

# Optical Internetworking Forum / OIF: ASON/GMPLS Inter-Domain Interfaces, Integration of Control and Data Plane Functions

Hans-Martin Foisel  
Deutsche Telekom

# Outline

- ◆ **Introduction**
  - **OIF**
  - **ASON/GMPLS multi-domain and multi-layer networks**
  - **ASON/GMPLS inter-domain interfaces**
  
- ◆ **External Network-Network-Interfaces (E-NNI)**
- ◆ **User-Network-Interfaces (UNI)**
- ◆ **Considerations from a carriers perspective**
- ◆ **Summary**

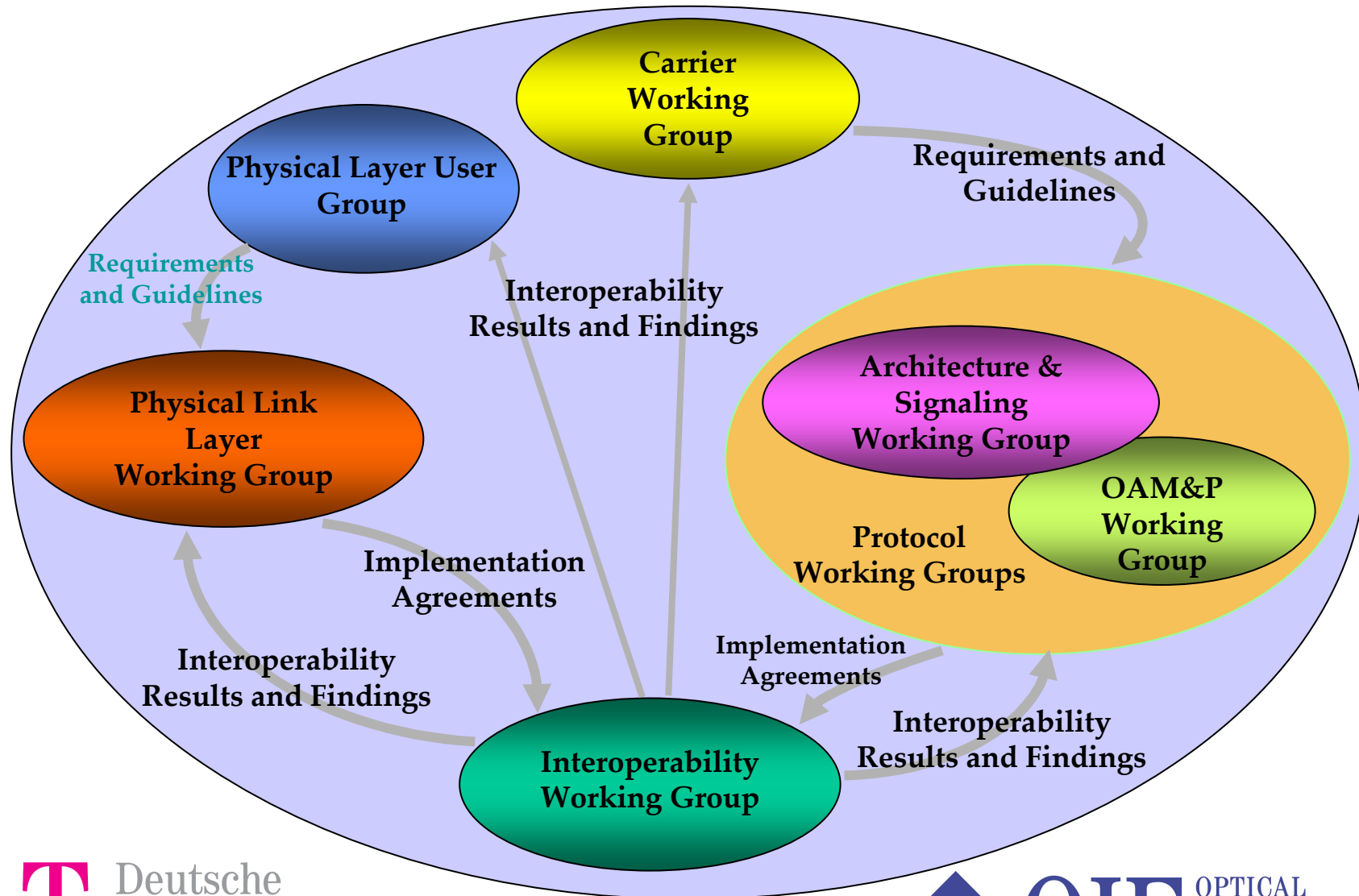
# OIF Background and Mission

- ◆ The only industry group bringing together professionals from the data and optical worlds
- ◆ Open forum: 100+ member companies
  - Carriers
  - Component and systems vendors
  - Testing and software companies
- ◆ Launched in April of 1998
- ◆ Mission: To foster the development and deployment of interoperable products and services for data switching and routing using optical networking technologies

# OIF Focus

- ◆ **Low-cost scaleable optical internetworking**
- ◆ **IP-over-switched optical network architecture**
- ◆ **Physical layer**
  - **Low-cost optical interfaces between networking elements**
  - **Standard device level electrical interfaces for low-cost systems**
- ◆ **Control layer interoperability between data and optical layers**
  - **Dynamic configuration using IP signaling and control mechanisms**
- ◆ **Accommodate legacy network under the new physical and control layer mechanisms**

# OIF Structure



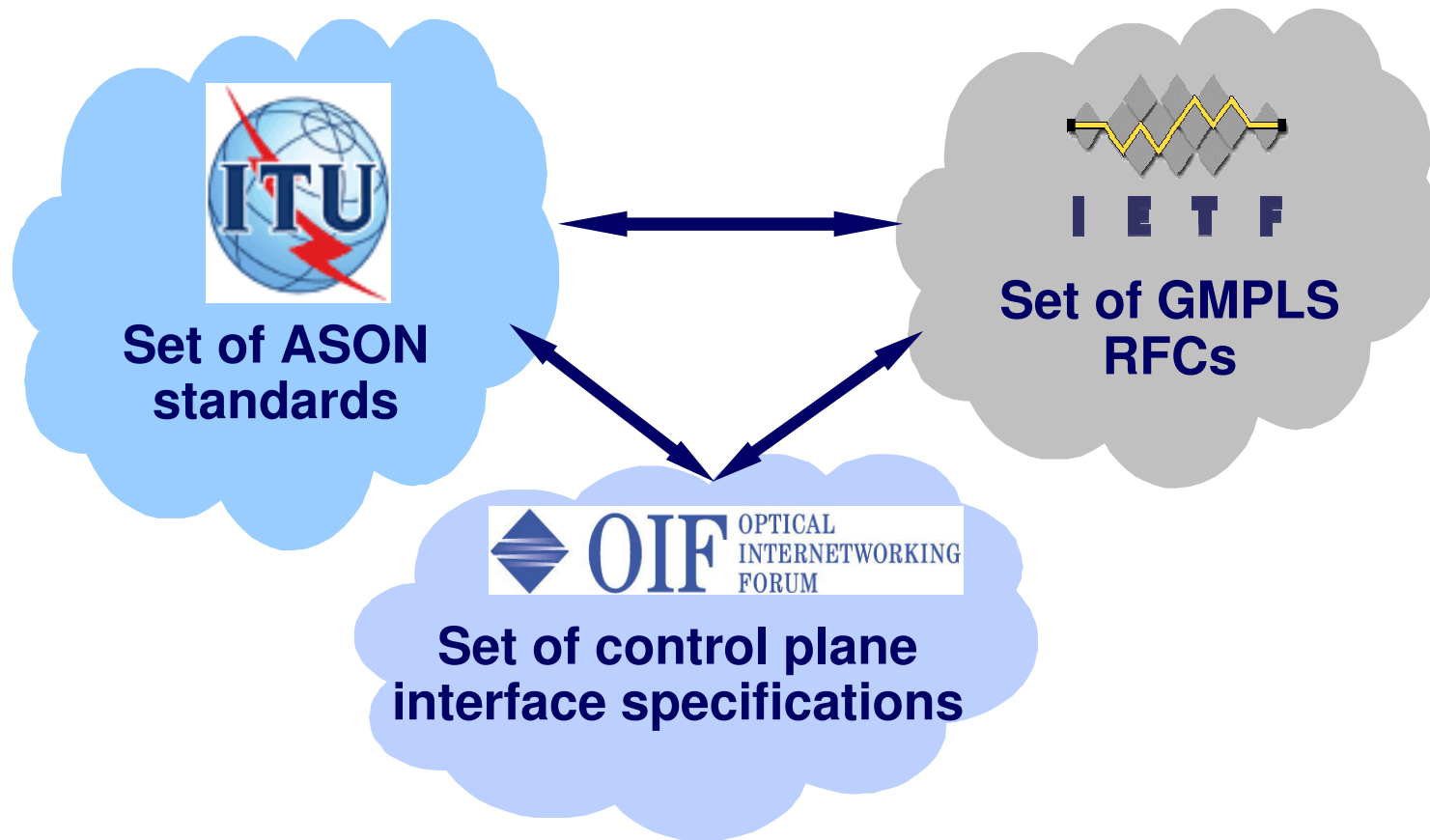
# Output from OIF

- ◆ **Develop implementation agreements using**
  - **Carrier group's requirements as input**
  - **Physical Layer User Group requirements as input**
  - **Existing standards and specification when available and developing new when necessary**
- ◆ **Develop interoperability testing procedure to ensure compliance and ultimately interoperable products and networks**
- ◆ **Provide input into other standards bodies**

