Scuola Superiore Sant'Anna

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Virtualization and service abstraction for network and non-network resources

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Outline

- Concepts and definitions
- Network resources
  - Service Platforms and service interface
  - Use cases
- IT resources
  - The Grid case
- Joint handling of network and IT resources
  - Single domain and multi-domain view
- Conclusion and open issues

Introduction and definitions (1)

- Network resource
  - a network capability of supporting (set-up, configure, monitor, tear-down) forwarding of data, possibly across multiple nodes, according to a certain encapsulation (e.g. a MPLS L2 LSP)
- Non-network (or IT) resource
  - a data processing capability over the payload of a data flow, realized in software or in hardware in a network node (e.g. a random access memory)
- Network service
  - a service, described in a technology-independent way, implemented in the provider's network that, leveraging on network resources, offers connectivity capabilities, directly or indirectly, to the customers' applications (e.g. a L2 VPN)
- Non-network service
  - a service, described in a technology-independent way, implemented in the provider's network or in another network attached to it, that leveraging on an IT resources offers a data manipulation capability (e.g. a storage service).

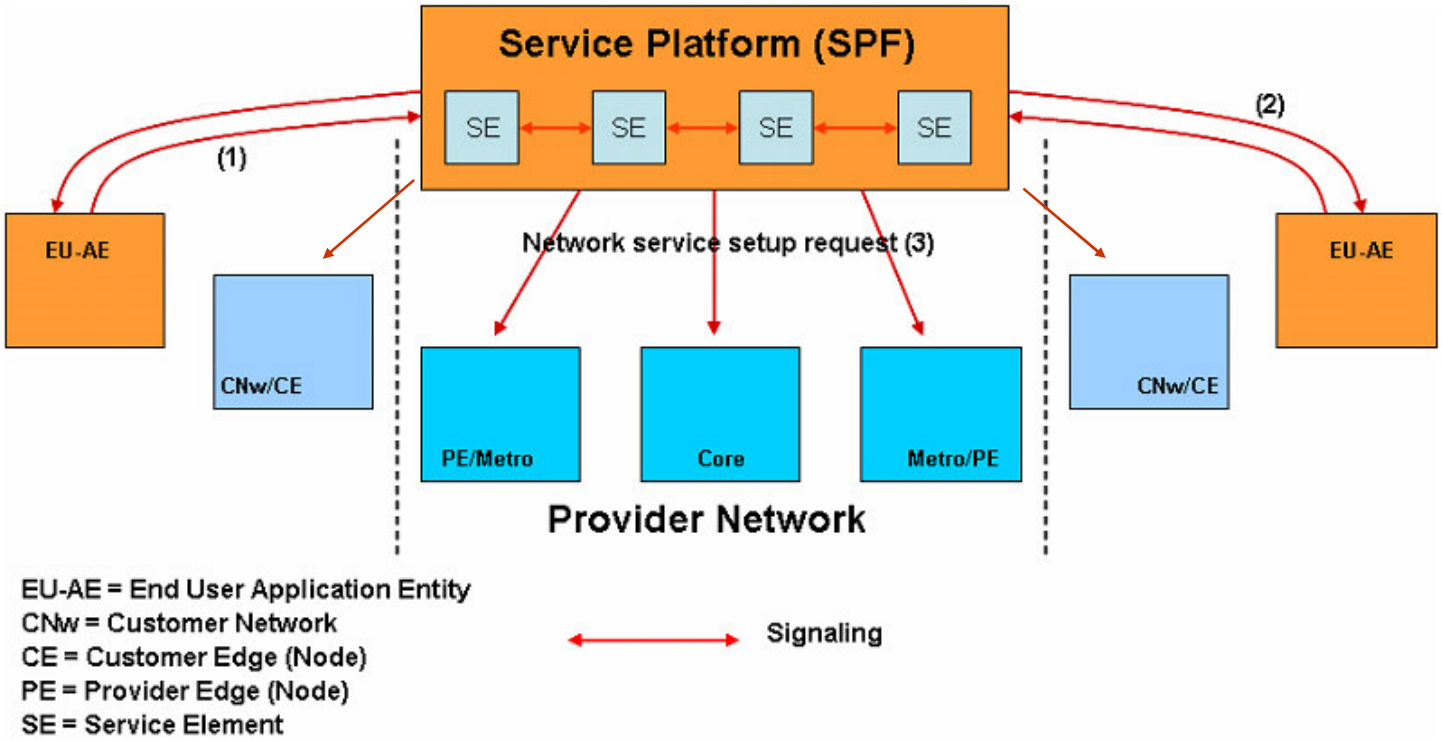
Introduction and definitions (2)

