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*OIF Worldwide Interoperability  
Demonstration 2007 – Consideration from a  
Carrier's Perspective*

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# *OTN Control Plane*

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- ◆ **OTN (Optical Transport Network) control plane**
  - Motivation
- ◆ **OTN control plane architecture reference framework**
  - Reference model – domains, planes & interfaces
- ◆ **End-to-end system architecture**
- ◆ **Interoperability**
- ◆ **Control Plan Enabled Services - JIT/BOD**
- ◆ **JIT service provisioning – a short Demonstration**

# *OTN Control Plane Motivation*

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- ♦ **Strategic value of OTN Control Plane:**
  - For SONET & DWDM connections
  - For Internal Network, Enterprise and Wholesale Services
  - For large scale bandwidth – 50 Mb/s and above
    - 10/100/GbE
    - SAN
    - OC-x services
- ♦ **Technical & Operational Factors**
  - Service engineering & design/re-design automation
  - Dynamic service activation
  - Capacity gains ("accurate" up-to-date inventory of available BW)
  - Protection & restoration (Minimize service outages with multiple protection schemes)
- ♦ **Business Factors**
  - Earlier revenue recognition
  - Strategic opportunities
  - New service offerings
- ♦ **Technology and Standards**
  - Stable technologies
  - Industry standards (IAs, RFCs etc.) reaching final stages
  - Interop demos. (OIF at ECOC 2007), lab testing

# Benefits of OTN Control Plane

**Improved capital utilization (CapEx savings)**  
**Reduced operating costs (OpEx savings)**

**LONG-TERM**

## New Revenue Opportunities

- Opens door for new services:
  - Just-in-Time Provisioning
  - Broadband BoD
  - Optical VPN
- SLA-based performance (QoS)
- Client-self service options
- Provides service differentiators

## Increased customer satisfaction

- Enables E2E provisioning across Vz and other networks
- Minimize service outage with multiple protection schemes

## Engineering & Operations Improvements

- Simplify network design
- Increased automation in planning & design
- Reduce need in future for OSS to track re-designs in dynamic network

## Network Efficiencies

- Auto-discovery to eliminate stranded resources
- Improve network reliability and availability
- Flexible, robust protection and restoration schemes
- Support mesh network topologies
- Aligns with 'convergence' of multi-layer network evolution path

**INITIAL**

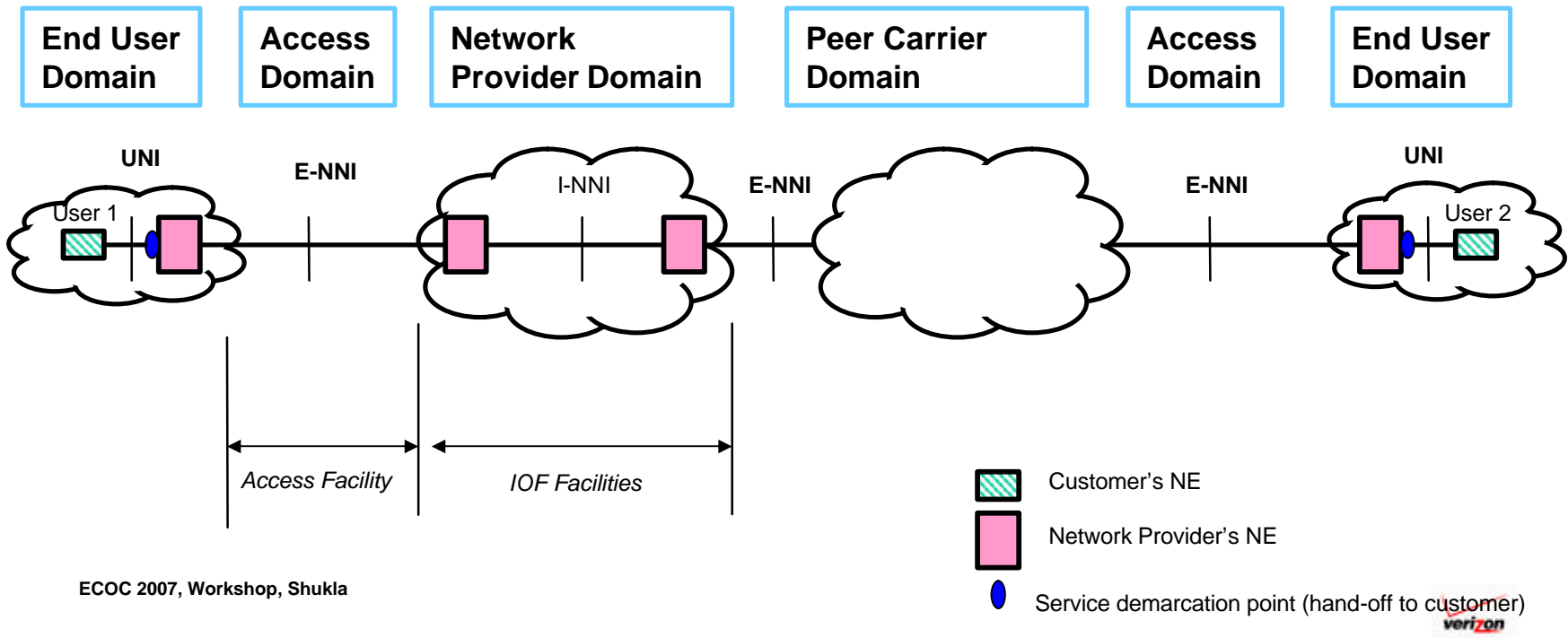
## *OTN Control Plane: Key Capabilities*

