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CANARIE

http://www.canarie.ca

http://www.canet3.net

Web services architecture for management of customer owned optical networks

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Canada's Advanced Internet Development Organization

- Mission: To facilitate the development of Canada's communications infrastructure and stimulate next generation products, applications and services
- Canadian equivalent to Internet 2 and NGI
- private-sector led, not-for-profit consortium
- consortium formed 1993
- federal funding of $300m (1993-99)
- total project costs estimated over $600 M
- currently over 140 members; 21 Board members

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Lambda Grids

- Researcher around the world are acquiring dark fiber and dedicated wavelengths for specific experiments and grids
  - DTF – 4 lambdas between Chicago and LA
  - SURFnet – trans-Atlantic lambdas
  - Iwire – Chicago research fiber network
  - etc
- Soon there will be a pool of wavelengths and fibers dedicated to various specific applications
- Similar to “grids” where we have a distributed computing and storage resources in different management domains

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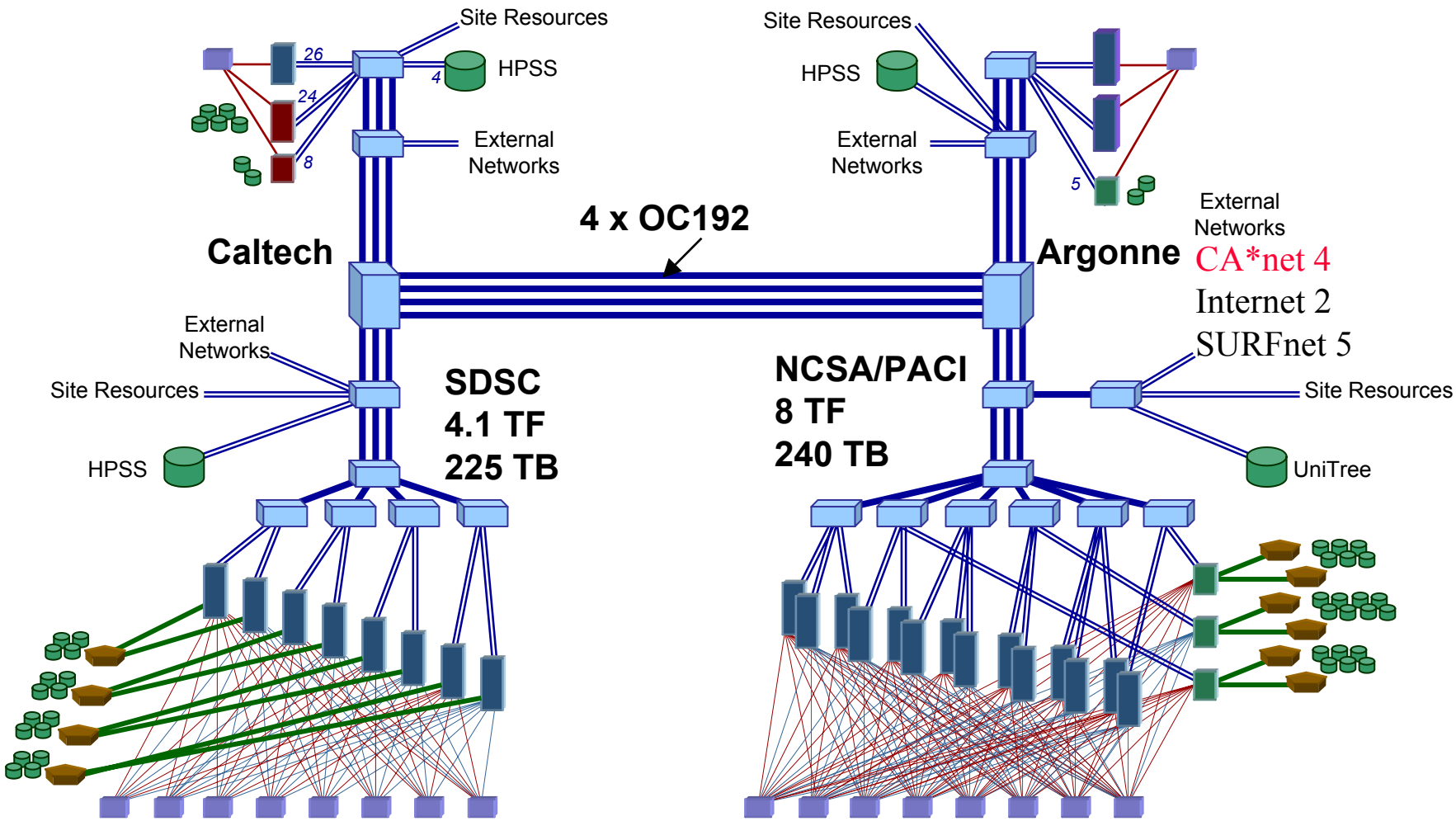
TeraGrid:Computing at 40 Gb/s



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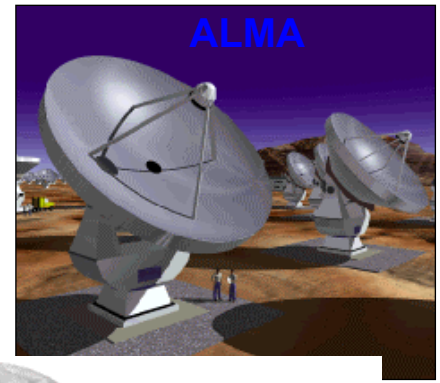
Many e-Science Lambda Grids

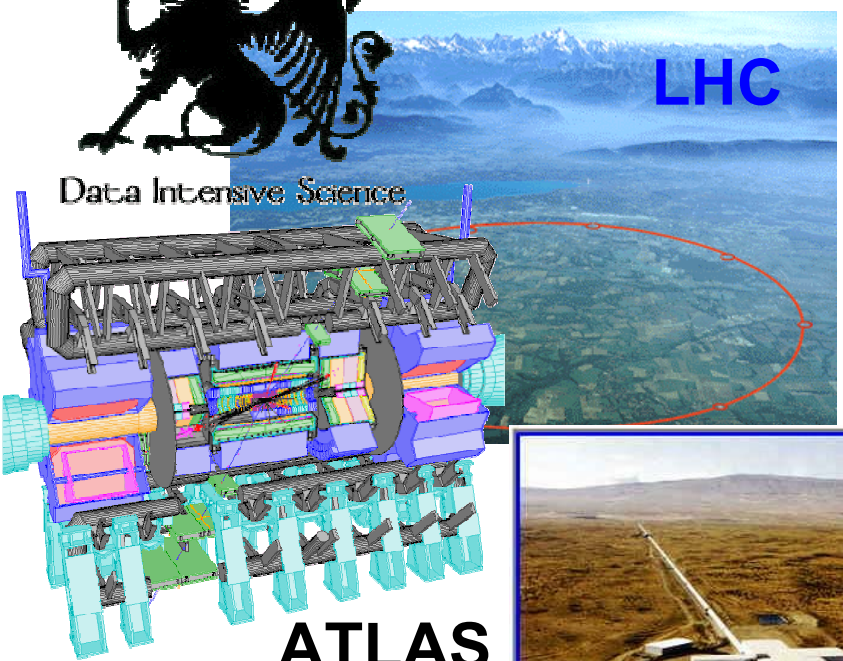
NEPTUNE
A Fiber-Optic Telescope to Inner Space

