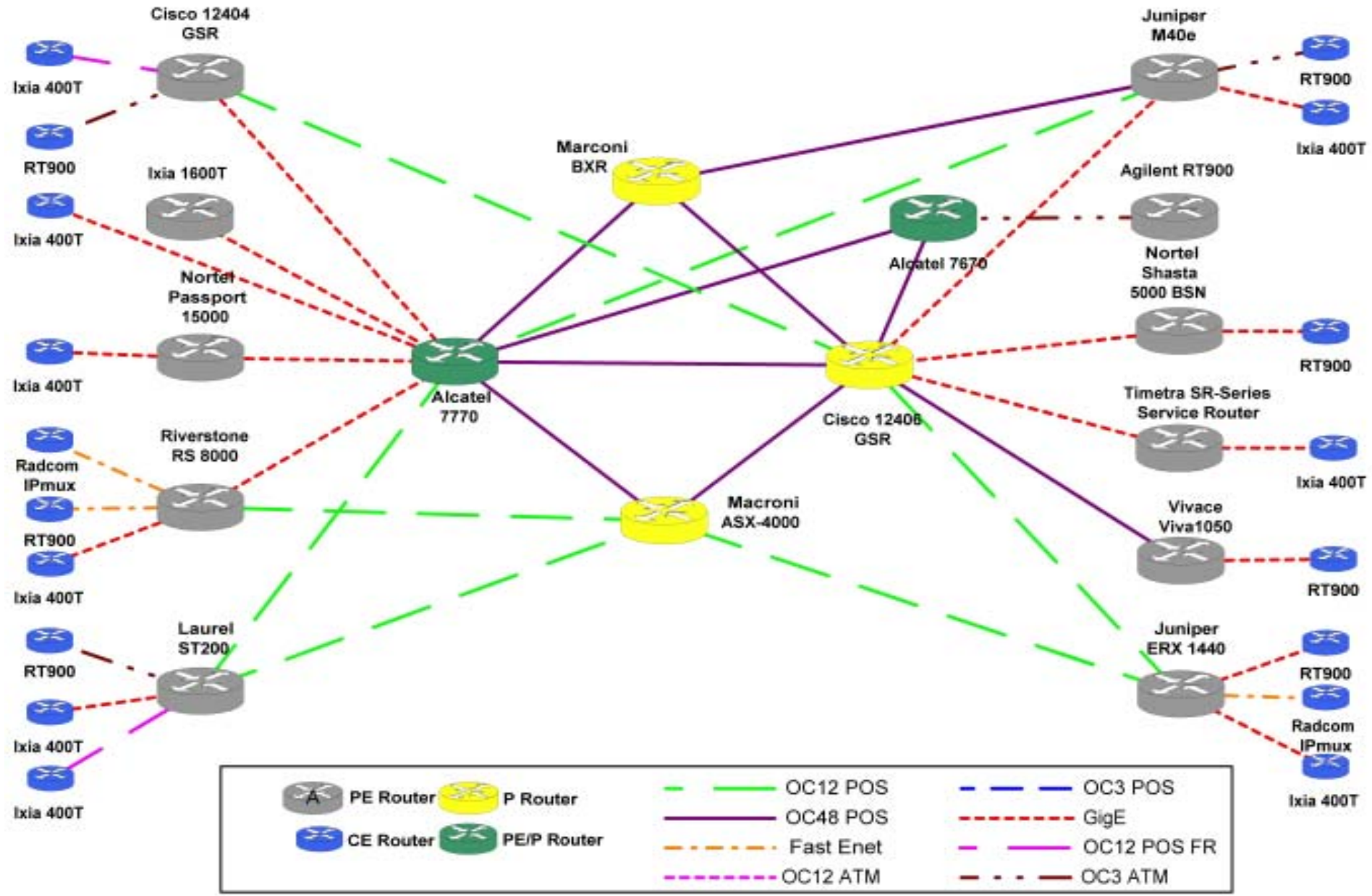
Traffic Generators

- Agilent RT900
- Ixia 400 & 1600T
- RAD IPmux

The Results

- **Interoperability achieved!**
- **Scalability achieved!**
- **Resiliency tested!**
- **A few issues were identified – read the white paper**

SuperDemo Test Network Topology



Summary

The multi-service future is a reality,
Fulfilling the promise of MPLS

All white papers available at:
http://www.mplsforum.org/tech/library.shtml

Upcoming Events!

- **MPLS World Congress 2004, Paris, France February 10-13, 2004**
  - ✓**Topic: Quality of Service from MPLS**
  - ✓**Hot Stage in late January, at EANTC, Berlin**
- **ICBN (International Conference on Broadband Networking) 2004, Kobe, Japan April 7-9, 2004**
  - ✓**Topic: To be decided (relevant to Japanese and Asian service providers)**

Thank You!

http://www.mplsforum.org