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- ◆ **Auto-Discovery & Self-Inventory**
  - High quality databases for attributes on nodes/links/ports, network topology, and services across the network
- ◆ **Dynamic Provisioning and Service Activation**
  - Fast end-to-end circuit design based on real-time resource map
  - Fast circuit provisioning and service activation via user-network signaling or customer service portals
- ◆ **Traffic Engineering**
  - Improved routing efficiency and resource utilization
  - Rapid service configuration adjustment
- ◆ **Protection & Restoration (P&R) for Mesh**
  - Improving network resilience and supporting COS (class of service)
  - Offering additional P&R options besides traditional UPSR and BLSR rings

# Reference Domains

- ◆ OTN control plane domains
  - End User domain
  - Access domain
  - Network Provider (Verizon) domain
  - Partner carrier domain



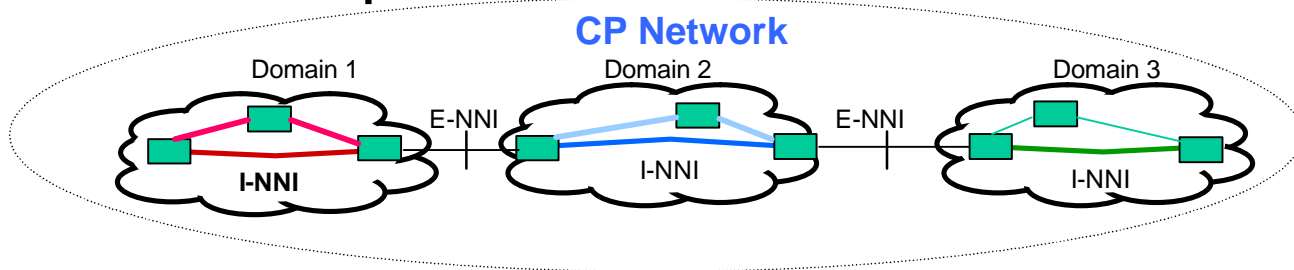
# OTN CP Physical Architecture

## ◆ Pre-requisites

- Network element resources, such as circuit packs pre-provisioned & made assignable
- Physical facilities pre-wired & available for use

## ◆ Network Topologies – Example (1)

- Full control plane network



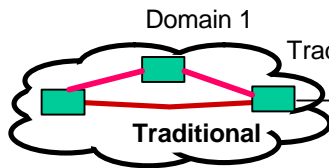
(a) Full CP Network

# OTN CP Hybrid Topologies

## ◆ Network Topologies – Example (2)

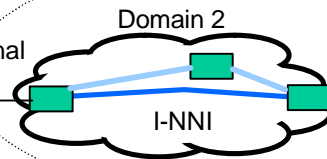
- Hybrid – mixed control plane & traditional networks