GENOMES to LIFE
BIOLOGICAL SOLUTIONS FOR ENERGY CHALLENGES
U.S. DEPARTMENT OF ENERGY



GriPhyN
Data Intensive Science

NEES



NEON
National Ecological Observatory Network

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High Bandwidth needs in Canada

- Distributed data storage e.g. Yotta, Yotta – needs dedicated 1 Gbps (currently running at 700 Mbps)
- McGill University HDTV media wall – 250 mbps x 4
- UoSaskatoon Synchrotron project – transmission of uncalibrated 1 Gbps data worldwide
- Neutrino observatory SNO moving from tape to network – 1 to 10 Gbps per second
- VISE project to model data flow from ALMA – 1 to 10 Gbps
- High energy physics to CERN
- Wavelength Disk Drive applications – real time Seti@home – needs dedicated wavelengths
- Number of extreme high bandwidth Grid projects planned – Neptune, Gryphen, Pacific Forestry, etc

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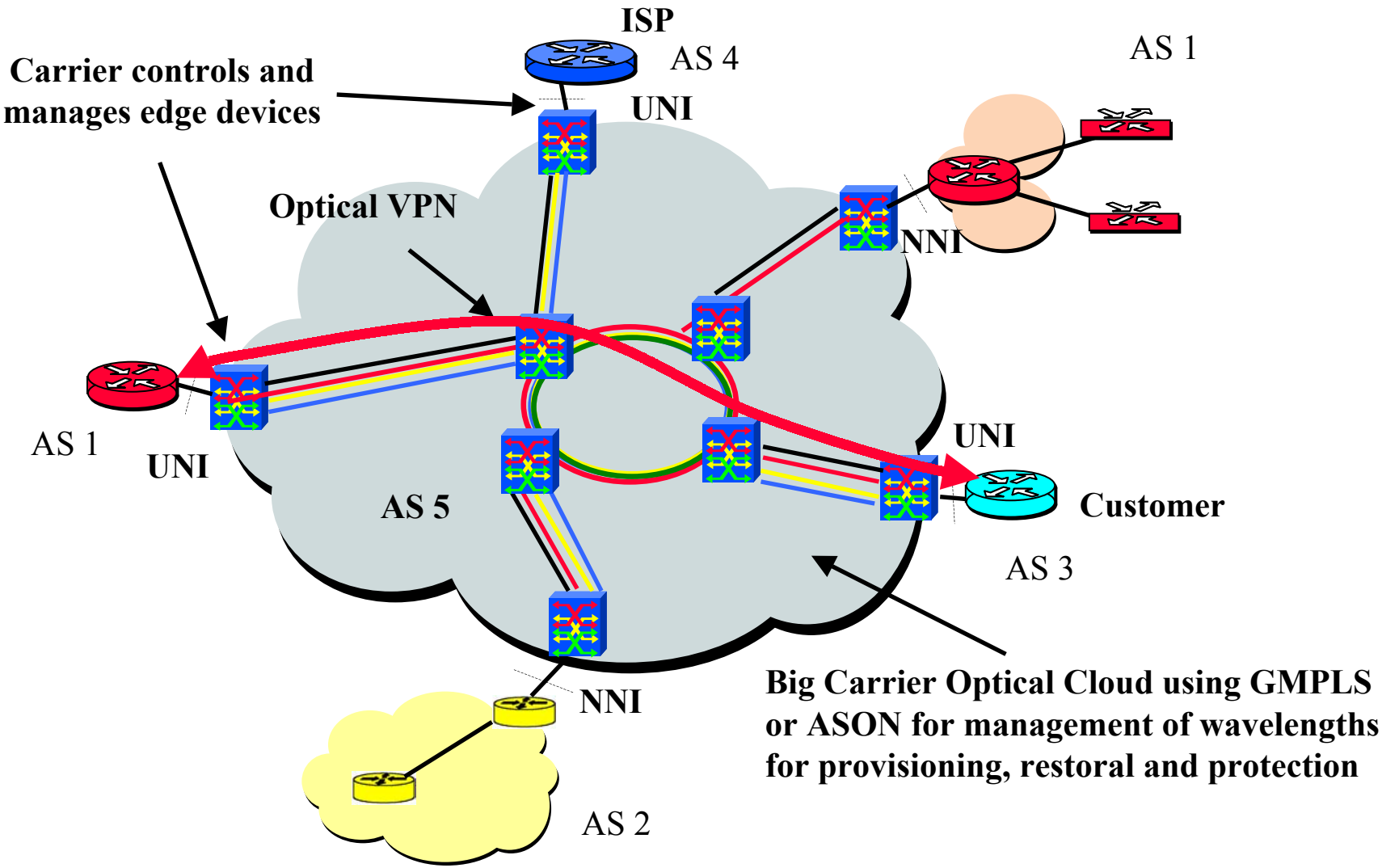
Current Optical Internets



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The Problem

- Current optical services are based on GMPLS, ASON or O-UNI
- Current optical services are “edge to edge” within a single carrier cloud
  - Any changes to customer optical VPN in terms of bandwidth or topology requires release of current VPN and establishment of new optical VPN
  - Customer cannot make topology or bandwidth changes within their own VPN, or cross connect to another VPN within the cloud
- No inter-domain optical routing protocol
  - Customer cannot set up an end to end wavelength across multiple domains
  - No optical services for end2end light path across the campus/enterprise and across the carrier cloud
- All current optical services are based on a client –server model
  - No ability to exchange wavelengths and services on a peer to peer basis
  - University/Research community comes from the Internet world where services and networks are offered on a peer to peer basis
    - BGP multi-homing, mail servers, web, etc
    - Peer to peer has enabled the powerful Internet end to end principle

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*The Concept for CA*net 4*

- There is a growing trend for many schools, universities and businesses to control and manage their own dark fiber
  - Can we extend this concept so that they can also own and manage their own wavelengths?
  - Will this help solve Steve Deering's waist problem?
- Customer empowered optical networks are built on the paradigm that customer owns and controls the wavelengths (Virtual Dark Fiber)
  - Customer controls the setup, tear down and routing of the wavelength between itself and other customers
  - Wavelength resource management is done on on peer to peer basis rather than by central administrative organization
  - Network is now an asset, rather than a service
- Will "empowering" customers to control and manage their own networks result in new applications and services similar to how the PC empowered users to develop new computing applications?

