Optical Control Plane: Practical Implementation Strategies

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Control Plane Considerations

- Unified control plane (UCP) initiatives strive to lower costs and increase service potential
- The UCP is made possible by advances in network elements and standards
- Several UCP standards efforts and implementation models exist
    - ITU-T ASON
    - IETF GMPLS
    - OIF UNI/NNI
- Adopting a UCP has impacts on transport and management processes, and requires input and involvement of multiple organizations
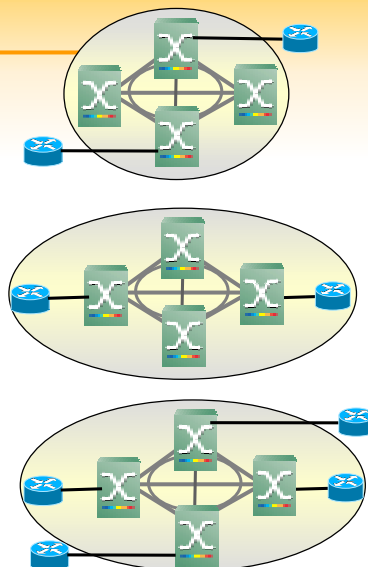
Managing the Transition

- Broad UCP adoption has multiple dependencies:
    - Standards progress and adoption
    - Ease of integration into existing networks
    - Predictability, control, reliability, security
- Organizational impacts must be minimized and controlled :
    - People
    - Process
    - Services

Management Plane

Control Plane

Data Plane

NE NE NE NE
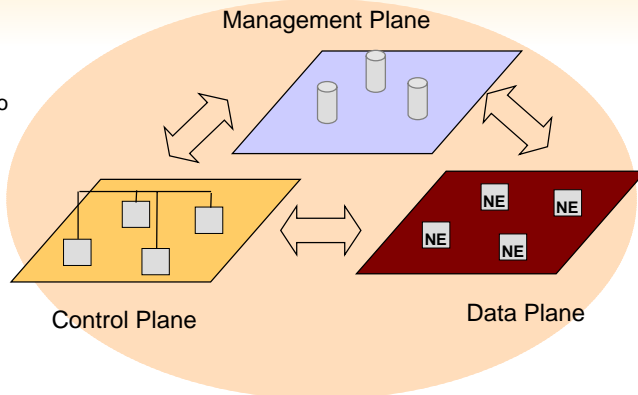
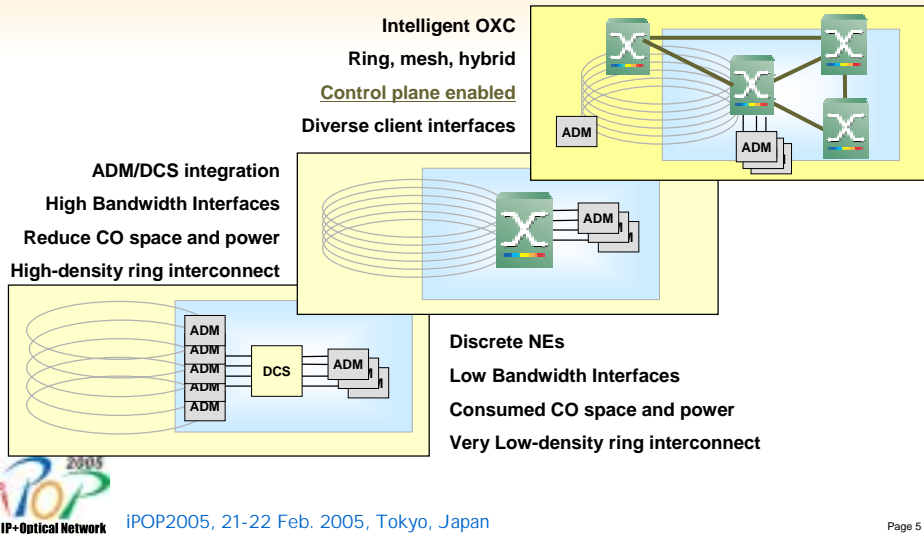
Implementation Models