Non-CP Network



Traditional

CP Network



Domain 2

I-NNI

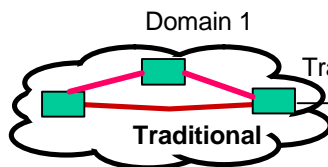
E-NNI

Domain 3

I-NNI

(b) Hybrid Network – Traditional Domain & CP-Domain

Non-CP Network



Domain 1

Traditional

CP Network

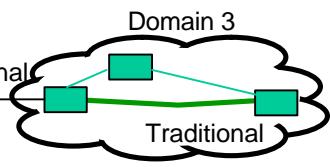
Traditional

Domain 2

I-NNI

Traditional

Non-CP Network



Domain 3

Traditional

(c) Hybrid Network – Traditional Domain & CP-Domain & Traditional Domain

# *JiT Product - Service Requirements*

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- ◆ **Offers Wholesale customers DS3, OC-n, and Ethernet private line 'Just-in-Time' service activation utilizing an intelligent optical transport network (OTN) to reduce provisioning intervals.**
  - OTN control plane technology provides the necessary intelligence
  - NG-SONET technologies (GFP/VCAT) provide Ethernet service adaptation
- ◆ **Utilizes control plane-enabled OTN with E2E circuit designs and activation performed by the control plane**
- ◆ **Service rates and characteristics:**
  - Supports DS3, OC-n, partial and full-rate GbE private line
  - STS-1 granularity for OC-n and Ethernet private line
  - Unprotected and control plane 1+1 protected, non-revertive
  - Full link diversity with best effort node diversity

# *E-NNI Multi-Vendor Interoperability*

## *Intra-Carrier E-NNI -- Key Functions*

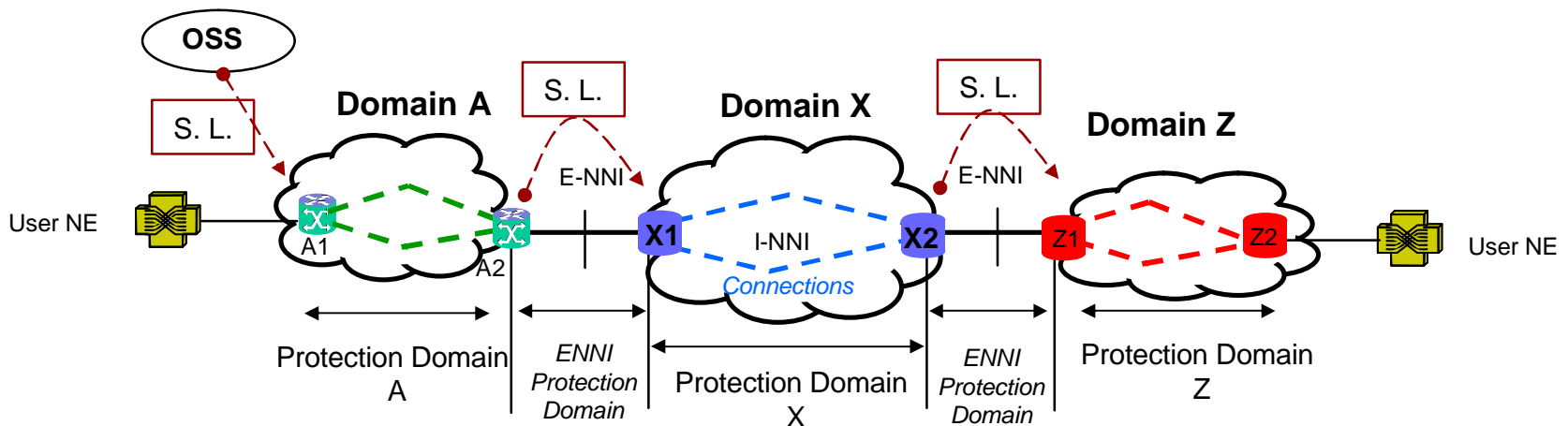
- ◆ **A demarcation point between domains to support cross-domain SERVICE provisioning**
  - Allow service to be realized in different ways within each domain
  - Allow separate address spaces to be used within each domain, especially when separately administered
  - Provide independent survivability (protection/restoration) for each domain
- ◆ **Inter-Domain Interworking**
  - Signaling Level Interworking
    - Cross-domain circuit activation
  - Routing Level Interworking
    - Cross-domain path calculation
    - A full range of topology abstractions: Managed Scalability
  - **Service Level Interworking**
    - **Cross-domain service continuity**