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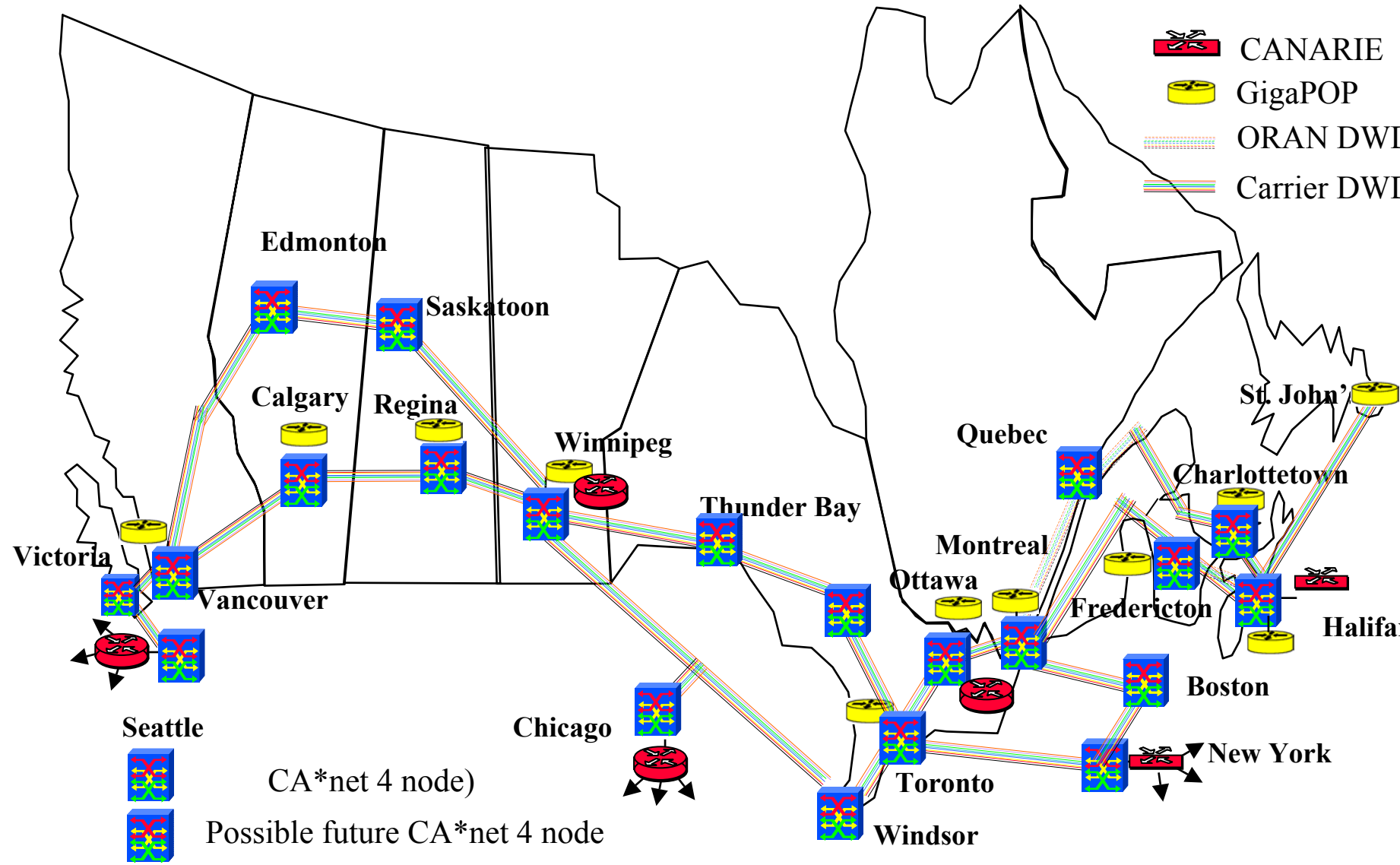
CA*net 4 Architecture Principles

- A network of point to point condominium wavelengths
- Web service architecture for management of optical networks
  - Uses OGSA, WSDL, UDDI, JXTA, J2EE, etc for optical management
- Owners of wavelengths determine topology and routing of their particular light paths
- All wavelengths terminate at mini-IXs where condominium owner can
  - Web serviced enabled “PeerMaker”
  - add/drop STS channel
  - cross connect to another condominium owner’s STS channels or wavelengths
- Condominium owner can recursively sub partition their wavelengths and give ownership to other entities
  - “Object oriented networking”
  - Dynamic creation of lambda proxy services
- Wavelengths become objects complete with polymorphism, inheritance, classes, etc

CA*net 4 Architecture



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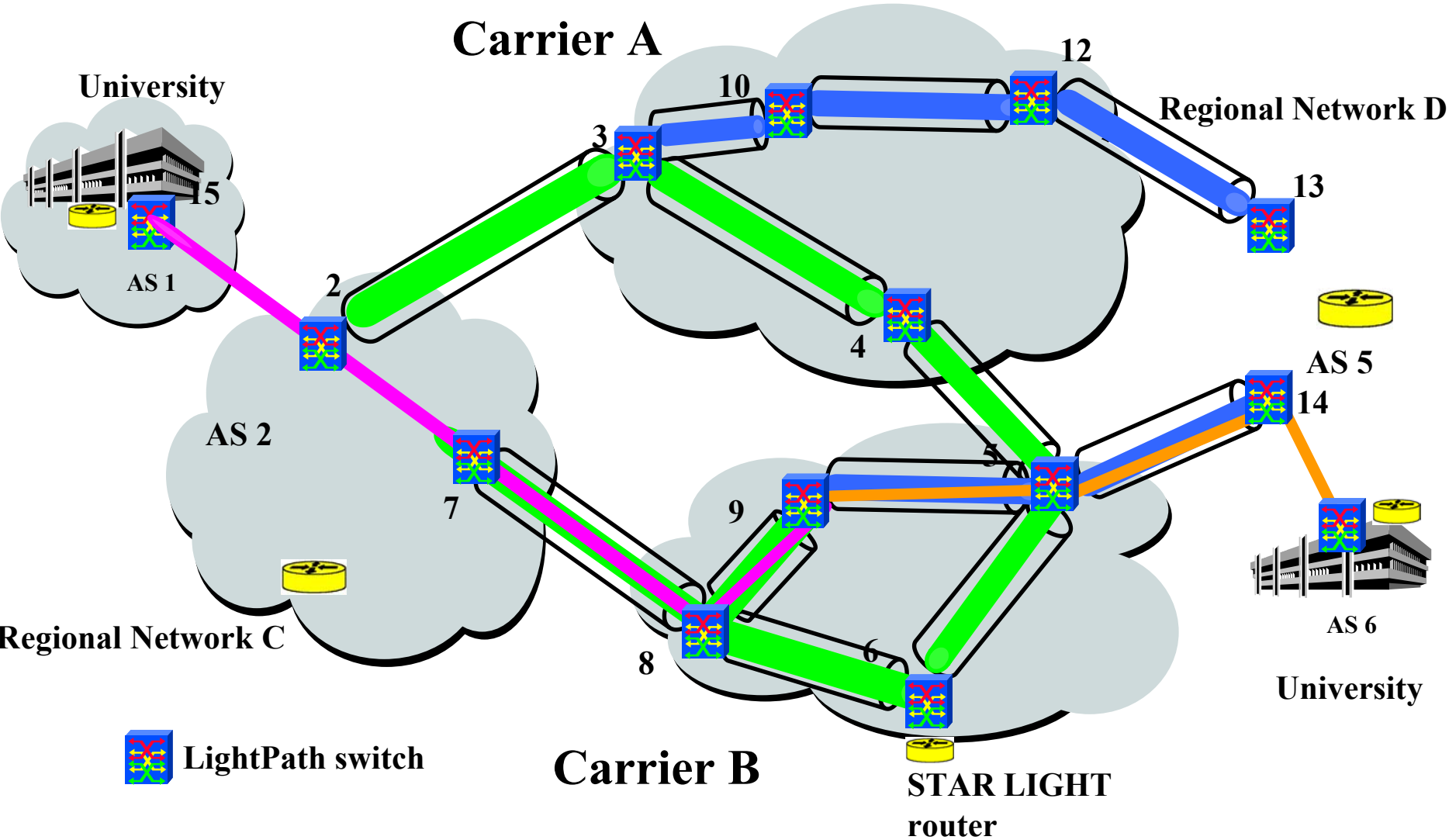
Nested Lightpaths