- Overlay model
    - Two independent control planes
        - IP Domain
        - Optical domain
    - Router is client of optical domain
    - Optical topology invisible to routers
- Peer model
    - Single integrated control plane
    - Router and optical switches are peers
    - Optical topology is visible to routers
- Hybrid options exists
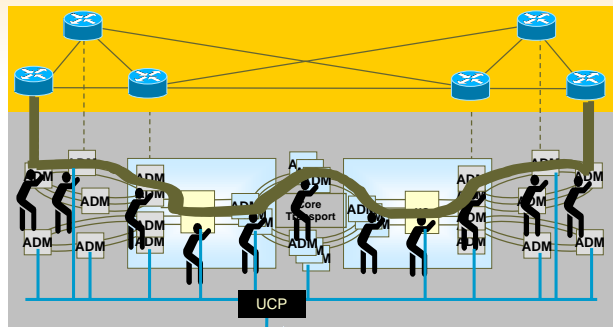   - Combine benefits of both models

Network Element Trends:
Consolidation and Intelligence

Intelligent OXC

Ring, mesh, hybrid

Control plane enabled

Diverse client interfaces

ADM/DCS integration

High Bandwidth Interfaces

Reduce CO space and power

High-density ring interconnect

Discrete NEs

Low Bandwidth Interfaces

Consumed CO space and power

Very Low-density ring interconnect

Unified Control Plane Benefits are Compelling. . .

- Rapid, flexible delivery of new services
  - Faster time to revenue
  - Improved customer satisfaction and appeal
  - Highly customizable, service-focused network
- Increased automation, standard based interop
  - Reduced OPEX
  - Reduced CAPEX
  - Optimization of transport capital investment

UCP

The dynamic nature of IP centric traffic challenges traditional OAMP practices

The increased automation offered by a multi-layer, multi-vendor unified control plane addresses these challenges

Control Plane Transition

|	**Today**		**Future**
Architecture:	Proprietary	Architecture:	ITU-T ASON or Peer Model
Control Plane:	<u>No Control Plane</u>, inventory, planning, provisioning via 3rd party tools and interfaces	Control Plane:	Embedded in distributed optical NEs, integrate with NMS and 3rd party tools
Inventory:	Offline inventory data-base, changes to network / services require manual input	Inventory:	UCP auto-discovers resources, synchronizes network with inventory data-base, changes auto-updated
Path Selection:	Offline, manual activity, resource info provided by inventory data-base	Path Selection:	UCP and/or NMS activity based on routing updates of current network resources and conditions
Path Placement:	via multiple manual local configuration activities or proprietary OSS	Path Placement:	dynamic placement via standard signaling protocols

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Transport Plane Transition

Today

- Ring-based protection schemes with dedicated protection
- No control plane
- Single, inefficient restoration option
- Limited service differentiation
- Limited Operations automation
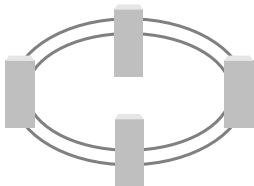
Future

- Mix of Ring, Mesh and Hybrid Schemes with a variety of protection mechanisms
- Implements Optical Control Plane
- Multiple, efficient restoration options
- Highly differentiated services options
- Highly automated operations
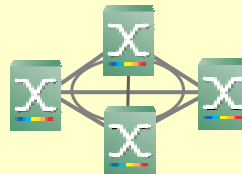
Management Plane Transition

Today

- FCAPS
- Wide variety of independent management and monitoring tools
- Data manually entered / maintained in offline data-bases: *information silos*
- Integration between management and monitoring tools, and between tools and OSS, achieved via a wide variety of standard and customized interfaces

