



GMPLS-Based Dynamic Provisioning and Traffic Engineering of High-Capacity Ethernet Circuits in Hybrid Optical/Packet Networks



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Xi Yang
Tom Lehman

Chris Tracy
Jerry Sobieski



University of Southern
California/Information
Sciences Institute
(USC ISI)

University of Maryland
Mid-Atlantic Crossroads
(UMD MAX)



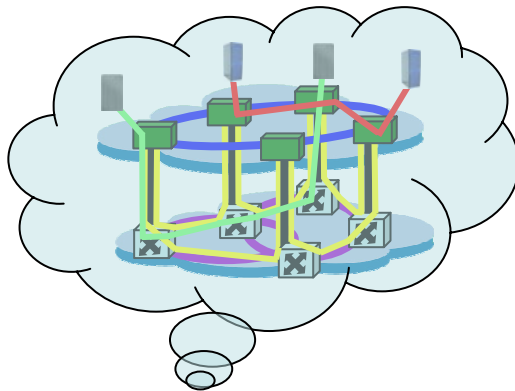


Outline

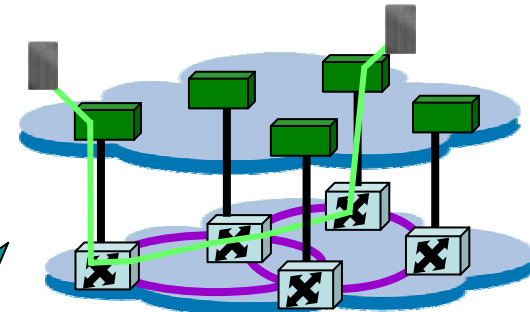
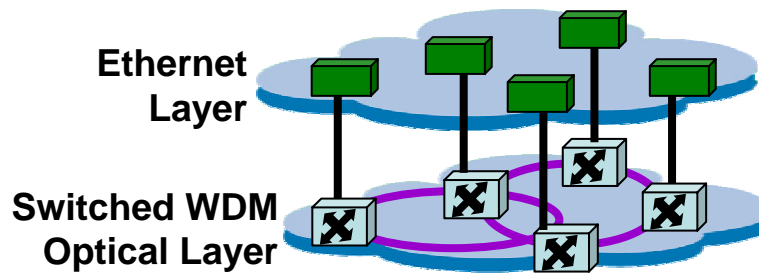
- GMPLS Control Plane Research and Testbed Activities
- Ethernet Service Provisioning via GMPLS
- Research Issues and Future Services
- Summary



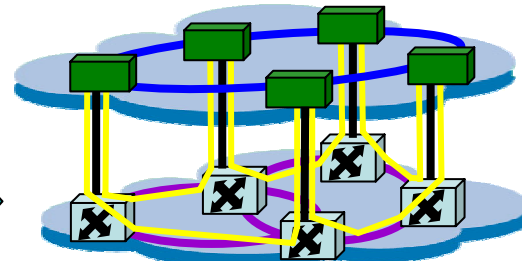
The Vision: One Infrastructure Multiple Topologies/Services



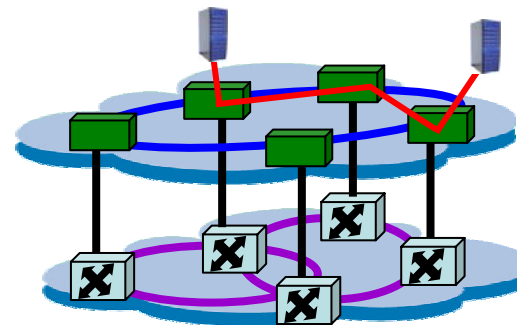
Multi-Layer GMPLS Network



“ Ethernet Framed Lambda ”



“Basic Ethernet Service”