# OIF Liaisons to Standards Bodies

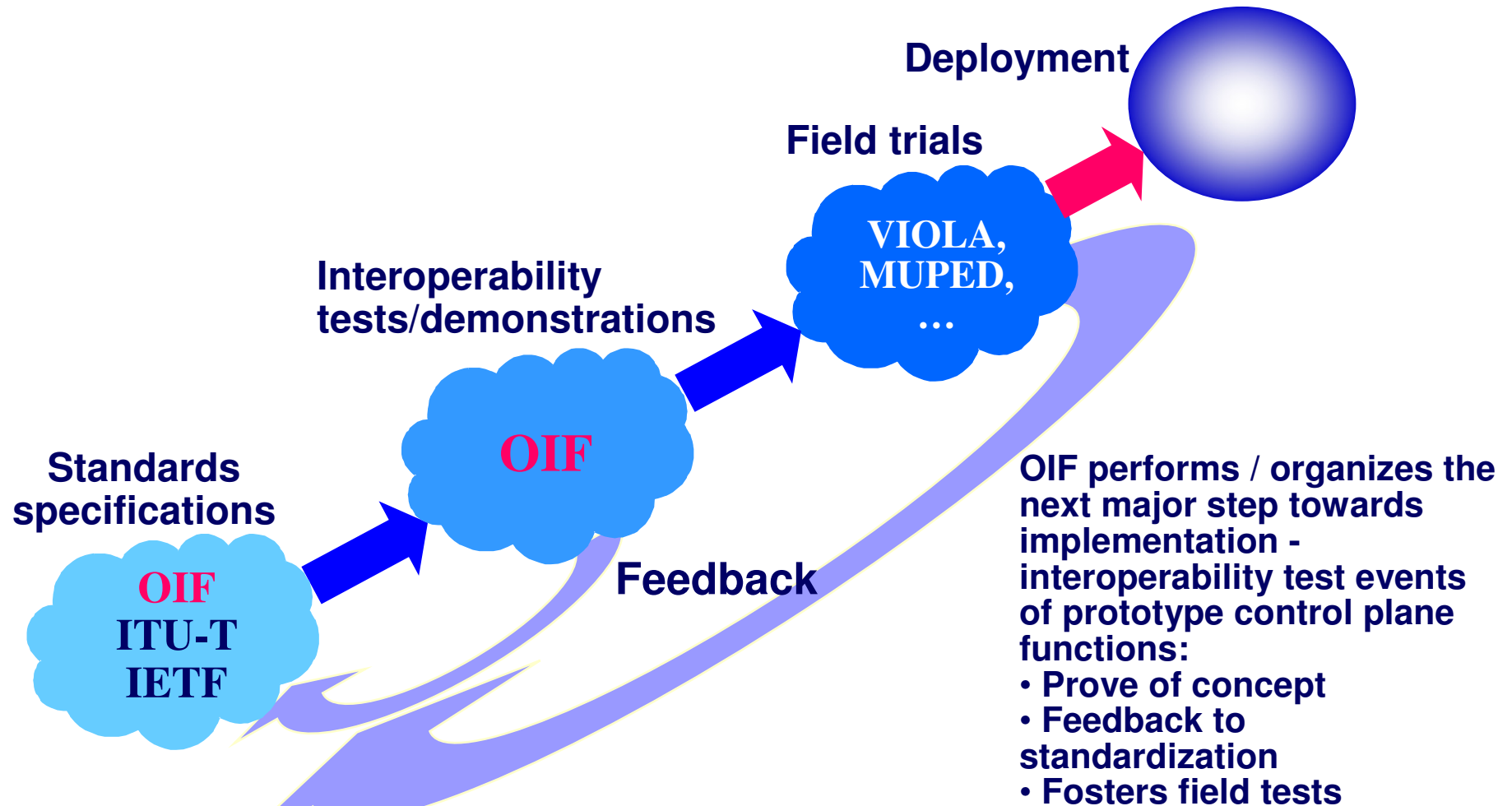
- ◆ **Alliance for Telecommunications Industry Solutions - ATIS**
- ◆ **International Telecommunications Union - ITU-T**
- ◆ **Internet Engineering Task Force - IETF**
- ◆ **IEEE 802.3 HSSG**
- ◆ **MFA Forum**
- ◆ **Network Processing Forum - NPF**
- ◆ **Metro Ethernet Forum - MEF**
- ◆ **Tele Management Forum - TMF**
- ◆ **Rapid I/O**
- ◆ **XFP MSA Group**
- ◆ **UXPi**

# ASON/GMPLS Standardization Bodies & Forums



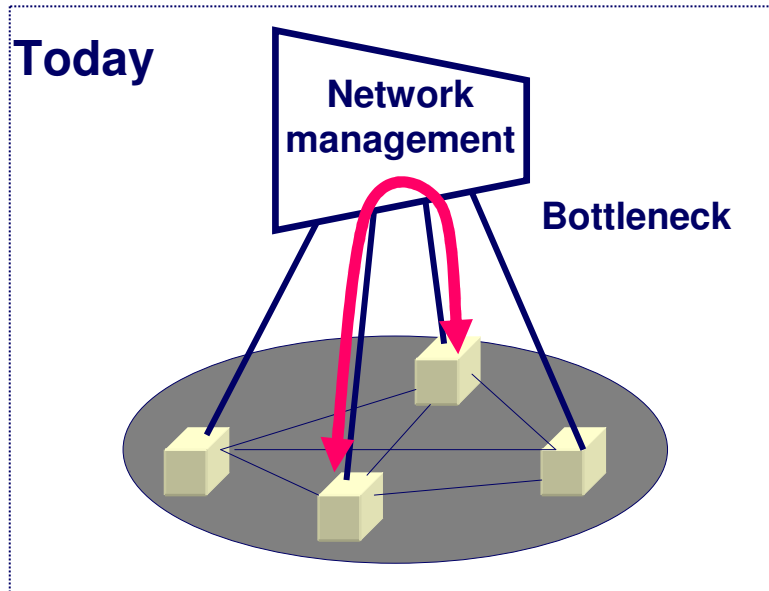
# Evolution from Standards to Deployment