- Virtualization of resources
  - capability to hide the network resource technology details to an application
- Service abstraction
  - capability to map the set of high-level parameters specified by an application, into a set of specific parameters used by the network for the provisioning of that service.
- The process of service abstraction requires virtualization of resources, defining a Service-Oriented Architecture (SOA)
  - In a SOA, resources on a network are made available as independent services that can be accessed without knowledge of their underlying platform implementation.
  - In a SOA services are defined by an ontology language to facilitate their composition.
  - In a SOA semantic rules can be defined to compose or orchestrate services
- Virtualization of resources and service abstraction are typically realized by Service Platforms (SPF)
- Service Platforms already exist for access networks (e.g. IP Multimedia Subsystem, IMS)
- Why and how extend this concept for metro/core networks?

Why virtualization of resources and service abstraction?

- For network resources, the driver is given by bandwidth-greedy applications
- For joint network and IT resources the driver is given by complex applications such as grid, or virtual terminals
- Environment: Control Plane enabled transport networks
- Facts:
  - No mechanism is foreseen in the transport or application domains for the direct optimization and aggregation of connectivity requested by applications,
  - A change in the network technology or in the network topology requires the need to change the customer service request primitives
  - Network Providers do not want to reveal their technology and topology details to their customers,
  - For complex services, an application should be able to interact with *several* (edge) transport nodes involved in the provisioning of that service,
- Approach:
  - Decouple network technologies from future evolution of the network services offerings
  - Unburden the control plane of service oriented functionalities and let it focus on the provisioning of connectivity services.

Network services
The service signaling level



- A Service Platform (SPF) is an entity that allows network service set-up and control by an Application Entity (AE):
  - Arrow (1) denotes service control messages (service request/indication/response) primitives issued to the SPF by the source EU-AE
  - arrow (2) denotes the primitives exchanged with the destination EU-AE(s).
  - Service control messages labelled by (3), are a set of messages that give a set of rules (i.e., policies enforcement) to trigger the actual network service (i.e. CP protocol)

Architecture of a Service Platform

- Service Platforms are composed by centralized and distributed entities
- The centralized entities of a SPF generally support
  - the client authentication
  - the (network) service authorization
  - the (network) service accounting
- The distributed entities generally deal with SPF functionalities regarding the SPF interactions with AEs and edge network nodes:
  - the abstraction of the (network) services provided via User-to-Service Interface
  - the virtualization of the (network) resources
  - the capability to request (network) services to the CP via a technology-dependent interface
  - the support of the dynamic aspect of the service provisioning such as the discovery, arrangement, and composition of specific (network) services.
- How can we implement a Service Platform for a metro/core network based on GMPLS Control Plane?

Application-network interaction

- The User-to-Service Interface (USI) is an evolved interface that must enable the application entity to require services:
  - provided by different administrative network domains
  - without dealing with the network technology details
  - without dealing with the network topology details
- The USI must support:
  - both executive on multiple administrative domains or informative services on an administrative domain
  - the transparency of applications across multiple domains
  - session-based services (e.g., high-definition multimedia, grid)
  - non-session-based services (e.g., e-Business transactions)