Inventory *Planning Tools* *Provision*

Manually intensive, multiple independent databases
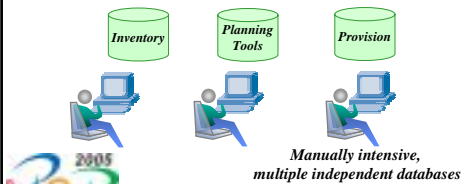
Future

- FCAPS
- Wide variety of independent management and monitoring tools integrated with network
- Data automatically gathered and maintained via control plane integration using TMF 814 CORBA: FCAPS + Connection Mgnt
- Integration between management and monitoring tools, and between tools and OSS, converges on standard interfaces

Inventory *Planning Tools* *Provision*

UCP

The network is the databases
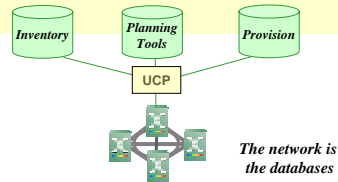
Putting it All Together

- Transport Plane

- Control Plane

- Management Plane

SPC Provisioning Example

Topology Auto-discovery and Inventory

NMS user identifies connection end points

NMS requests ingress EMS to create a LSP

EMS A   **EMS B**   **EMS C**

EMS forwards requests to the ingress node

Ingress Node initiates signaling to establish end-to-end network-routed LSP

Organizational Impacts

Successful UCP implementation requires communications between all organizations—

internal **and** *external*

- Training
  - IP signaling, routing
- OAMP Validation
  - Testing
  - Integration with OSS
- **Services**
  - SLAs
  - Customer control?
  - On-demand, scheduled?

End-Use Customer

Customer Service   **Technical Support**   **Sales & Marketing**

Operations

NMS Team   IP Team   Transport Team   Plan/Design Team   OSS Team

CTO, R&D Labs

IETF   **OIF**   **ITU-T**

IP Router   **ATM Switch**   **SONET SDH**   **Transport**

Vendors

Service Differentiation

- Increase Market Appeal
  - Customization via a range of restoration, bandwidth, provisioning, and management options
- Reduced OPEX Costs
  - Automated service delivery and modification
- Increased Revenue Generation
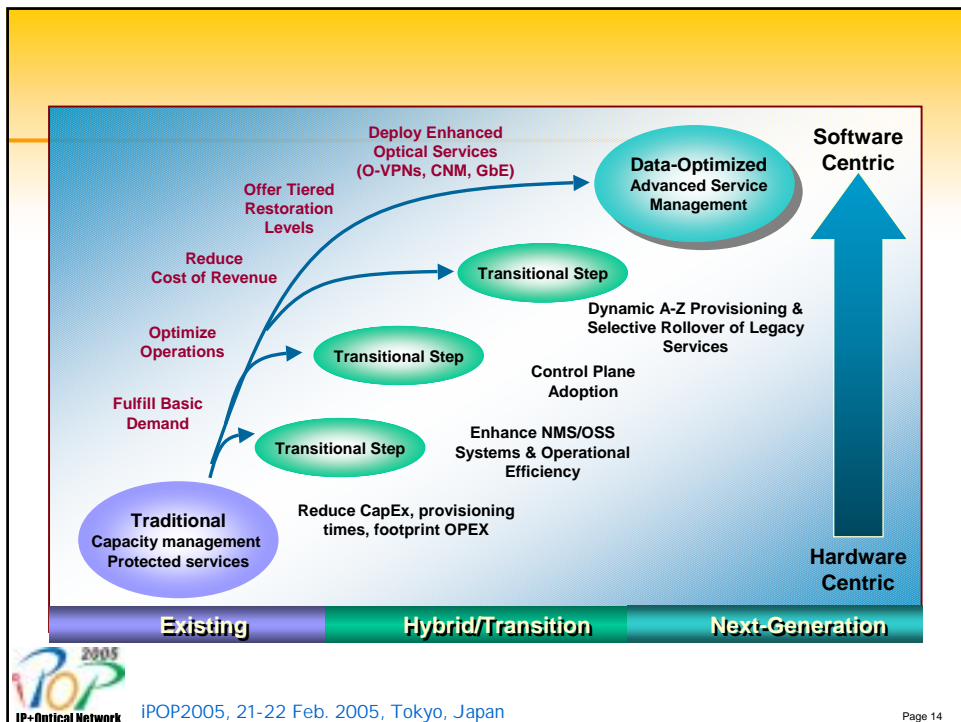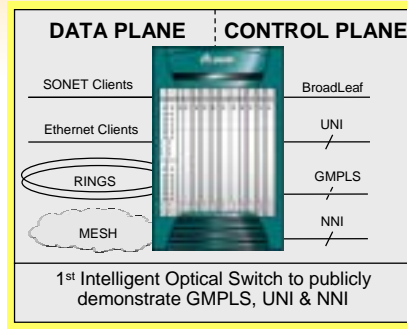 - Via innovative services and improved network utilization