Close relation of standardization and R&D activities

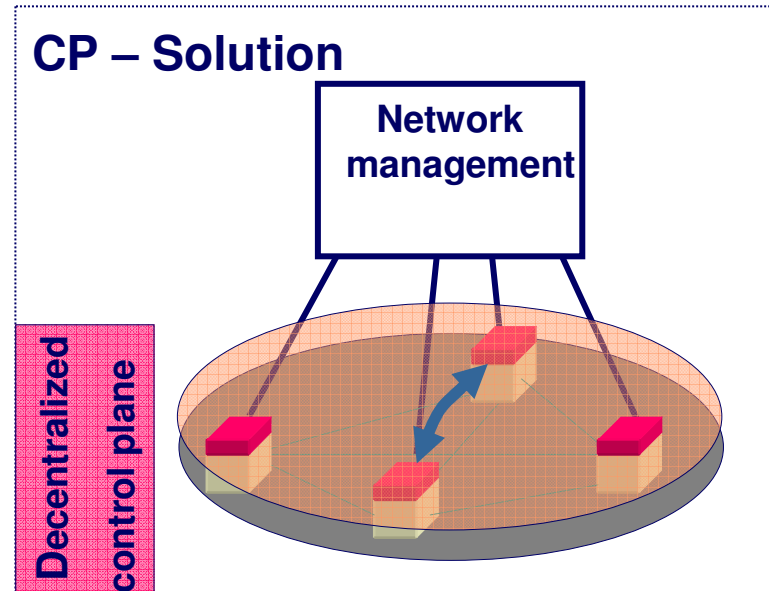


# Control Plane enabled Networks

## Reduced complexity of network management and control

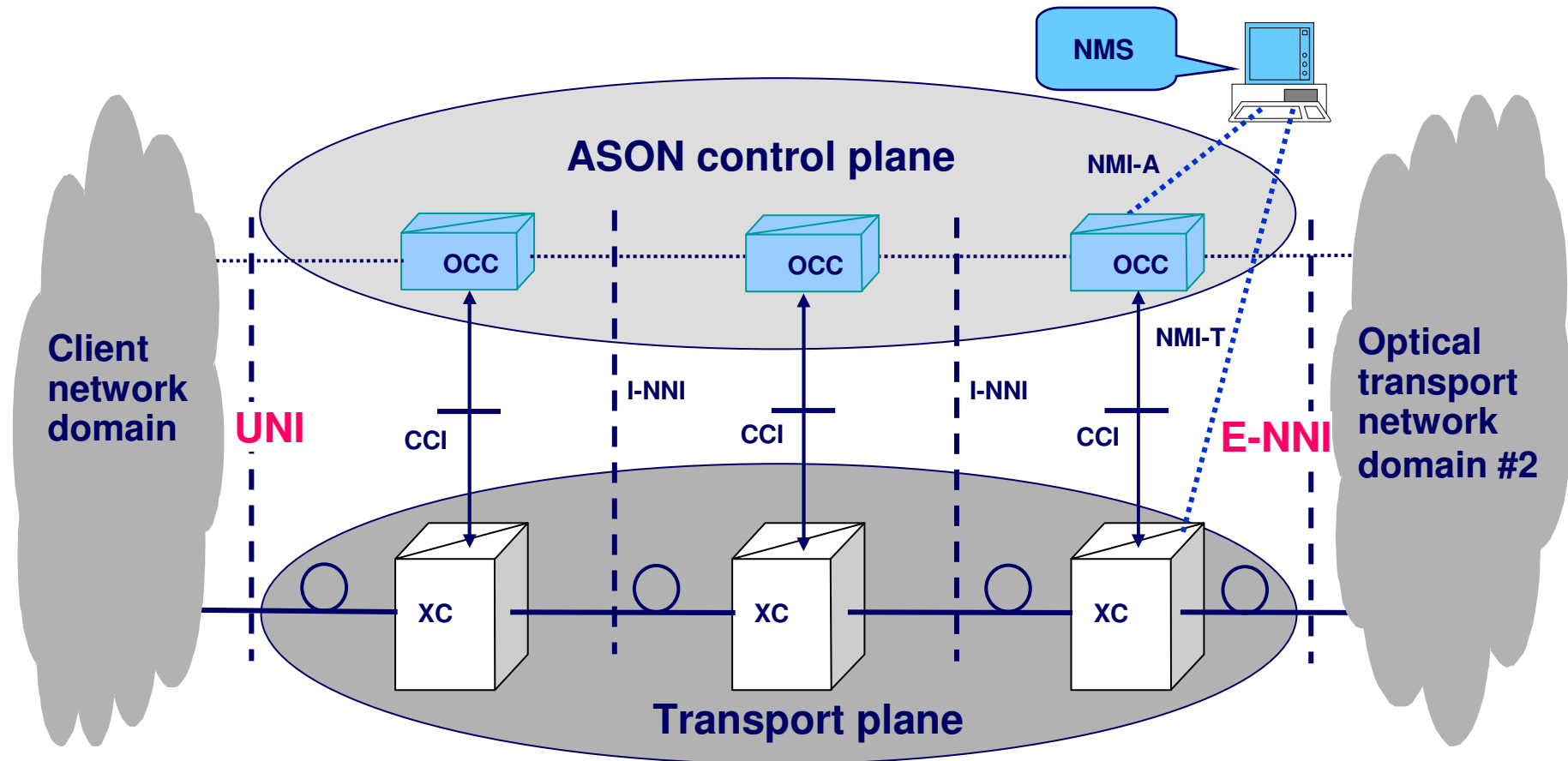


- **Every control communication** between nodes has to be handled **via the network management**
- A node has **no information about the network**
- Only **central** decisions
- **High complexity** of network management



- **Direct control communication** between nodes
- A node has **information about the network**
- **Local (and fast) decisions** are possible
- **Reduced complexity** of network management

# ASON Network Architecture



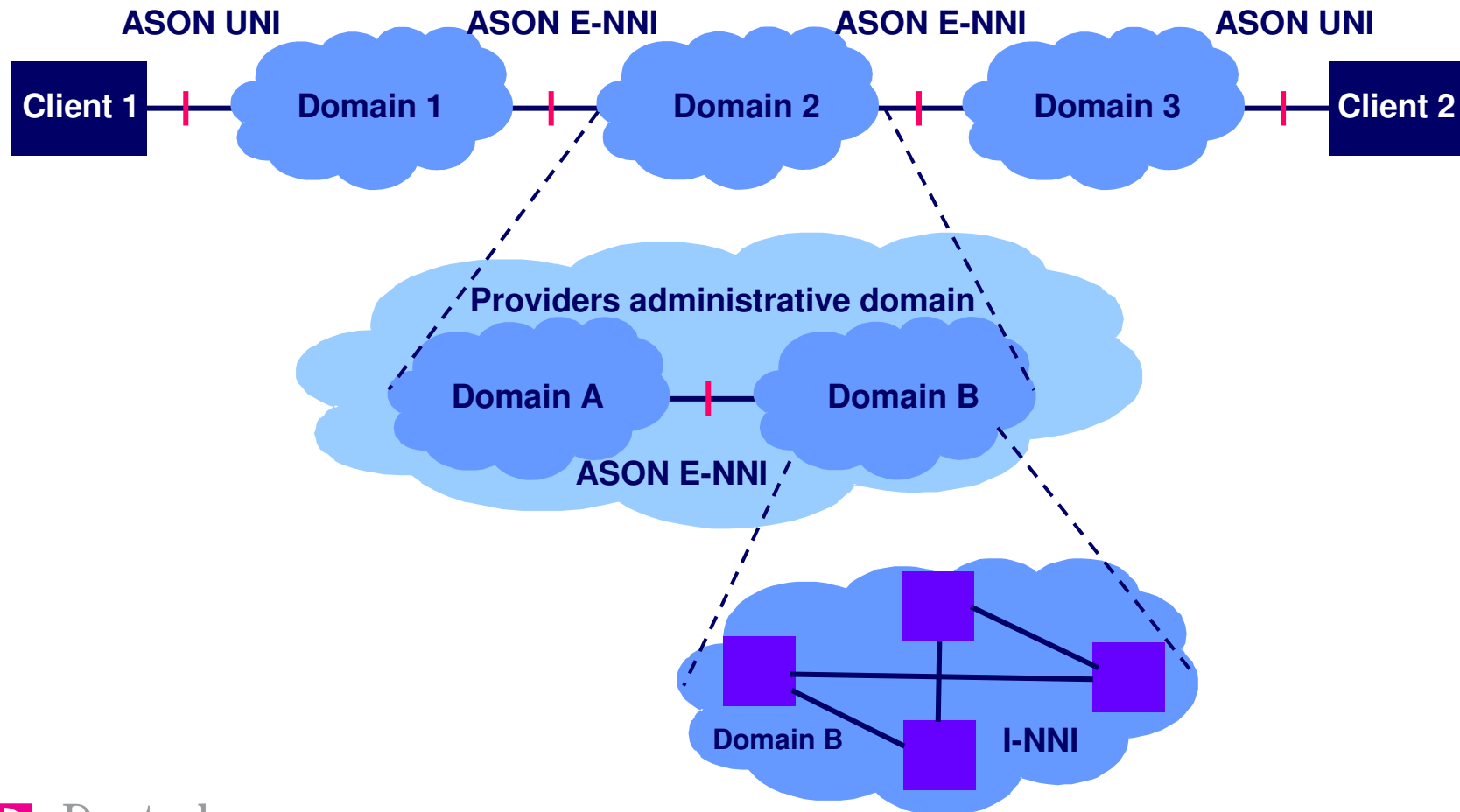
OCC: Optical Connection Controller  
 CCI: Connection Control Interface  
 NMS: Network Management System Interfaces

NNI: Network Network Interface  
 UNI: User Network Interface  
 NMI-A/T: Network Management