A network service - The VPLS

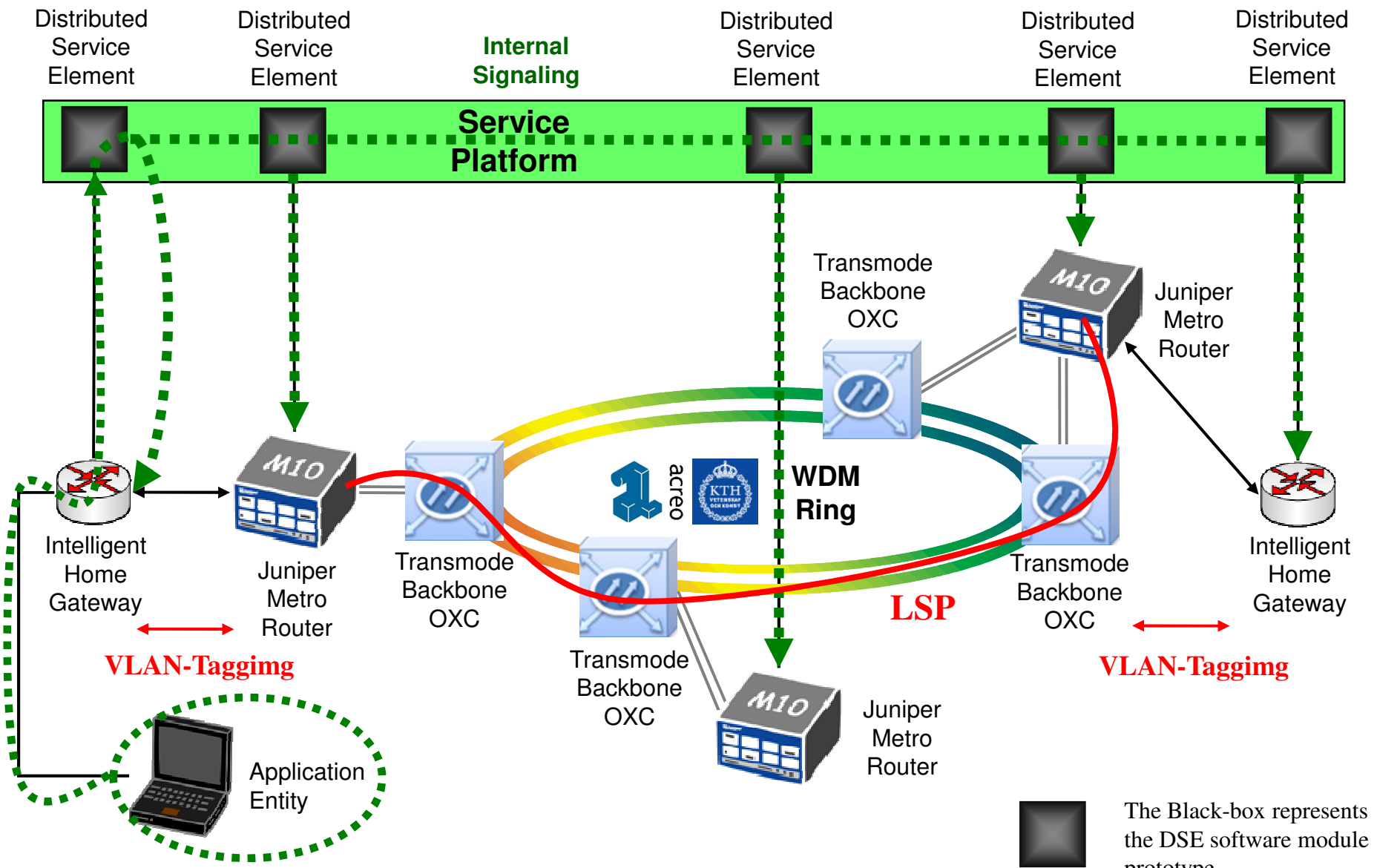
- The **Virtual Private LAN Service (VPLS)** is an architecture that emulates LAN using the shared physical IP backbone (RFC4761)

- The VPLS is based on :
  - Layer 2 VPN Architecture (full L2 learning and switching capabilities)
  - Virtual LAN (VLAN tagging)
  - MPLS transport network architecture
- The main Benefits are **:**
  - The possibility of multi-point connectivity
  - The network devices hardware is already aware
- Respect to a simple LSP
  - VPLS provide to a superior coordination at the Metro edge
  - VPLS provide a private routes database
- Respect to VPN L3 architecture:
  - VPLS increases the knowledge towards the end-user domain