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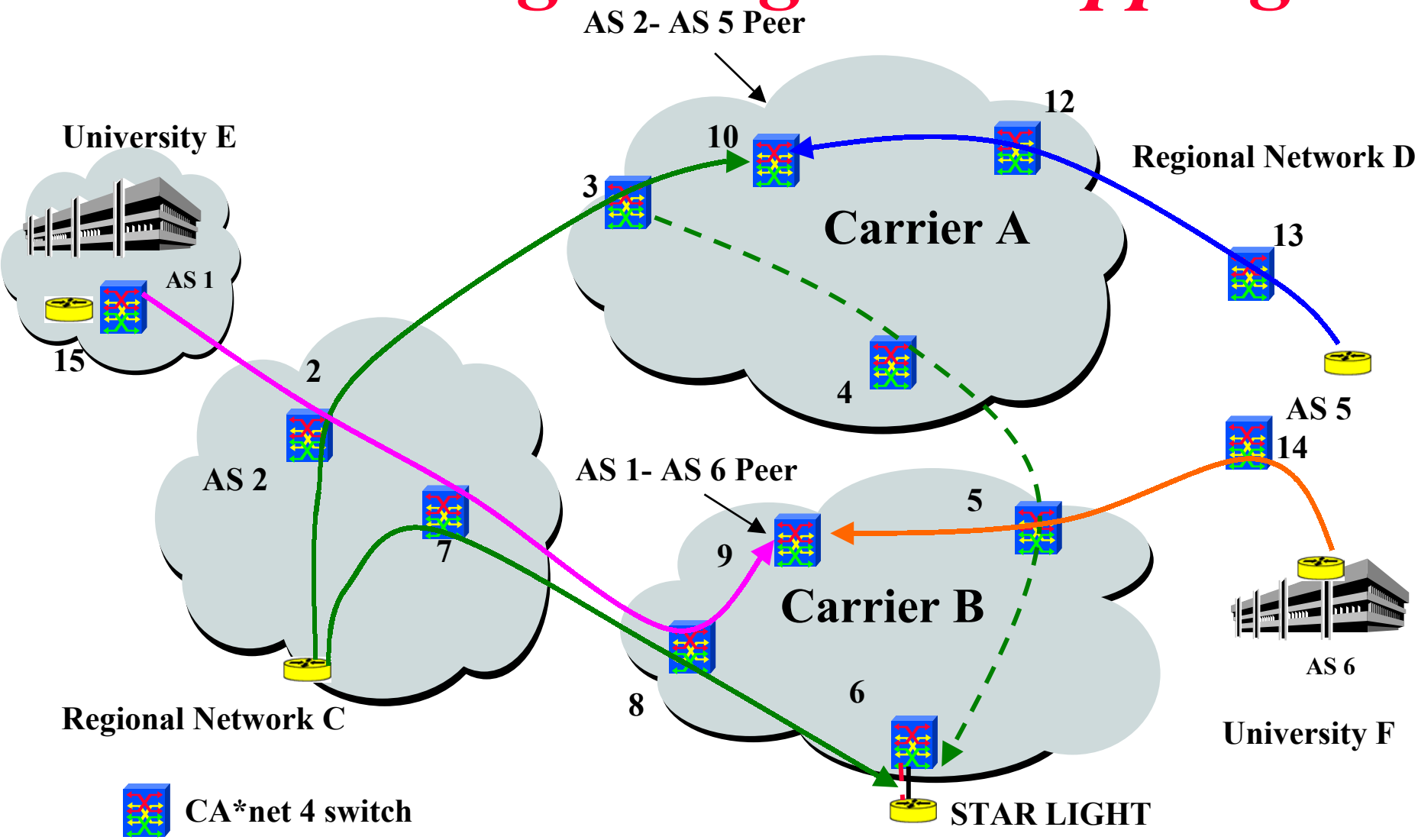
Wavelength Logical Mapping



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Object Oriented Networking

- Combines concepts of Active Networks, Internet 2 e2e principles, web service architecture and Grids
- Customer owns sets of wavelengths and cross connects on an optical switch
- Similar in concept to nested VPNs with customer control of Add/Drop
  - Network elements or nested VPNs can be treated as a set of "network objects" in software applications or grids
  - Complete with inheritances and classes, etc
- In future researchers will purchase networks just like super computers, telescopes or other big science equipment
  - Networks will be an asset – not a service
  - Will be able to trade swap and sell wavelengths and optical cross connects on commodity markets

Web services architecture

- Definition: A Web service is an interface that describes a collection of operations that are network accessible through standardized XML messaging.
- Web Service Description Language (WSDL) is an XML language that contains information about the interface, semantics and "administrivia" of a call to a Web service
- WebDAV allows
- Once a Web service is created, its description and a link to it is created in a UDDI (Universal Description, Discovery and Integration) repository so that potential users can find it.
- When someone thinks they want to use the service, they request the specific WSDL file in order to find out the location of the service, the function calls and how to access them.
- Then they use this information in the WSDL file to form a SOAP (Simple Object Access Protocol) request to the designated computer offering the service

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Advantage of Web Services

- Functionality of a service is defined in WSDL as opposed to being “locked” into a standard
- Standards today are made up of 3 parts: Communication and signaling, service definition and exception handling
  - Each standard does this in a unique and proprietary way e.g. UNI-C, GMPLS, ASON, etc etc
- But, WSDL and SOAP provide an open standard for signaling, communications, exception handling and service definition
- WSDL and SOAP make it easy to define new services and functionality without going through complex standards approval process
- WSDL and SOAP can be bound to traditional API calls e.g. O-UNI to provide open interface to users
- Web services will be the foundation of Grids and distributed computing
  - Allows for optical networks to be just another seamless service in the grid toolbox
- With JXTA optical networks can be managed on a peer to peer basis