Service Characteristics	Broad Range of Options	Value
Bandwidth	STS-1/VC-3, OC-3/STM-1, OC-12/STM-4, OC-48/STM-16, OC-192/STM-64	BW Dependent
+ Service Selection	Protected Fixed Private Line, Unprotected Fixed Private Line, Flex Private Line, Optical VPN, etc.	Selection Dependent
+ Provisioning Option	Basic, Rapid, Self Service, Dynamic, Policy, etc…	Option Dependent
+ Protection Scheme	Local Restoration, Mesh Restoration, Unrestored, Client Protection, Diversely Routed...	Scheme Dependent
+ Management Choice	Managed Service, Customer Network Management	Choice Dependent
+ Service Level Agreement	Tiered Optical SLA (based on uptime, delay, restoration)	Agreement Dependent

= **Highly Customized Service Offering**
with
Flexible Market-Based Pricing

Deploy Enhanced Optical Services (O-VPNs, CNM, GbE)

Data-Optimized Advanced Service Management

Software Centric

Offer Tiered Restoration Levels

Reduce Cost of Revenue

Transitional Step

Dynamic A-Z Provisioning & Selective Rollover of Legacy Services

Optimize Operations

Transitional Step

Control Plane Adoption

Fulfill Basic Demand

Transitional Step

Enhance NMS/OSS Systems & Operational Efficiency

Traditional
Capacity management
Protected services

Reduce CapEx, provisioning times, footprint OPEX

Hardware Centric

Existing | Hybrid/Transition | Next-Generation

Sycamore Control Plane Highlights

- Supports multiple approaches
  - GMPLS, OIF UNI, OIF ENNI, BroadLeaf
- Long standing standards participation
  - Founding, Principal Member of OIF, '00
  - Interim UNI Test; Supercomm '01
  - GMPLS Signaling Test, NGN '02
  - UNI 1.0 / Interim NNI Test; OFC '03
  - MPLS over GMPLS Test, MPLS Conf. '03
  - OIF Worldwide Demo, Supercomm '04
  - Isocore IP/Optical Test, Supercomm '04
  - Isocore, October 2004
  - iPOP, February 2005

DATA PLANE	CONTROL PLANE
SONET Clients	BroadLeaf
Ethernet Clients	UNI
RINGS	GMPLS
MESH	NNI

1st Intelligent Optical Switch to publicly demonstrate GMPLS, UNI & NNI

Summary

- Optical control plane initiatives promise to lower costs, increase service potential
- Co-existence with existing OAM&P, traditional services
  - NMS and OSS
  - Ring and mesh
- The Unified Control Plane can implemented gradually, practically
  - Transition involves communication with vendors, standards bodies, and internal organizations

Data Plane — Intelligent Optical Network Elements

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Optical Control Plane — IP Centric Routing, Signaling and Service Discovery

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Management Plane — NMS with standard interface to existing OSS

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Intelligent Optical Networking