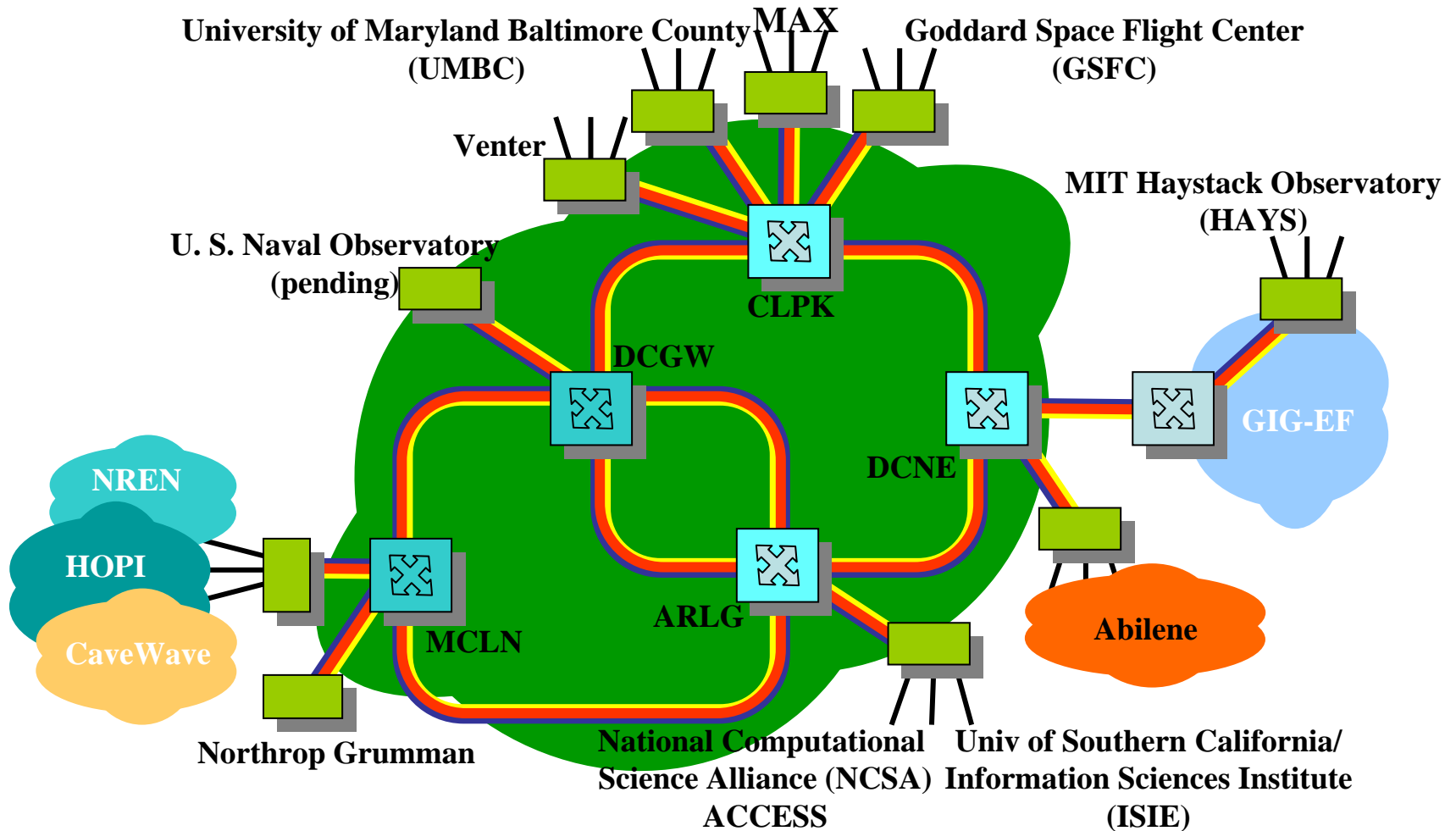


“Dedicated VLAN Connection over Ethernet”