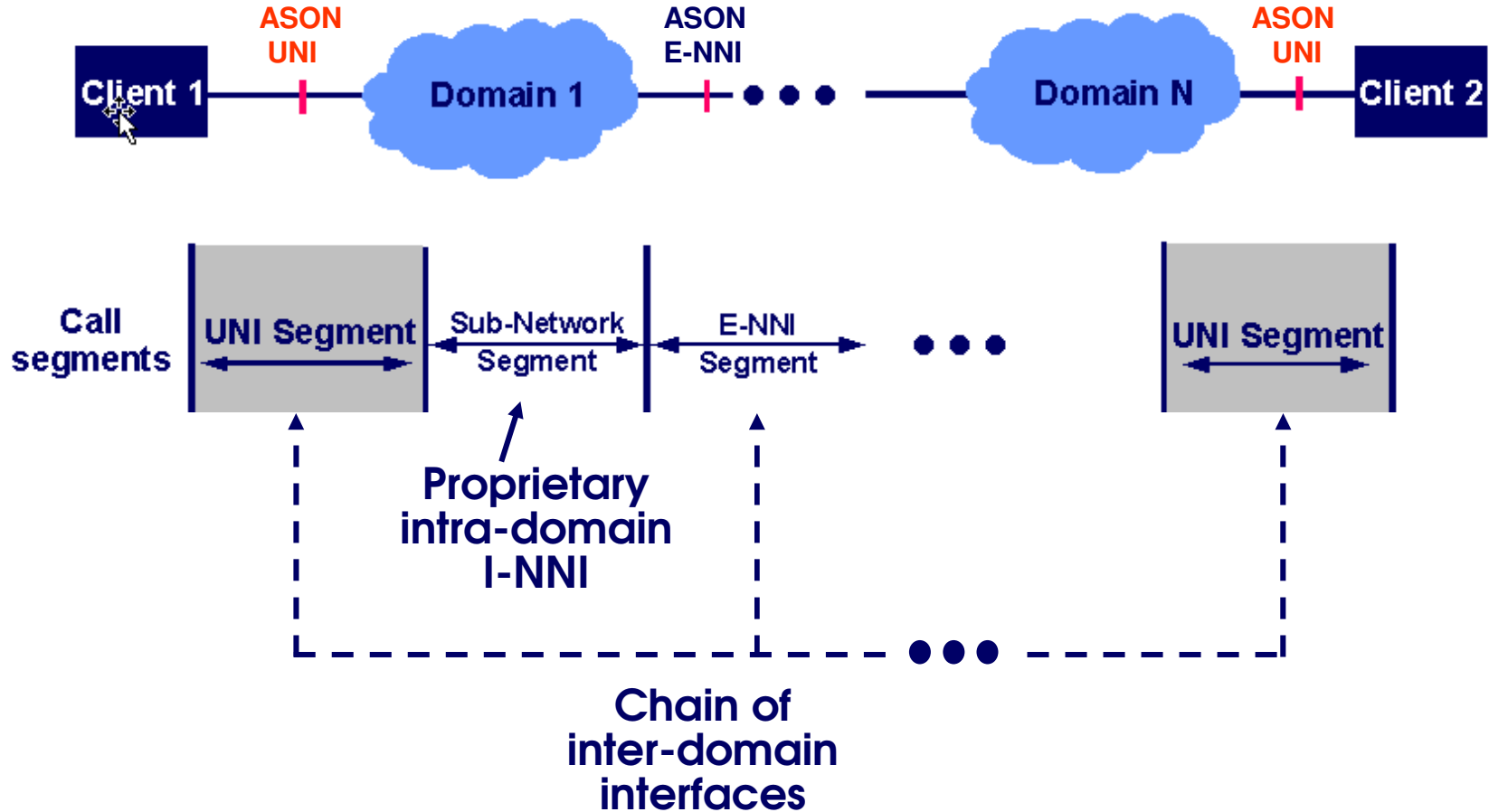
# ASON Multi-Domain Network Scenario

## Partitioning of networks – inter-domain interfaces



# Inter-Domain ASON Interfaces

Enable multi-domain, on-demand services



# ITU-T and OIF Collaboration

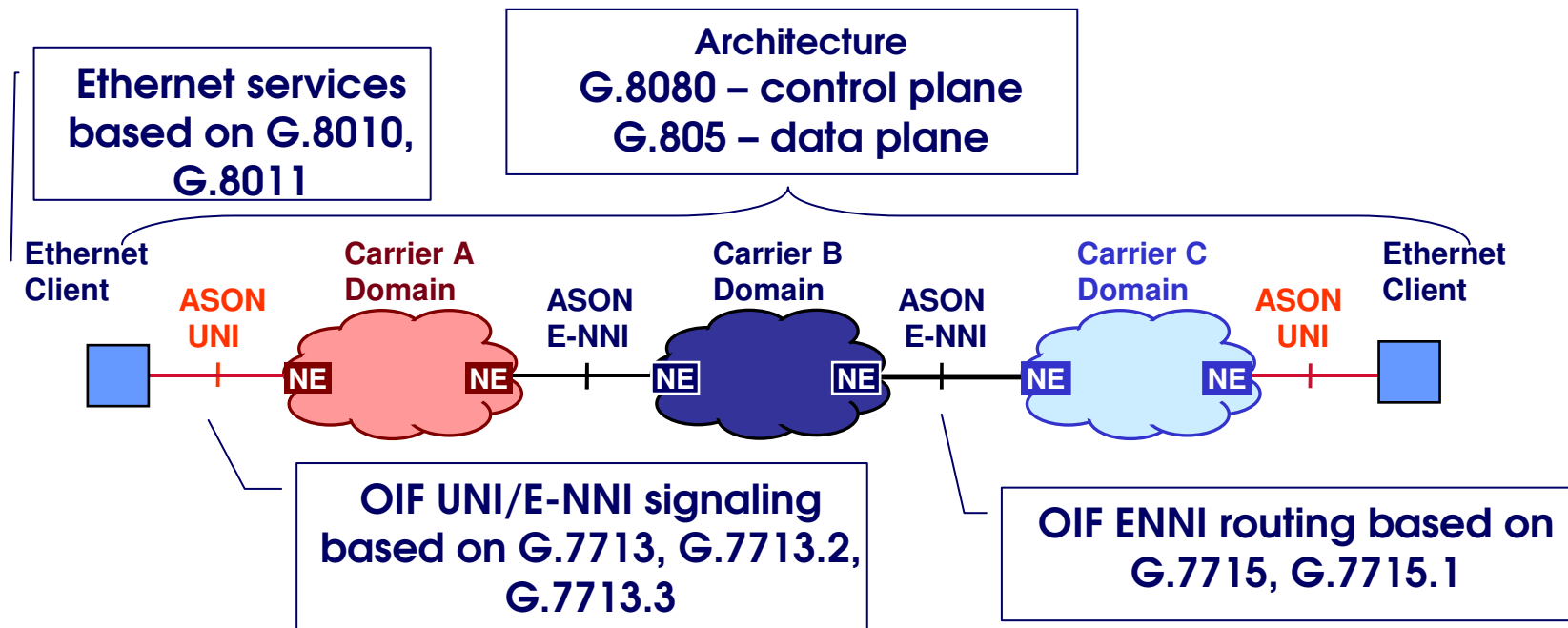
## Correlation of IUT-T and OIF standards/specifications

### OIF

- ◆ Carrier requirements
- ◆ Interoperability testing
- ◆ Protocol specifications in Implementation Agreement
- ◆ Adoption of ITU-T Recs.

### ITU-T

- ◆ ASON Recommendations for optical signaling and routing
- ◆ Transport Recommendations



# Outline

- ◆ Introduction
- ◆ External Network-Network-Interfaces (E-NNI)
- ◆ User-Network-Interfaces (UNI)
- ◆ Considerations from a carriers perspective
- ◆ Summary

# E-NNI Functions

## Main characteristics

- ◆ **The ASON E-NNI provides signaling and routing among different administrative ASON network domains**
- ◆ **Major features of the ASON E-NNI include:**
  - **Support for ASON call control**
  - **Hierarchical routing domains which enable scaleable routing control. This allows for partitioning of networks in local, regional, national and international levels**
  - **Based on OIF extensions to IETF GMPLS signaling and routing protocols**
  - **Successfully demonstrated at OFC 2003, SuperComm 2004 and 2005**

# E-NNI Functions

## Related standards and specifications

### OIF Implementation Agreements and draft specifications:

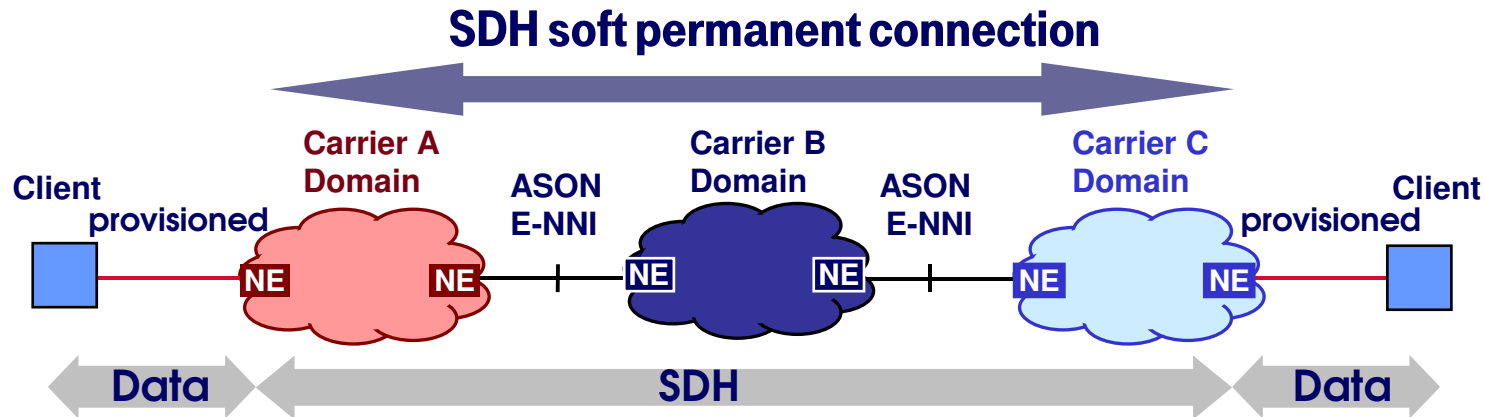
- ◆ E-NNI 1.0 signaling IA: Intra-Carrier E-NNI Signaling Specification
- ◆ oif2005.381, E-NNI 2.0 signaling: Update on signaling specification based on findings of the OIF interoperability event 2005
- ◆ oif2005.313, E-NNI 1.0 routing draft specification for intra-carrier E-NNI routing using OSPF
  - IA will include findings of the OIF interoperability event 2005

### ITU-T standards related to E-NNI:

- ◆ Data plane:
  - G.707, Network node interface for SDH, incl. VCAT function
  - G.805 – Functional architecture of transport networks
- ◆ ASON control plane:
  - G.8080: Architecture for ASON
  - G.7713: Distributed connection management
  - G.7715: Architecture and requirements for routing
  - G.7715.1: Routing architecture and requirements for link state protocols

# E-NNI Functions

## Inter-domain transport network interface



- ◆ E-NNI enable seamless interworking of multiple, individual (different architecture, technology, management,...) transport network domains
- ◆ Supports soft permanent connections (SPC): EMS/NMS initiated automatic connection provisioning over multiple ASON network domains
- ◆ SPCs could be used for all not control plane enabled client networks (no UNI function available) and for all signal formats for which UNI functions are not defined, e.g. SAN signal formats (FC)

# Outline

- ◆ Introduction
- ◆ External Network-Network-Interfaces
- ◆ User-Network-Interfaces
  - UNI 1.0R2, SDH based
  - UNI 2.0, focus on Ethernet
- ◆ Considerations from a carriers perspective
- ◆ Summary

# UNI 1.0 Release2 Functions

## Main characteristics

- ◆ **Support on-demand transport services for SDH clients**
  - **Signaling to automatically create, delete and query connections**
- ◆ **Signaling protocols based on GMPLS**
  - **RSVP-TE or CR-LDP with UNI extensions**
- ◆ **Service discovery & neighbor discovery**
  - **Based on OIF extensions to Link Management Protocol (LMP)**
- ◆ **UNI signaling mechanisms**
  - **Out-of-band or in-band control channels**
  - **Initiated either directly via client NE or via proxy server**