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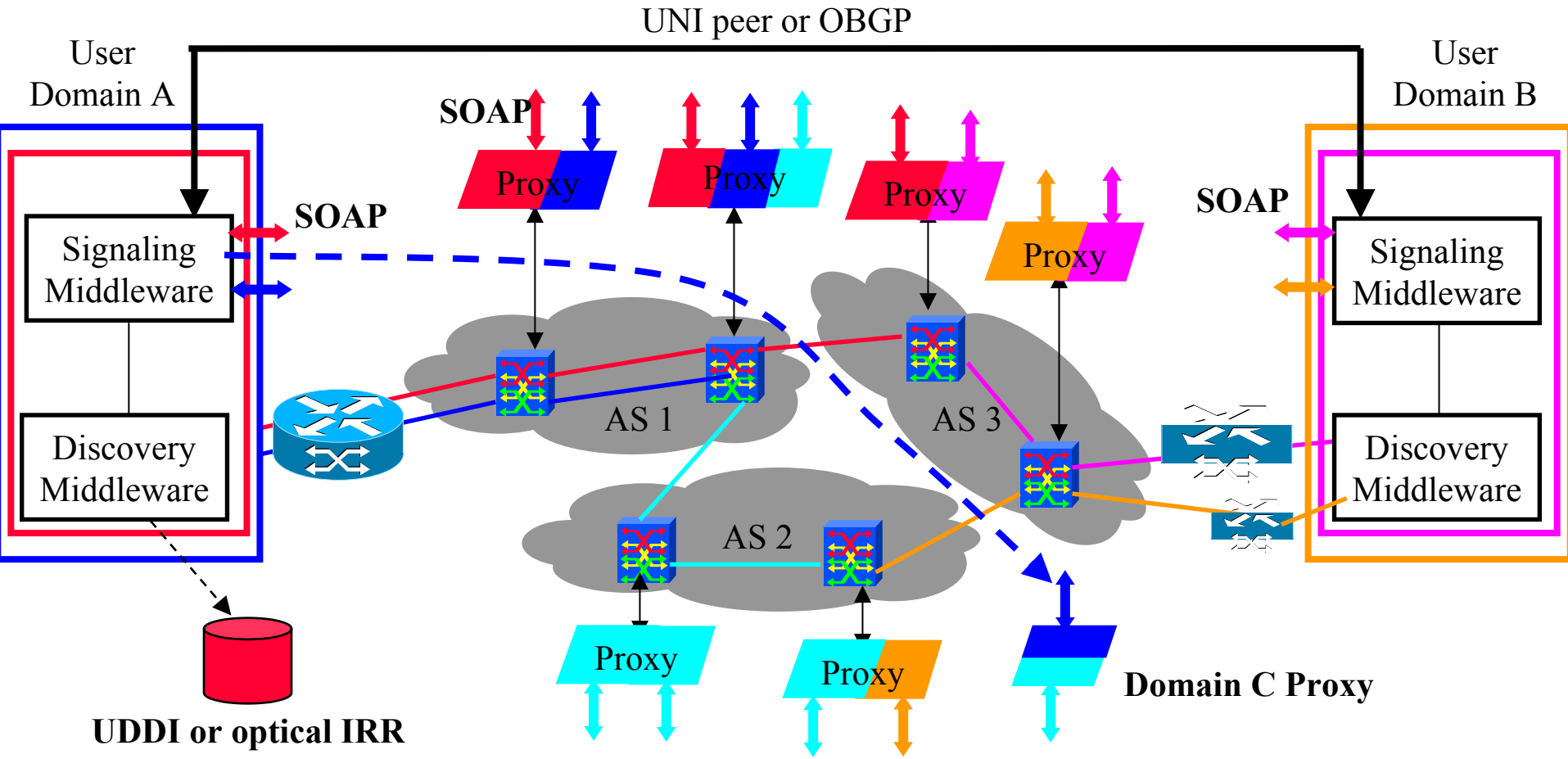
Distributed Control Plane over Multiple Domains



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What is a mini-IX?

- Similar in principle to traditional large IX in a carrier neutral hotel
- But instead of bricks and mortar a mini-IX is a crossbar switch where the switch ports are under the control of the end user
  - Using WebSerbices or Object Oriented Networking (OON) techniques each switch port and groomer is a software object under control of end user
  - Object communication protocols like SOAP are used so that end user can control and monitor individual switch port and grooming objects
  - End user also owns the pipe to the mini-IX – wavelength or dark fiber
- The switch matrix is equivalent to a fiber meet-me room
- Mini-IX protocols include BGP, OSPF, ISIS and Peermaker
- Customers responsible for bringing their own circuits to the IX
  - Customer owned wavelengths in a condominium wavelength network
  - Customer owned dark fiber (with perhaps CWDM)

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*Mini-IXs are the core of CA*net 4*

- Ideal for large data flows used in Grid applications
- Networks of mini-IXs can be linked together for specific application communities and allow direct peering between institutions and researchers
  - E.g. High energy physics network of mini-IXs
- Regional networks and universities can connect to mini-IXs to off load P2P traffic
- Or network of mini-IXs for residences and student dormitories to off load P2P traffic
- The beauty of mini-IX is that architecture is recursive like other successful Internet protocols e.g. HTTP, DNS, etc
- Most optical protocols are reiterative and subject to scaling issues e.g. GMPLS

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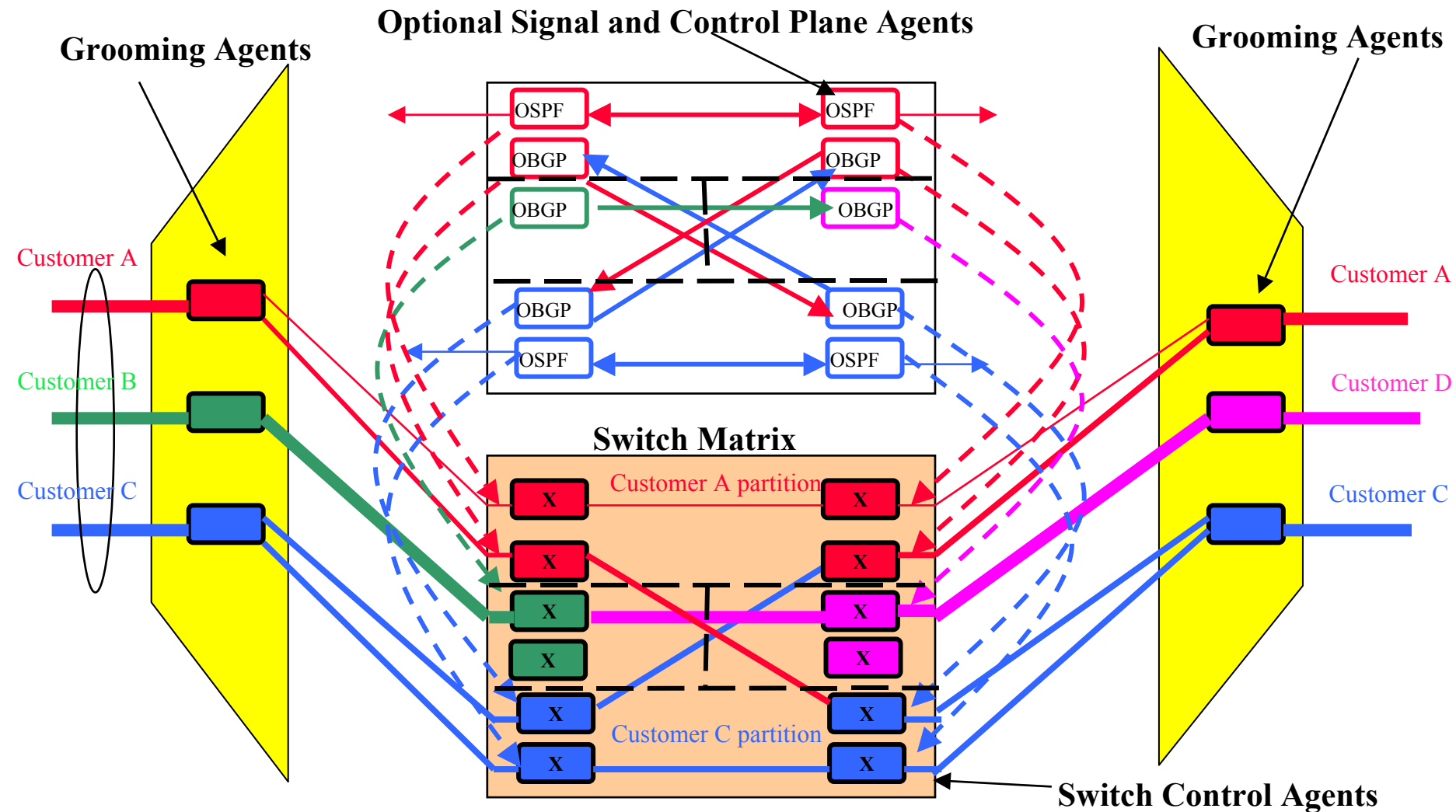
Mini-IX with OON