The DRAGON Testbed

Washington, DC, USA metro region



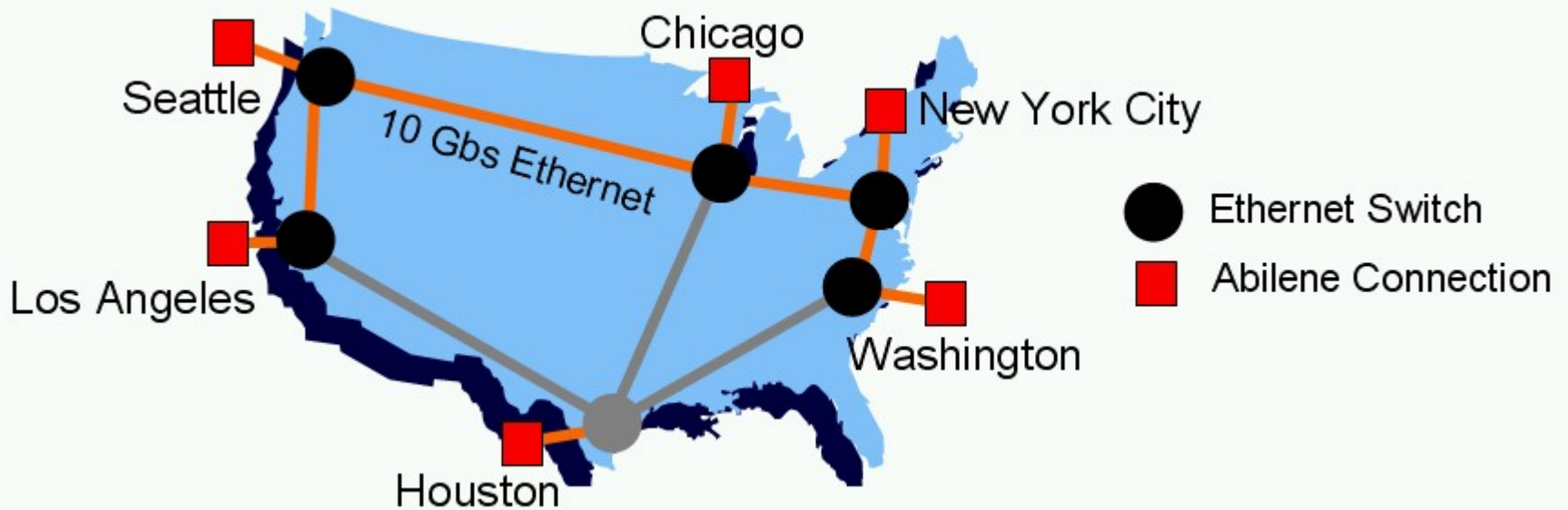


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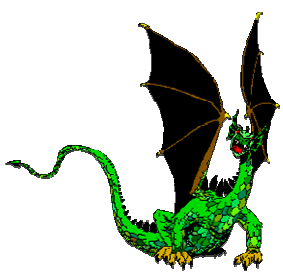
Single-Slide Overview

- Principal Investigators
 - Jerry Sobieski - Mid-Atlantic Crossroads (MAX)
 - Tom Lehman - USC/ Information Sciences Institute (ISI East)
 - Bijan Jabbari - George Mason University (GMU)
- Commercial Partner – MOVAZ Networks
- NSF Funded program
 - Testbed deployed in the Washington DC region
- GMPLS based control plane
 - Dynamic provisioning across heterogeneous network technologies
 - Fiber (FSC), Lambda (LSC), SONET (TDM), Ethernet (L2SC), Packet (LSC)
 - Multi-layer Traffic Engineering
 - Open Source Software
 - Interdomain Provisioning (routing, path computation, signaling)
 - Authentication, Authorization, Accounting (AAA)
 - Scheduling
- <http://dragon.maxgigapop.net>

Internet 2's Hybrid Optical Packet Infrastructure (HOPI)