# UNI 1.0 Release2 Functions

## Related standards and specifications

### OIF Implementation Agreements (IA):

- ◆ **UNI 1.0 signaling specification, release 2**
  - **Common - user network interface (UNI) 1.0 signaling specification**
  - **RSVP extensions for user network interface (UNI) 1.0 signaling specification**

### ITU-T standards related to UNI 1.0 R2

- ◆ **Data plane:**
  - **G.707, Network node interface for the synchronous digital hierarchy (SDH), incl. VCAT function**
  - **G.805 – Functional architecture of transport networks**
  - **G.7042: Link Capacity Adjustment Scheme (LCAS)**
- ◆ **Control plane (ASON):**
  - **G.8080: Architecture for ASON**
  - **G.7713: Distributed connection management**

# Next Generation NG-SDH Functions

## Virtual concatenation (VCAT) of containers VC-12, VC-3, VC-4

Increasing the efficiency of data over SDH transport:

- ◆ VC-12-Xv (X \* 2.240 Mbit/s )
- ◆ VC-3-Xv (X \* 48.960 Mbit/s )
- ◆ VC-4-Xv (X \* 150.336 Mbit/s )

Client	Bitrate	in SDH	SDH Efficiency
Ethernet	10 Mbit/s	VC-12-5v	~ 89 %
Fast Ethernet	100 Mbit/s	VC-3-2v	~100 %
Gigabit Ethernet	1 Gbit/s	VC-4-7v	~ 96 %
Fiber Channel/FICON	1.0625 Gbit/s	VC-4-8v	~ 89 %
Digital Video	270 Mbit/s	VC-4-2v	~ 90 %
Serial Digital HDTV	1.485 Gbit/s	VC-4-10v	~ 100 %

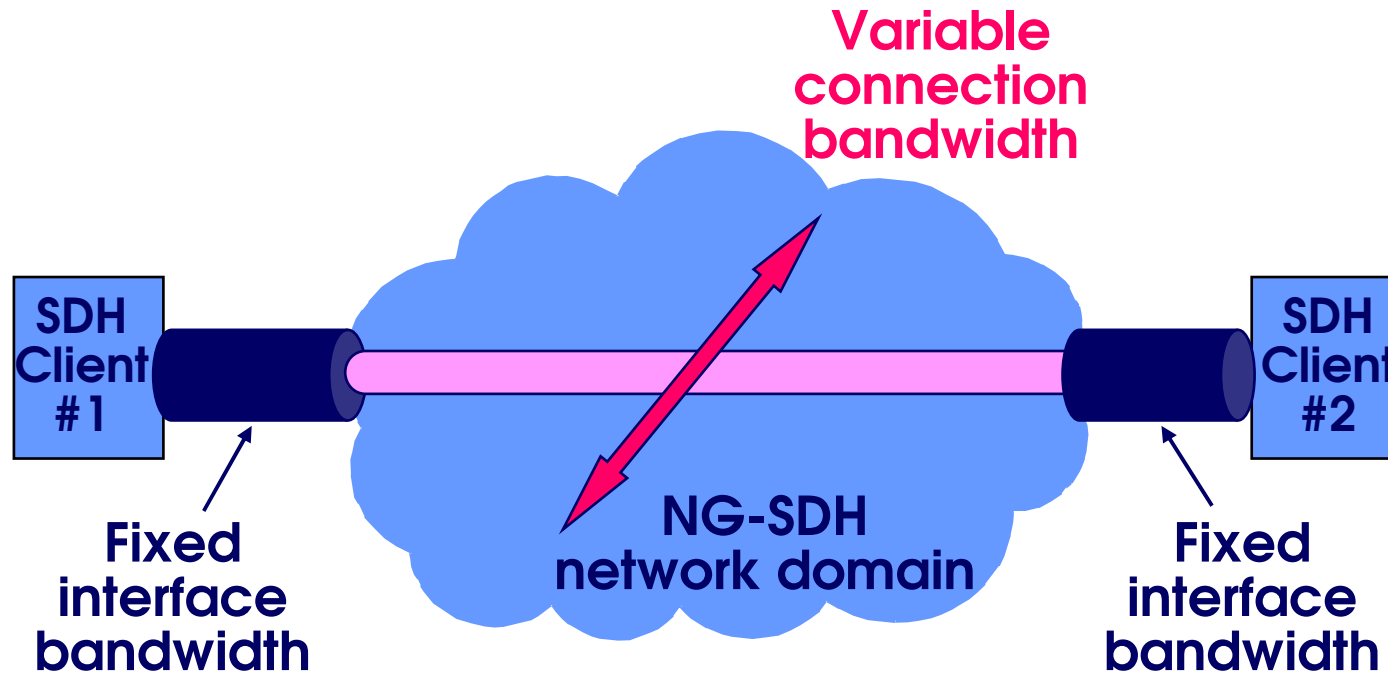
# Next Generation NG-SDH Functions

## Link Capacity Adjustment Scheme (LCAS)

- ◆ LCAS is a methodology for dynamically and smoothly changing (i.e., increase and decrease) the capacity of a container that is transported in a generic transport network (e.g., over SDH or OTN network using Virtual Concatenation)
- ◆ LCAS in the virtual concatenation source and sink adaptation functions provides a control mechanism to smoothly increase or decrease the capacity of a VCG (Virtual Concatenation Group ) link to meet the bandwidth needs of the application
- ◆ Main goal: Synchronization of changes of capacity

# Next Generation NG-SDH Functions

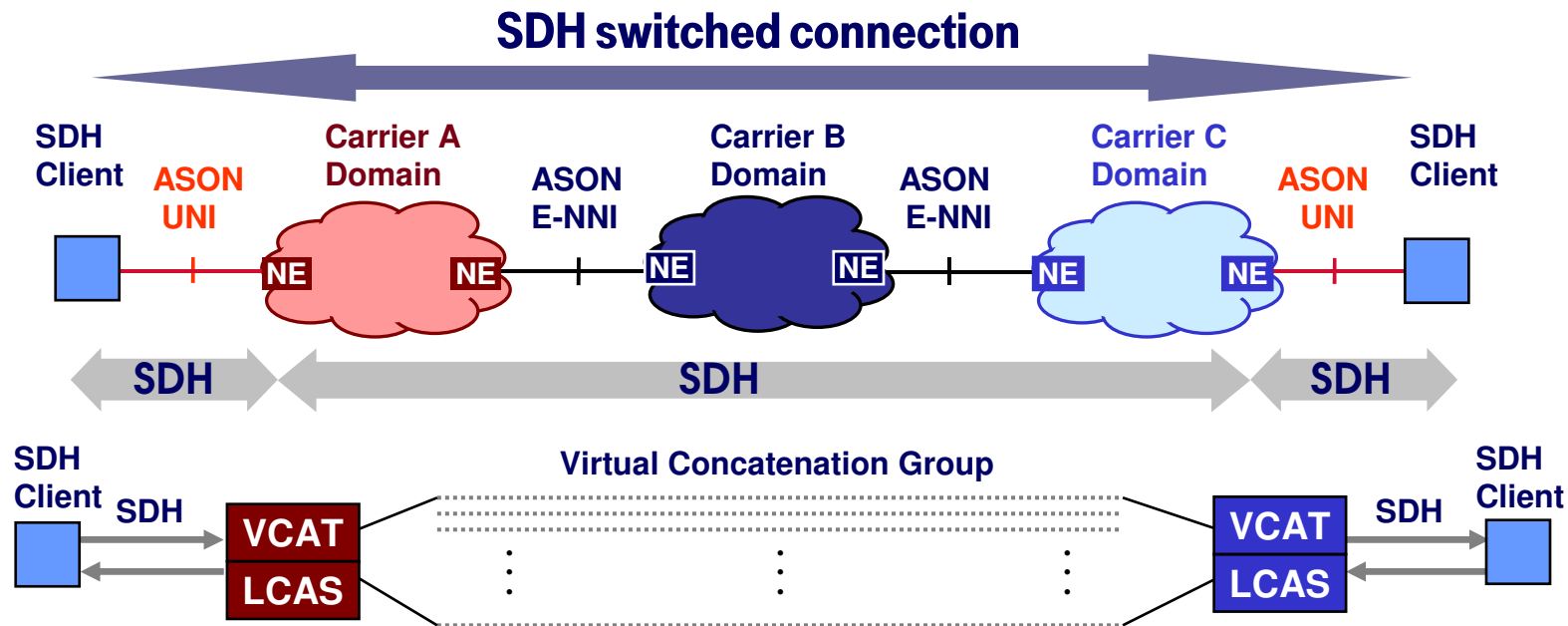
## Virtual concatenation (VCAT) and LCAS