**Need to support comprehensive service interworking**

# *E-NNI Multi-Vendor Interoperability*

## *E-NNI Service Interworking Mechanism*

- ◆ **“Service Level” defined for Intra-Carrier E-NNI and UNI signaling specs**
  - For SPC: OSS passes Service Level to edge node in SPC request
  - An eight-bit integer: code-points and semantics are operator specific
    - Service Features: protection and restoration type, diversity, ..etc.
  - A circuit-level parameter with end-to-end significance



# *E-NNI Multi-Vendor Interoperability*

## *Challenges*

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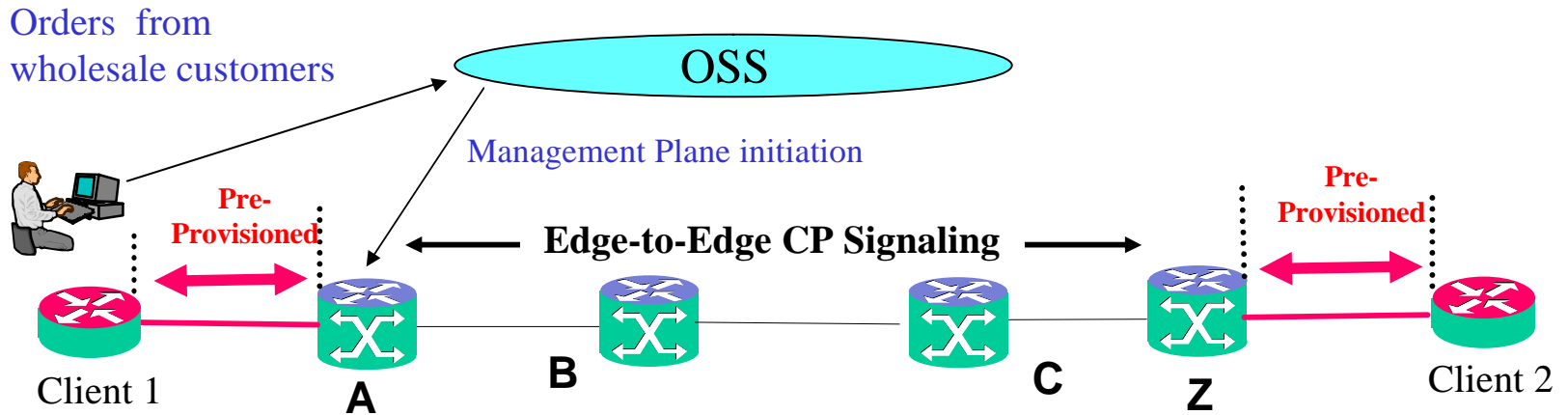
- ◆ **Robust interoperability at signaling and routing levels**
  - Need well-defined interoperability requirements
- ◆ **OIF Intra-Carrier E-NNI IAs support a limited set of end-to-end service features**
  - Service discontinuity exists for some features