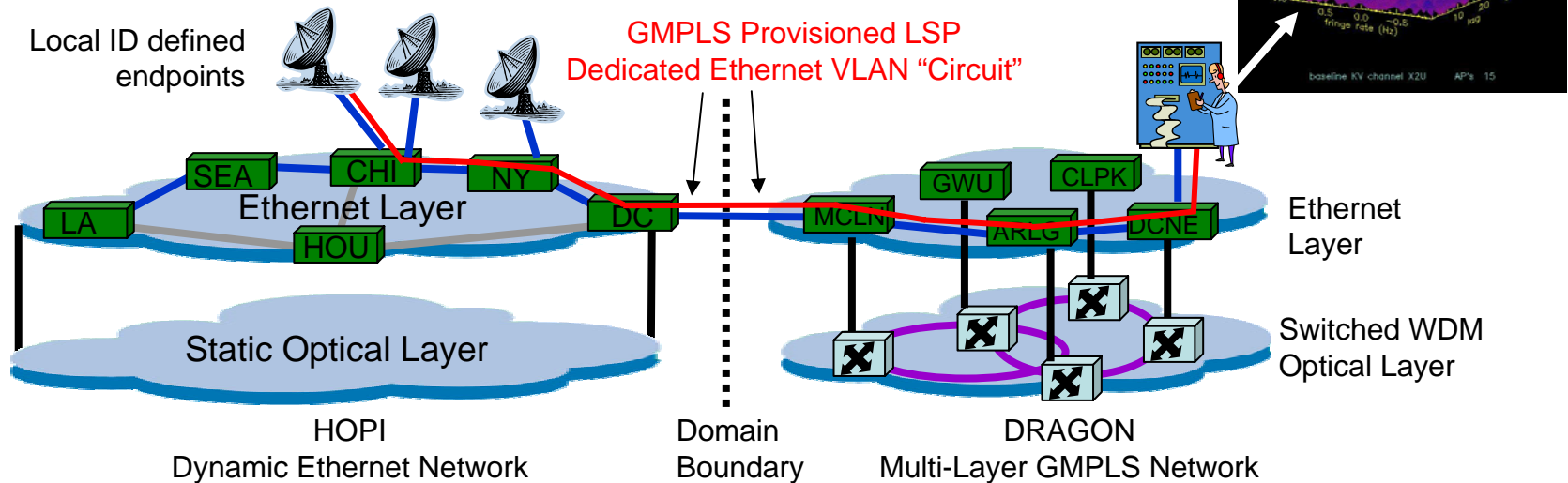


- Footprint across United States
- Ethernet Switches on top of National Lambda Rail (NLR) infrastructure
- Ten Gigabit/s backbone
- Multiple One and Ten Gigabit connections at sites for users, regional networks, and Abilene connection
- networks.internet2.edu/hopi



DRAGON/HOPI Control Plane Provisioning Environment

- GMPLS Multi-layer, Multi-Domain
- Ethernet Service Provisioning
- Dynamic dedicated VLAN based connections





DRAGON Control Plane

Key Components

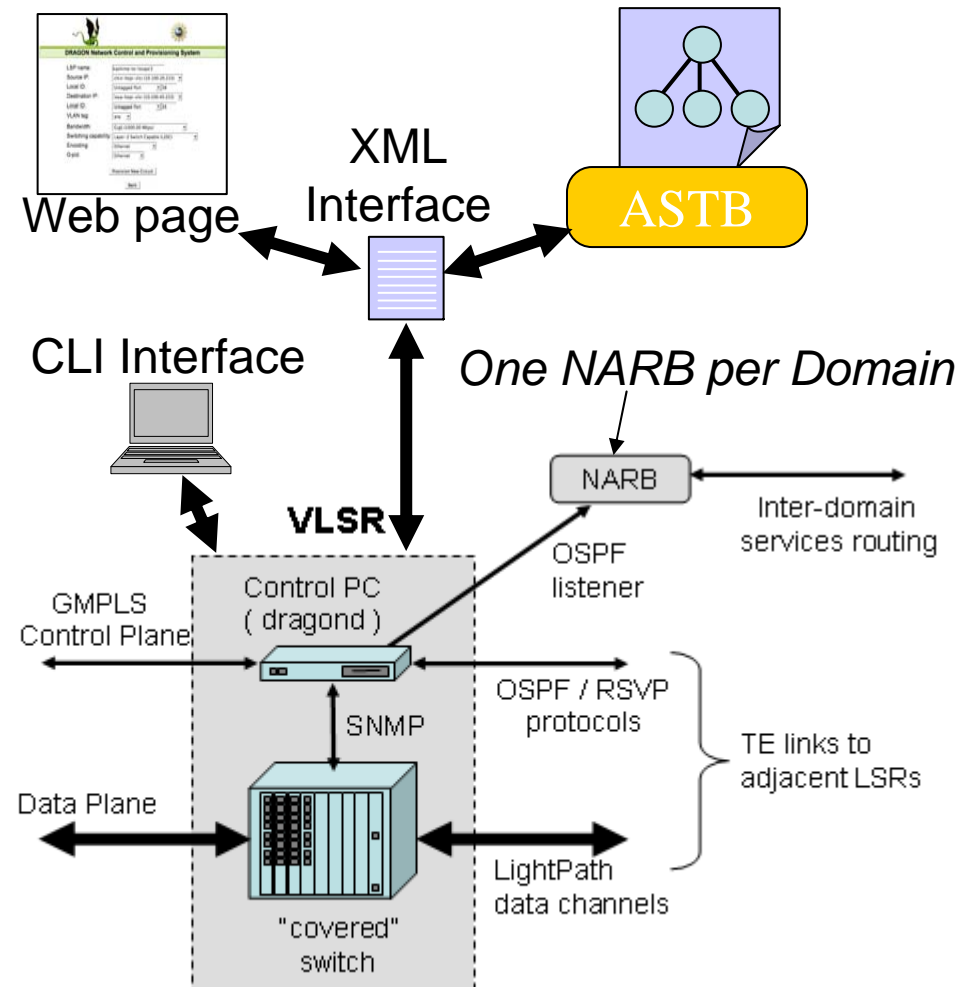
- Network Aware Resource Broker – **NARB**
 - Intradomain listener, Path Computation, Interdomain Routing
- Virtual Label Swapping Router – **VLSR**
 - Open source protocols running on PC act as GMPLS network element (OSPF-TE, RSVP-TE)
 - Control PCs participate in protocol exchanges and provisions covered switch according to protocol events (PATH setup, PATH tear down, state query, etc)
- End System Agent – **ESA**
 - End system or client software for signaling into network (UNI or peer mode)
- Application Specific Topology Builder – **ASTB**
 - User Interface and processing which build topologies on behalf of users
 - Topologies are a user specific configuration of multiple LSPs