**Interface bandwidth is decoupled from the bandwidth of the connection in the transport network!!!**

# UNI1.0 Release2: Data Plane

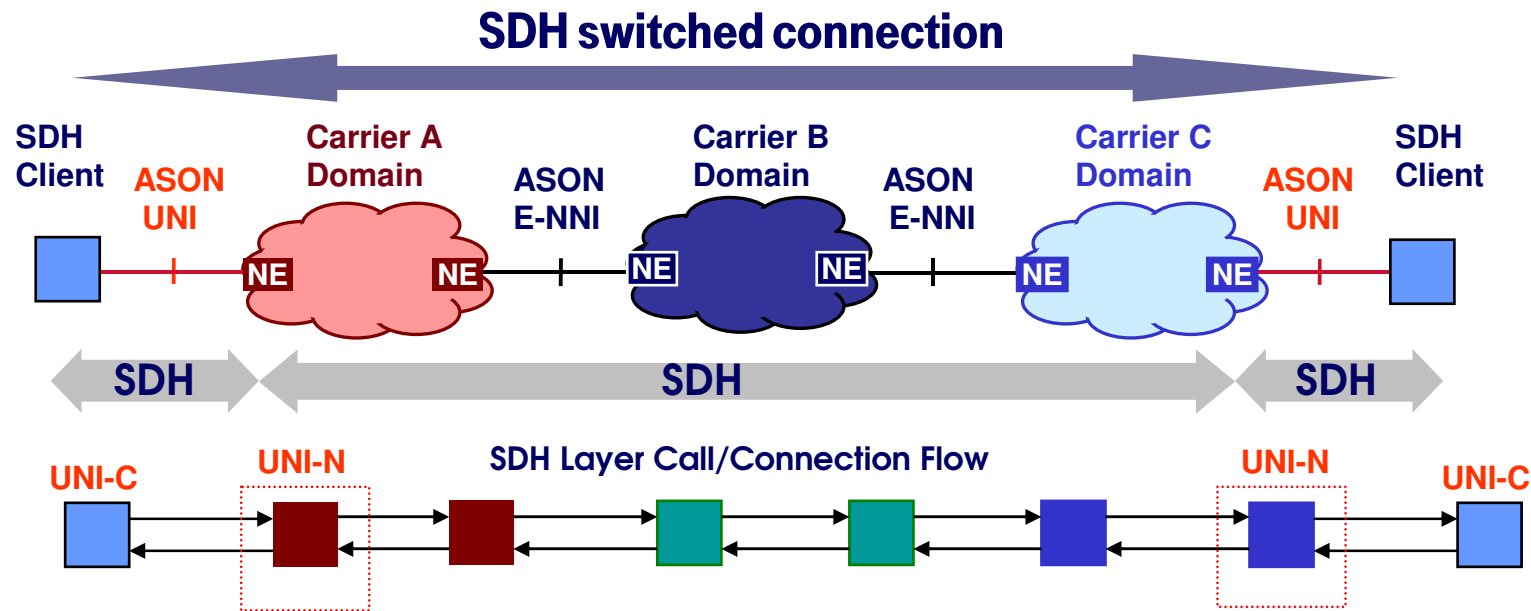
## Data plane flow of SDH switched connections (UNI 1.0R2/E-NNI)



The SDH transport network domains connect the client domains with VC-x-nv according to the requested bandwidth

# UNI1.0 Release2: Control Plane

## Control plane flow of SDH-SC (UNI 1.0R2/E-NNI)



- ◆ OIF UNI1.0 signaling interfaces enable customers to directly signal their SDH transport requests to the appropriate transport networks
- ◆ Including E-NNI inter-domain interfaces, on-demand SDH service provisioning over multiple ASON domains could be configured

# UNI 2.0 Functions

## Main characteristics

- ◆ UNI2.0 is based on UNI1.0R2 functions
- ◆ The UNI 2.0 provides advanced services and applications to leverage capabilities of UNI 1.0
  - Driven by carrier priorities
  - Aligned with OIF E-NNI developments
- ◆ Major UNI 2.0 enhancements:
  - Call control for ITU-T ASON compliance
  - Additional transport signal types:
    - Ethernet
    - G.709
    - sub STS-1 rates
  - Control plane security
  - Improved network resiliency

# UNI 2.0 Ethernet Functions

## Related standards and specifications

### OIF draft specifications:

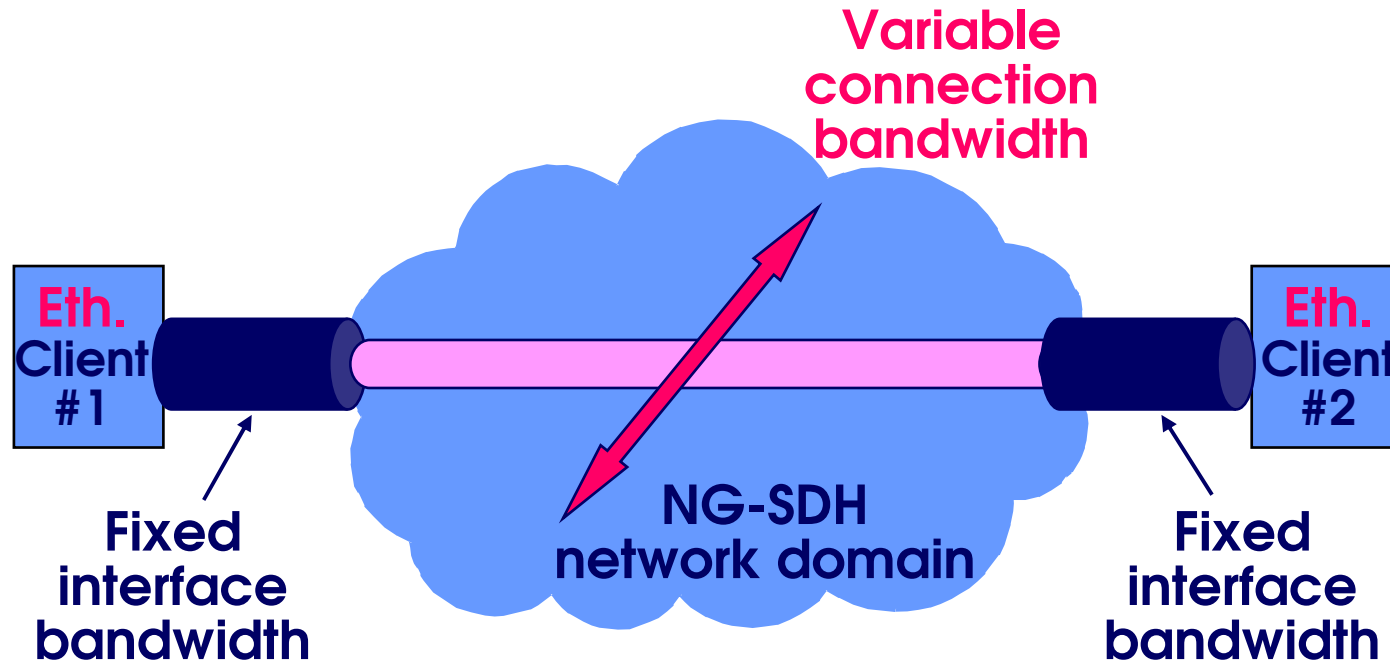
- ◆ oif2005.204.01 User Network Interface (UNI) 2.0 signaling specification: Common part (draft document)
- ◆ oif2005.205.00 RSVP extensions for User Network Interface (UNI) 2.0 signaling specification (draft document)

### ITU-T standards related to UNI 2.0 Ethernet

- ◆ **Data plane:**
  - **G.805: Functional architecture of transport networks**
  - **G.707: Network node interface for SDH, incl. VCAT function**
  - **G.7041: Generic Framing Procedure (GFP)**
  - **G.7042: Link Capacity Adjustment Scheme (LCAS)**
  - **G.8010: Architecture of Ethernet layer networks**
  - **G.8011: Ethernet over Transport – Ethernet services framework**
- ◆ **Control plane (ASON):**
  - **G.8080: Architecture for ASON**
  - **G.7713: Distributed connection management**

# Next Generation NG-SDH Functions

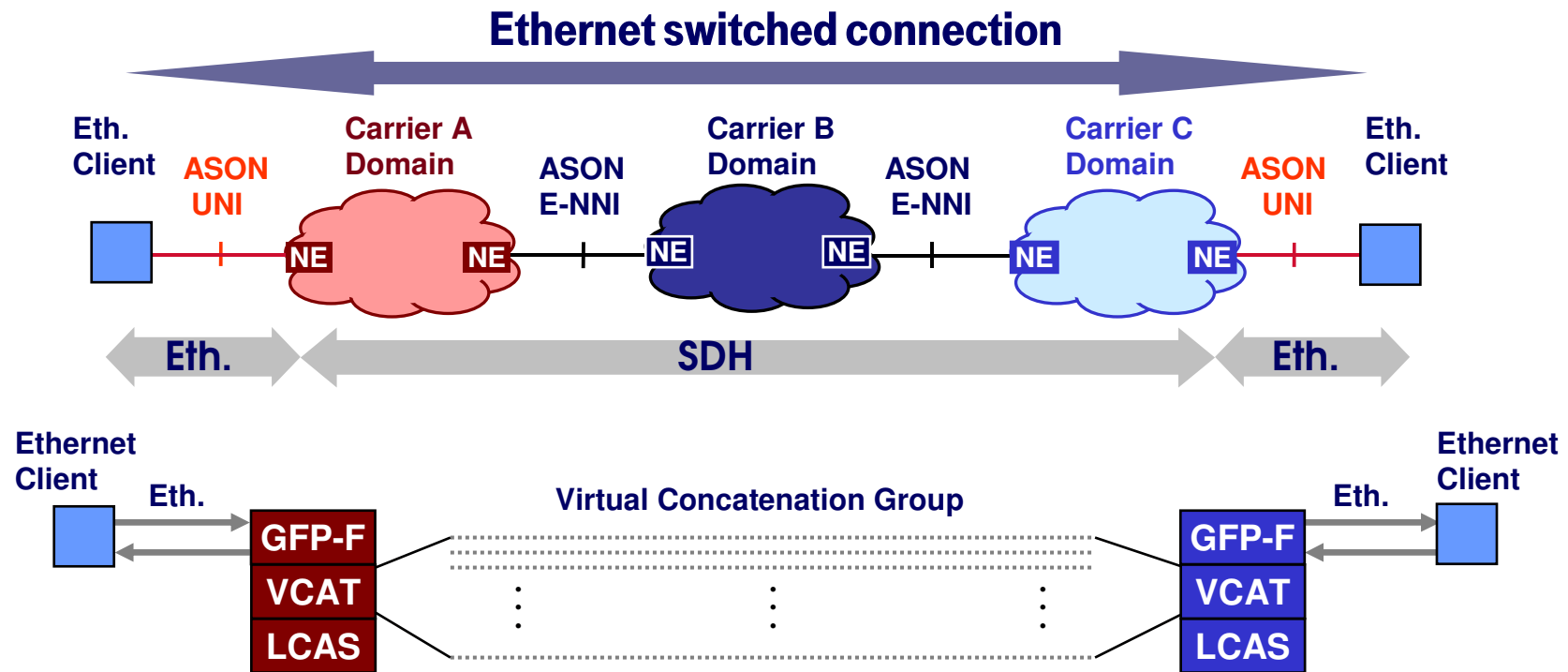
## Virtual concatenation (VCAT), LCAS and GFP-F