Note: Switch and Signal Planes are partitioned to respective condominium owner. All objects are controlled remotely via SOAP

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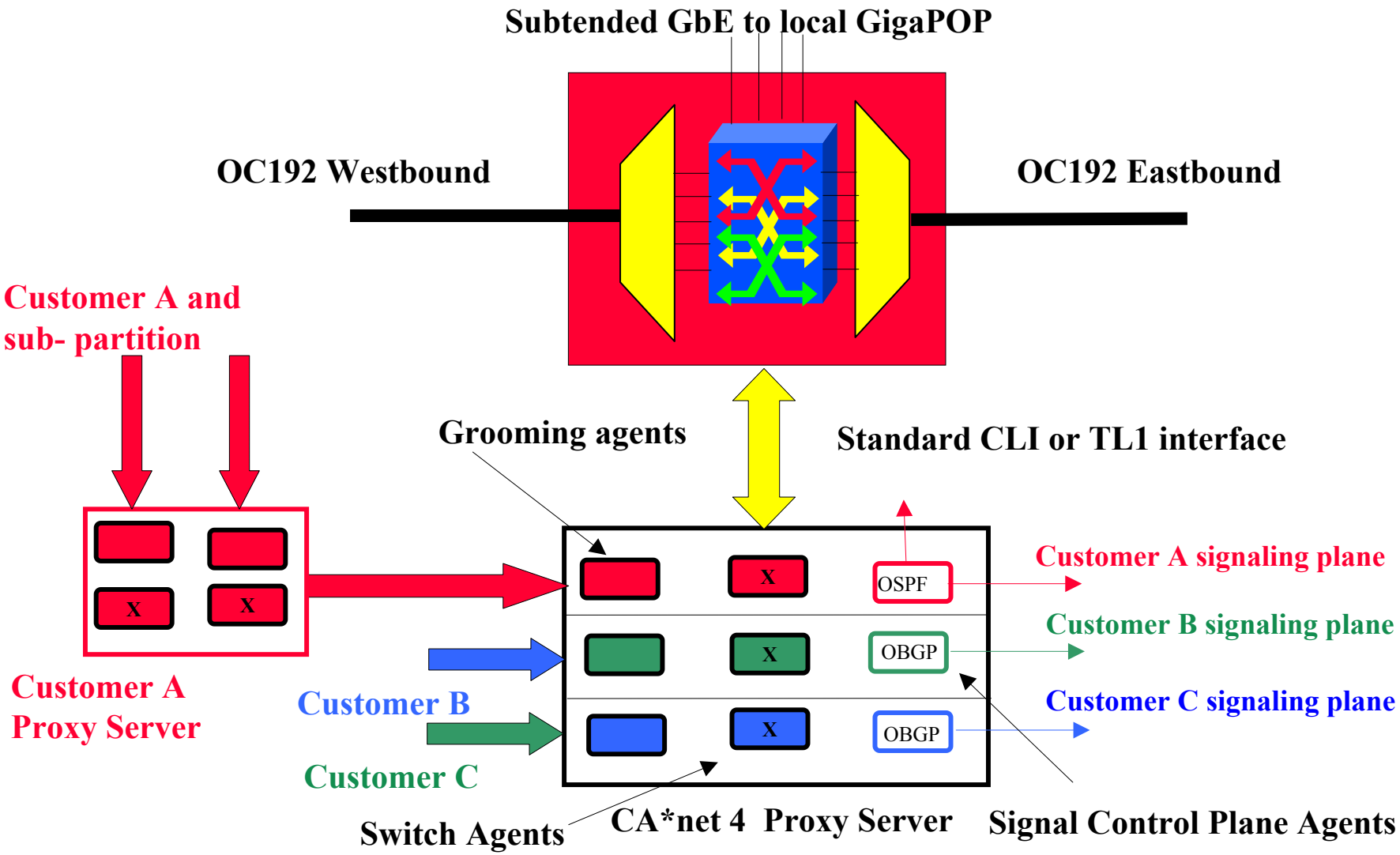
Mini-IX Operation

- The mini-IX is partitioned into different domains by IX manager
  - Each partitioned domain is functionally equivalent to a cage or a room in a carrier neutral IX
  - The IX manager creates agents and/or objects associated with each partition to control the various functions within the partition
  - All agents or objects created are controlled by owner of condo wavelength using messaging protocol like SOAP
  - Three types of agents or objects:
    - Grooming agents that map customer owned wavelength into smaller STS channels
    - Switch agents to cross connect resulting STS channels
    - Signaling and control plane agents to signal to other partitioned domains in other mini-IXs that are connected to the same customer owned wavelength
- Mini-IXs allow the application to drive the network topology
  - To date network topology drives the application

Mini-IX Proxy Server



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OBGP

- Proposed new protocol to allow customer owned wavelengths to interconnect to each other at an optical switch
- Optical switch is in effect a mini-IX
- Use BGP routing information for process to establish light path cross connects
- Allows customer to maintain routing policy on cross connect
- Traditional BGP gives no indication of route congestion or QoS, but with DWDM wave lengths edge router will have a simple QoS path of guaranteed bandwidth
- OBGP can use “optical” AS path to concatenate wavelengths across multiple AS to have continuous QoS path