DRAGON

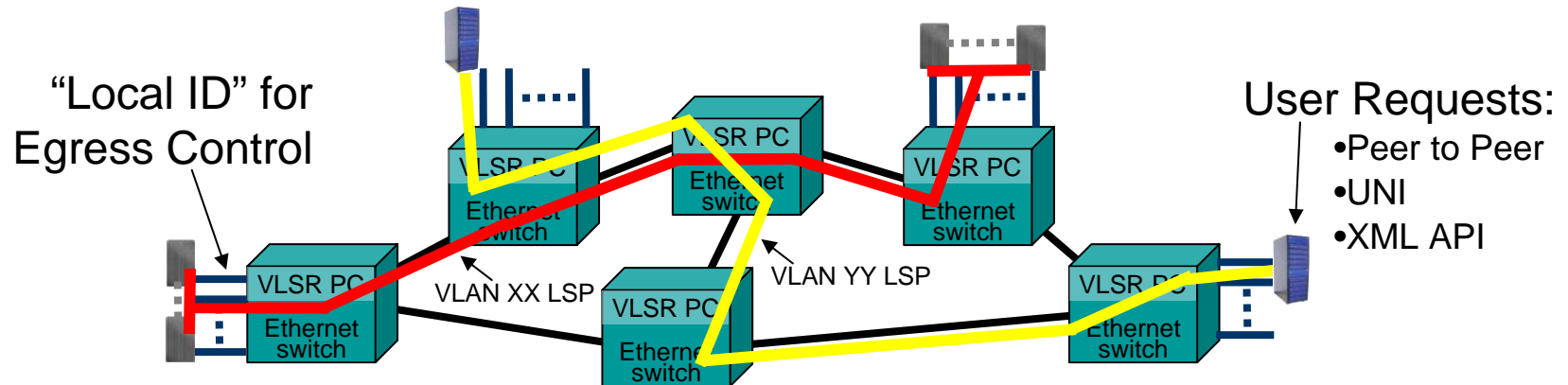
Control Plane Elements

- GMPLS Adaptations to allow Ethernet VLAN based provisioning:
 - OSPF-TE advertises (and updates) available VLAN Tag IDs
 - Path Computation includes a constraint for available VLAN Tag
 - RSVP-TE includes VLAN Tag information in signaling messages





GMPLS Provisioned Ethernet Services



- Multiple Ethernet Provisioning Options
- Point to Point Ethernet VLAN based LSPs
- Ethernet switch (vendor specific) features applied to guarantee LSP bandwidth in increments of 100 Mbit/s
- Edge connection flexibility provided by use of “Local ID” feature which allows flexible combinations of one port, multiple ports, tagged ports, and untagged ports to be glued on to end of LSP.
- Users can request services via Peer to Peer GMPLS, UNI style GMPLS, or via an XML application interface
- Ethernet VLAN space is “global” across provisioned space. Constrained based path computation utilized to find available VLAN Tags.



GMPLS Provisioned Ethernet Services - Summary

- Why do we want to do this?
 - Integrating Ethernet services into an overall multi-layer GMPLS environment provides for a rich set of services and a powerful path forward toward true multi-layer, multi-service architectures.
- What are the main (research) issues?
 - Currently we are limited to provisioning point to point Ethernet VLAN LSPs with flexible edge control (via Local ID)
 - Really need true point to multipoint and multipoint to multipoint provisioning
 - Global nature of VLAN tags is limiting. Need to incorporate features like QinQ, VLAN tag label swapping, or some other technique into the GMPLS provisioning environment
 - How do applications find out about and use different services from a network which has multiple services to offer?
 - Many issues with mutli-layer networks in general: path computation, routing, signaling (stitching, hierarchical, contiguous), vendor limitations