**Interface bandwidth is decoupled from the bandwidth of the connection in the transport network!!!**

# UNI2.0 Ethernet: Data Plane

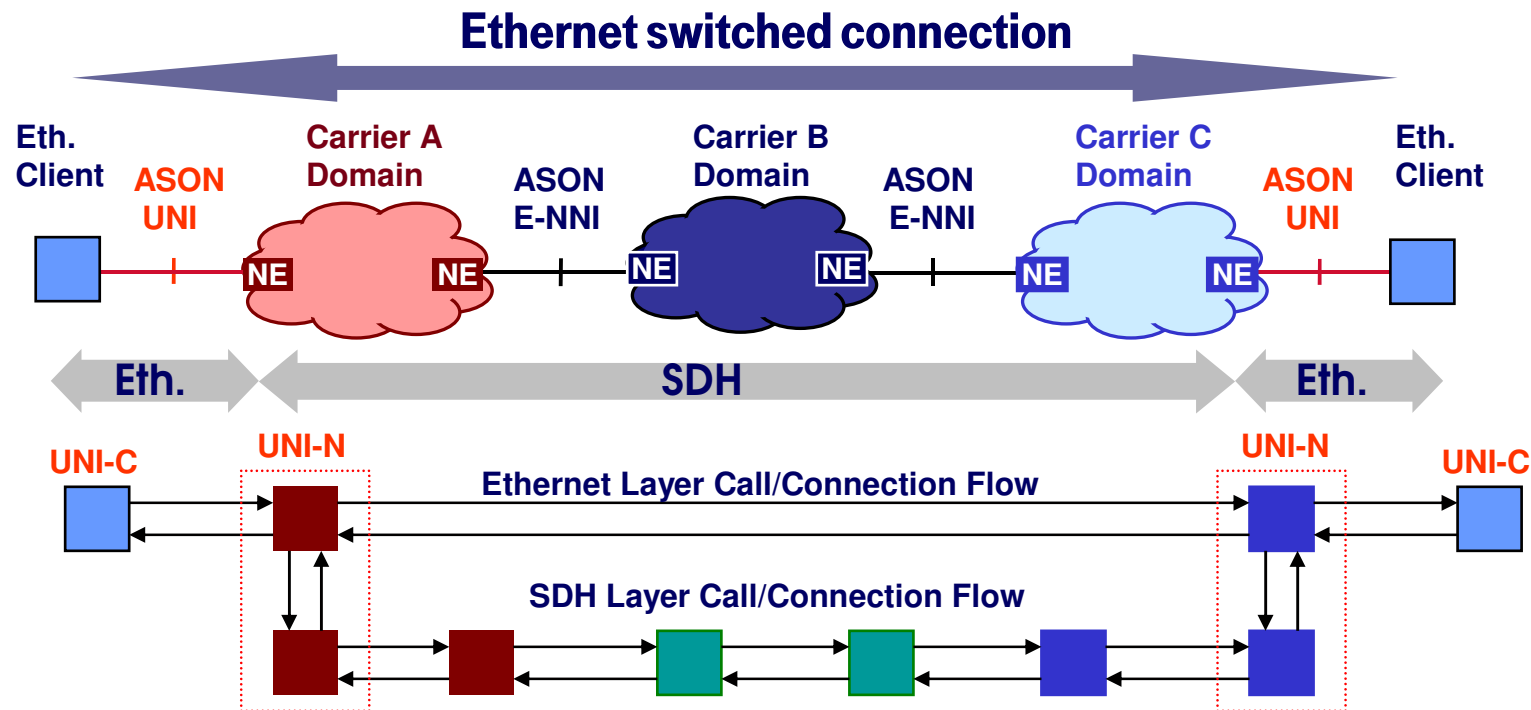
## Data plane flow of Ethernet-SC (UNI 2.0 Eth/E-NNI)



The SDH transport network domains connect the Ethernet client domains with VC-x-nv according to the Ethernet service bandwidth requested

# UNI2.0 Ethernet: Control Plane

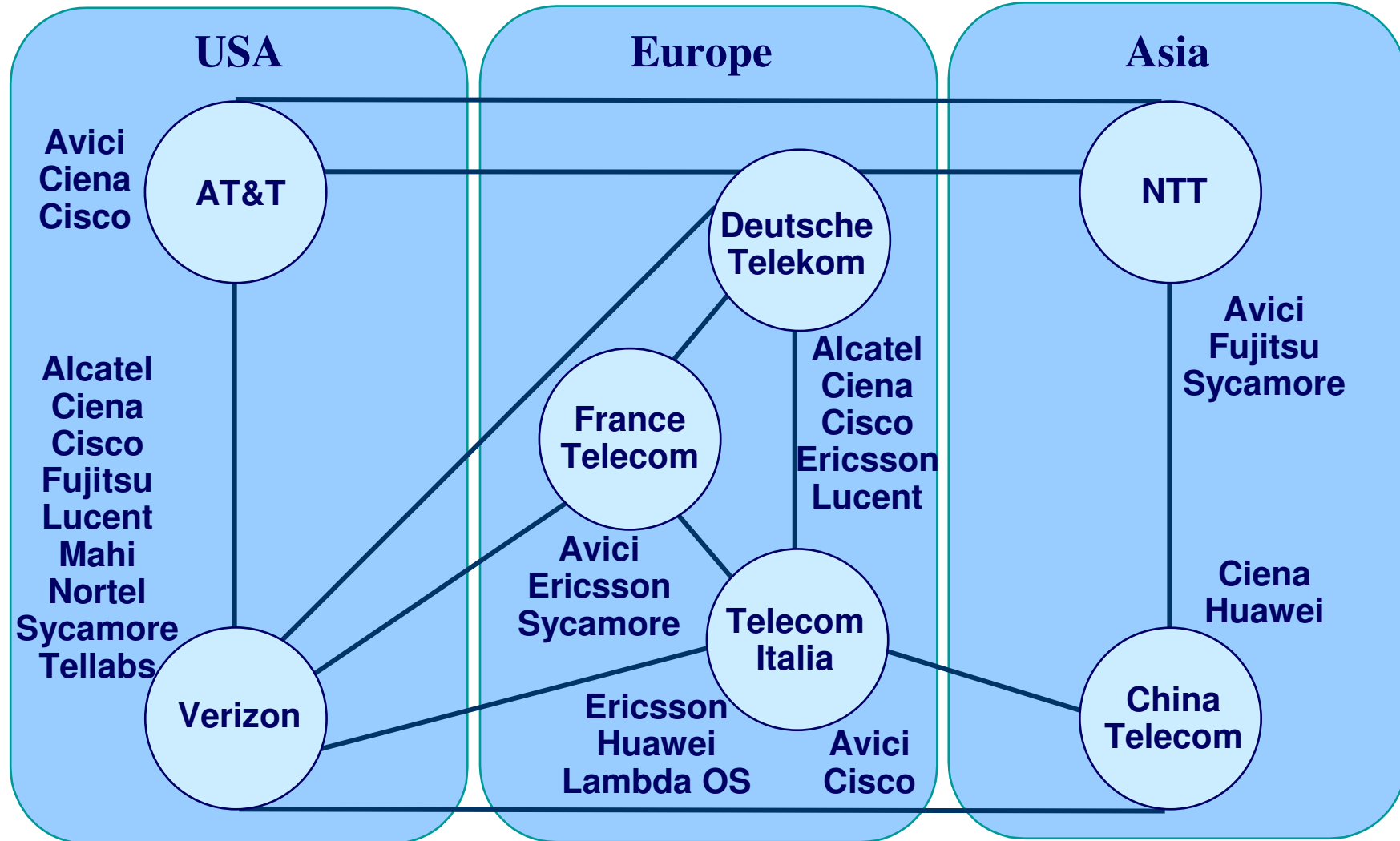
Control plane flow of Ethernet-SC (UNI 2.0 Eth/E-NNI). First multi-/dual-layer, integrated data and control plane solution