**E-NNI is not quite service ready**

# OTN Control Plane for BoD

## Soft Permanent Connection

Soft Permanent Connection (SPC) – Initiated by management plane action



**A Soft Permanent Connection**

# JiT Product Launch - Service Architecture

## Two main components

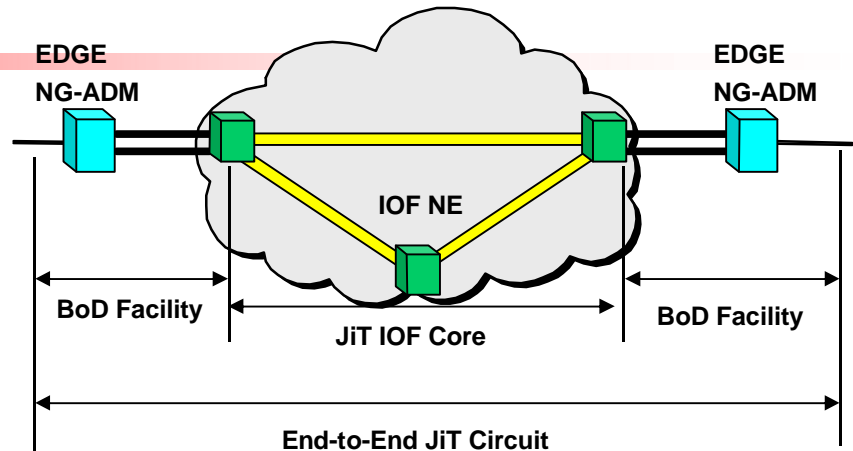
- BoD Facility
- JiT IOF Core transport network

## Pre-Requisites

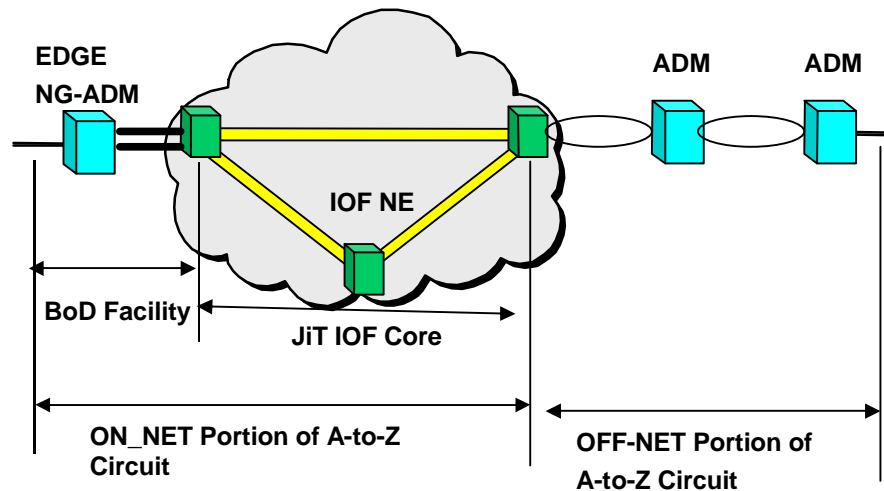
- BoD Facility and IOF facilities are pre-wired and pre-provisioned
- EDGE NE and IOF NE is pre-configured & circuit packs pre-provisioned & made assignable

## Network Scenarios

- ON-NET:
  - CP domains only
- OFF-NET:
  - Interworking between CP domain & traditional domain
  - Flow-thru provisioning of hybrid circuit that crosses traditional domain & CP domain



(a) ON-NET Scenario



(b) OFF-NET Scenario

# *JiT Product Launch - Service Rates & Characteristics*

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- ◆ **Drop port termination types**
  - **Standard symmetrical drop ports**
    - **GbE port (for partial or full-rate GbE)**
    - **OC-n full-rate SONET port**
    - **DS3 port**
  - **'Stub-hub' facility**
    - **OC-12, OC-48**
    - **To allow lower speed optical circuit to ride within the higher speed OC-n facility**

# ***OTN Services***

## ***Conclusions***

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- ◆ **Enabling technologies for JiT/BOD Provisioning are here today**
  - Integrating NG technologies to provide high value services
  - NG-OSS delegating service provisioning/activation to control plane to achieve scalable (across technologies, across regions), high performance flow-through process.
  - NG-OSS capable of supporting inter-layer provisioning
- ◆ **JiT and BBoD as value-added services for Verizon**
- ◆ **BBoD as an intelligent provisioning tool for operating converged services (Layer 1, Layer 2, and Layer 3) networks**
- ◆ **JiT/BOD Service launch in progress in many metro areas**