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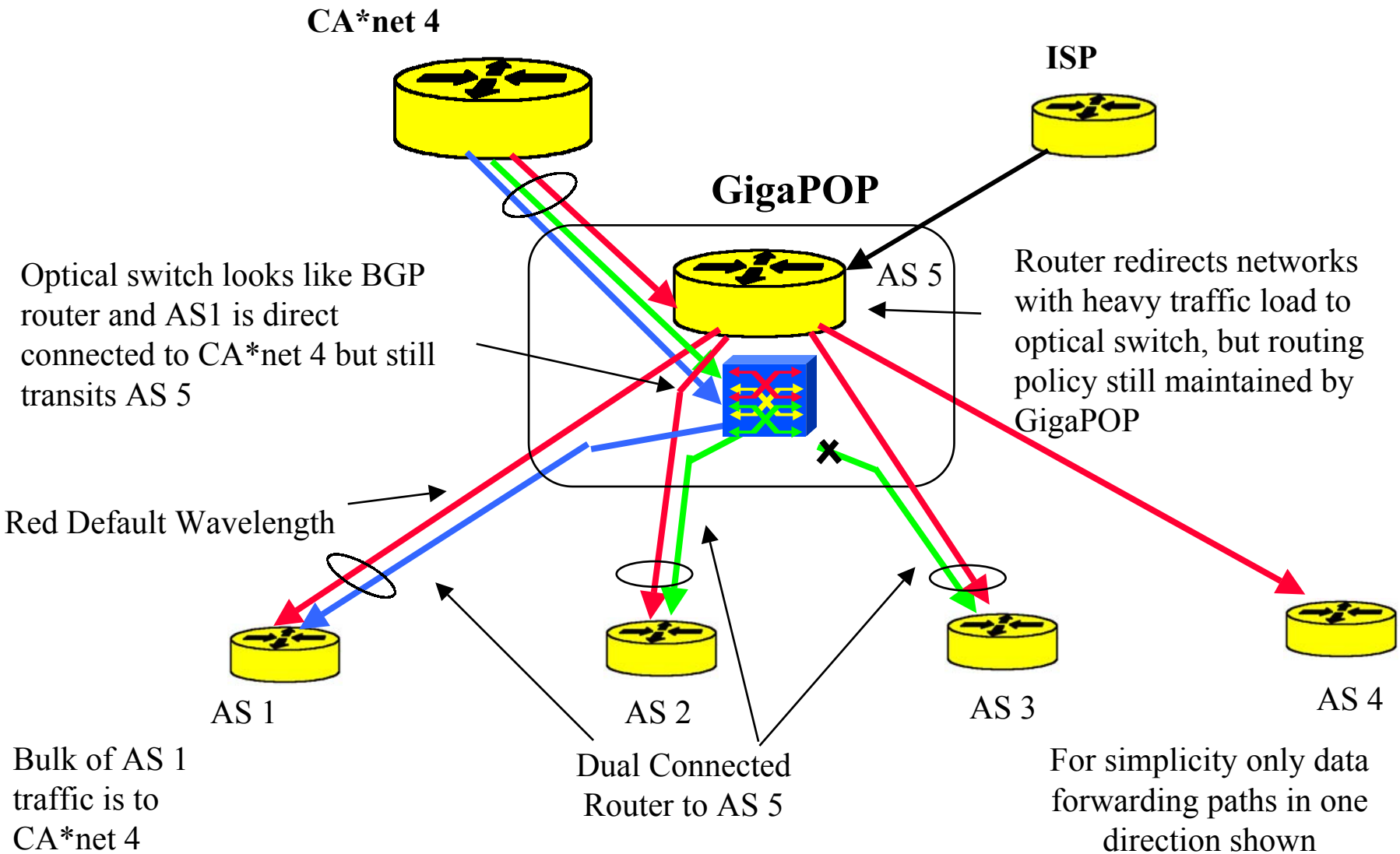
OBGP Variations

1. OBGP Cut Thru
   - OBGP router controls the switch ports in order to establishes an optical cut through path in response to an external request from another router or to carry out local optimization in order to move high traffic flows to the OXC
2. OBGP Optical Peering
   - External router controls one or more switch ports so that it can establish direct light path connections with other devices in support peering etc
3. OBGP Optical Transit or QoS
   - To support end to end setup and tear down of optical wavelengths in support of QoS applications or peer to peer network applications
4. OBGP Large Scale
   - To prototype the technology and management issues of scaling large Internet networks where the network cloud is broken into customer empowered BGP regions and treated as independent customers

OBGP Cut Thru - Physical



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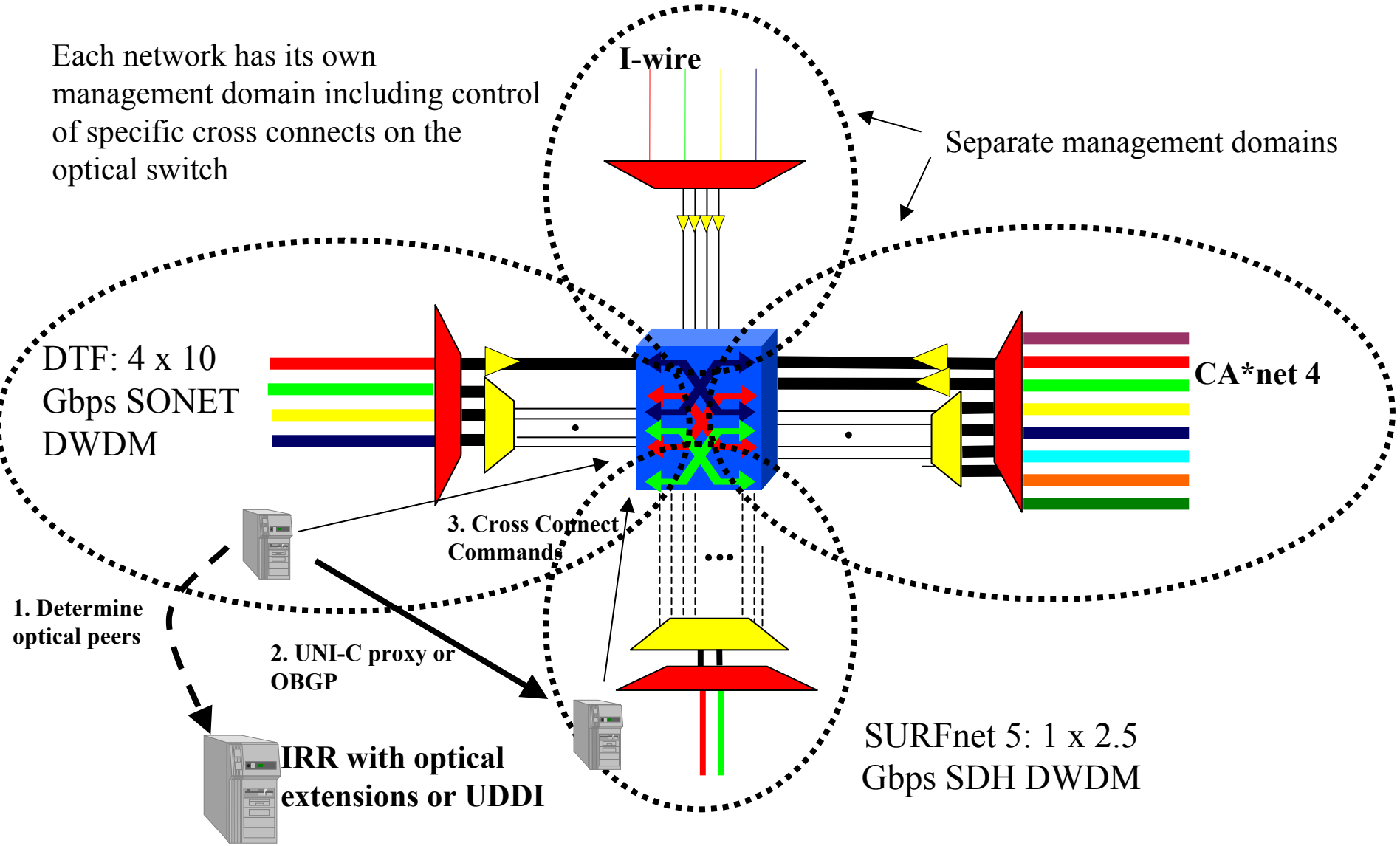
OBGP Peering