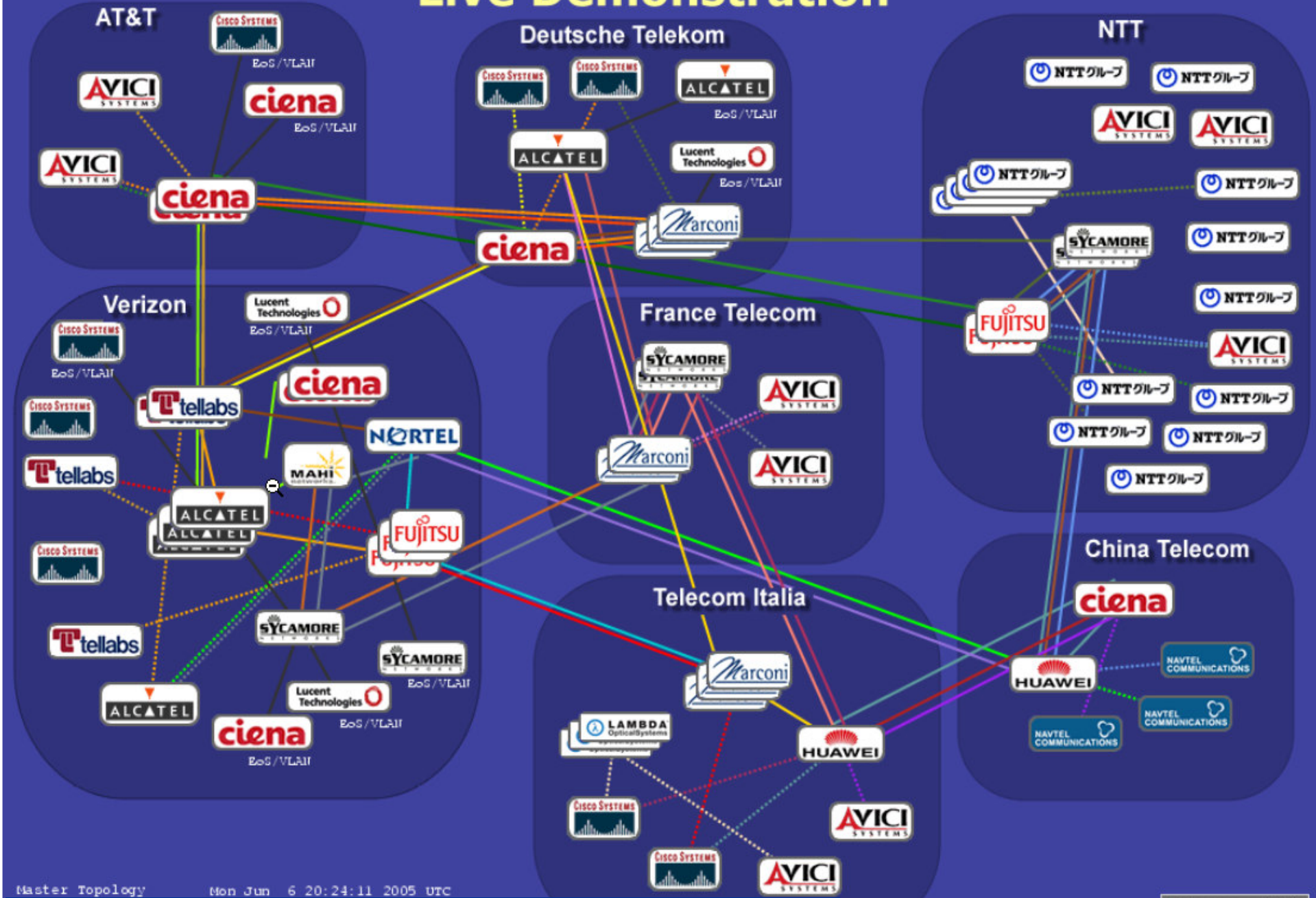
- ◆ ASON UNI2.0 Ethernet signaling interfaces enable customers to directly signal their Ethernet transport requests to SDH based ASON transport networks
- ◆ Including E-NNI intra-domain interfaces, automatic Ethernet service provisioning over multiple domains could be configured

# OIF Interoperability Demonstration 2005

## Global test network topology



# Live Demonstration



Master Topology Mon Jun 6 20:24:11 2005 UTC

[http://www.oiforum.com/public/supercomm\\_2005v1.html](http://www.oiforum.com/public/supercomm_2005v1.html)

Compress VCAT  
Ethernet SONET/SDH Both Mixed

# Outline

- ◆ Introduction
- ◆ External Network-Network-Interfaces
- ◆ User-Network-Interfaces
- ◆ Considerations from a carrier's perspective
  - **Mainly focused on UNI2.0 Ethernet and E-NNI**
- ◆ Summary

# Multi-layer, integrated DP & CP Solution

Efficient, integrated multi-layer solution

**UNI 2.0 Ethernet: First multi-/ dual-layer, integrated data and control plane solution within a network domain, enabling:**

- ◆ **Automatic, dual-layer connection provisioning**
- ◆ **Efficient inter-layer interworking**
- ◆ **Concept could be extended to any other dual/multi-layer approach**

# Multi-layer, integrated DP & CP Solution

Mandates cooperation among SDOs and forums

Data and control plane functions integration mandates integration of function from different SDOs / forums and therefore their close cooperation, e.g. for UNI2.0 Ethernet:

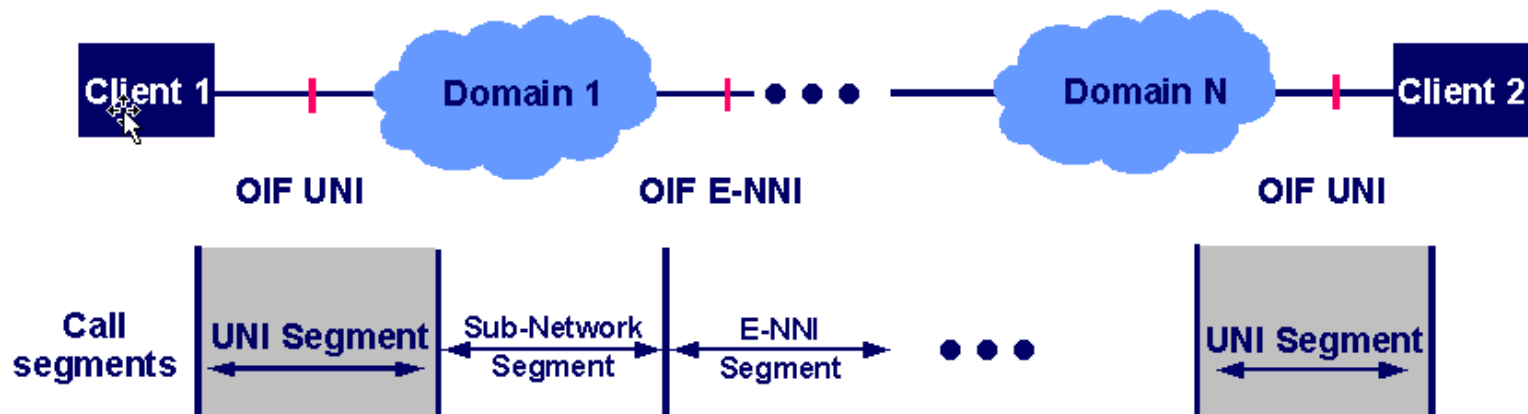
- ◆ OIF UNI2.0 Ethernet specification
- ◆ ITU-T set of ASON Rec.
- ◆ ITU-T set of NG-SDH Rec.
- ◆ ITU-T set of Ethernet service Rec.
- ◆ MEF Ethernet service specifications
- ◆ IEEE set of Ethernet standards
- ◆ IETF signaling standards

# Interoperability of UNI & E-NNI functions

## Multi-domain coverage of client controlled services

Interoperable UNI and E-NNI specifications and implementations ensure multi-domain coverage of services invoked by transport network clients via UNI

- ◆ Ethernet and SDH/SONET switched connections
- ◆ Address correctly the multi-domain carrier environment of today and future
- ◆ Enable national and global service coverage



# Separation of TN and client view

Independent technology platforms used by TN and client

Using UNI2.0 Ethernet the client and transport network (TN) view is separated not only on the control plane level, but even on the technology level (data plane), enabling

- ◆ Client Ethernet view and functions
- ◆ For the TN an independent selection of the technology platform as appropriate, e.g.
  - **Native Ethernet**
  - **SDH/SONET**
  - **OTN**

# UNI-C 2.0 Ethernet – Client Interface

As simple as possible

Client could stay with the preferred Ethernet functions, capabilities and know how, all the needed adaptation and multi-domain issues are accomplished by the TN: UNI-N and E-NNI interfaces.

Nevertheless the UNI-C control plane functions have to be implemented by the clients!

- ◆ How to insure broad implementation/deployment of UNI-C 2.0 Ethernet interfaces in a client environment not familiar with control plane topics??
  - **Advertisement & education, by making the implementation easy to understand (cookbook)**
  - **Making UNI-C 2.0 Ethernet proxy commercially available**

# Summary

**ASON/GMPLS inter-domain interfaces build the bases for interoperable solutions and carrier benefits:**

- ◆ **Provisioning of end-to-end dynamic connections for flexible data services over multiple, control plane enabled SDH domains**
- ◆ **Deploy at faster pace innovative network technologies**
- ◆ **Select cost effective and leading edge network elements, platforms and multi-vendor solutions**
- ◆ **Reduce operations overheads and simplify provisioning of new services**