- Possible technique for allowing automatic peering at IXs between consenting ISPs
- External routers are given control of specific ports on the OXC
- The router that controls switch can act as an optical route server notifying all peers of any new consenting OBGP peers
- External routers signal to each other if they wish to setup direct optical connection
  - Choice of partner can be based on size of traffic flows
  - Partners can be changed through a routing flap
- Only see each other's customers routes – not the default core

OBGP Peering



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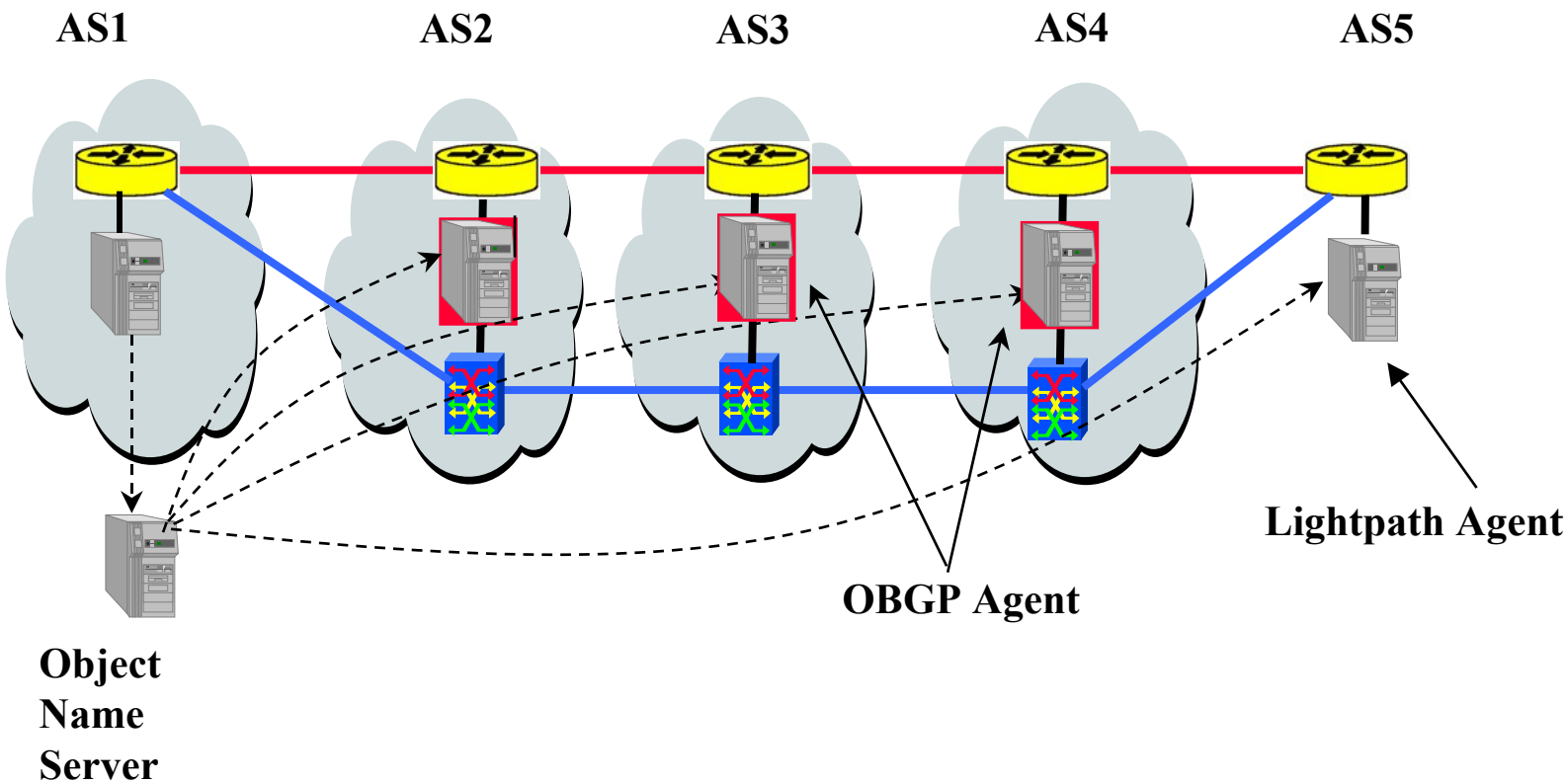
OBGP Optical Transit

- Wavelengths are under control of another entity who has temporarily allowed them to be available for transit
- Viagenie – Marc Blanchet and Florent Parent
  - Designed specifically for optical transit applications
  - Uses MBGP and establishes new address family for OBGP
  - Community tags are used to advertise availability of optical paths as part of NLRI and COMMUNITY TAG
  - Reservation and setup is done by advertising update NLRI message
  - Exploring using CR-LDP & RSVP-TE with AS loose routing for path reservation and setup
- Changcheng Huang
  - The same NLRI message is sent back and forth and modified to indicate first availability of wavelengths, reservation and setup
  - Over rides loop back detection in RIBS for advertised NLRI messages

OBGP transit



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e2e Light Paths

- High end users (e.g Grids) can apply for their own end 2 end light path
- Requirements:
  - Must demonstrate real need for required bandwidth
  - Must implement high performance kernels and IO process to take advantage of bandwidth
  - Must resolve bandwidth bottle necks across campus and local loop (funding may be available for this)
  - If demand is greater than supply then CANARIE may prioritize or implement charges
- Examples (illustrative purposes only):
  - OC48 TRIUMF to CERN
    - CWDM across UBC campus and local loop to CA*net 4
    - OC48 light path to Chicago to connect to CERN
  - WestGrid Interconnection
  - SNO Interconnection to HPCVL

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Light Path Scenarios