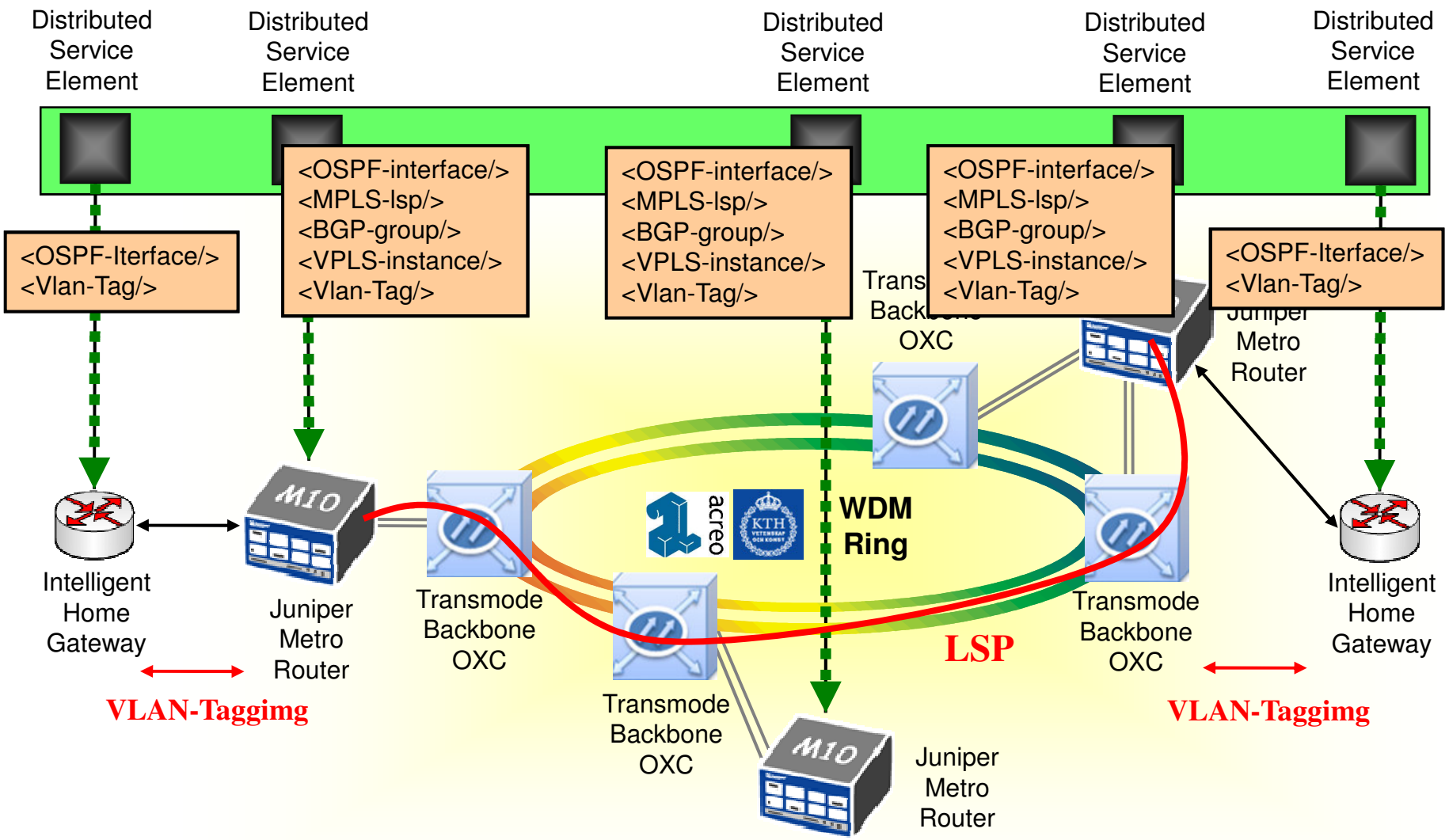
- **Drawbacks:**
  - Complicated provisioning
    - Complex operational setup
    - Complex network design

How to "mask" the complexity of the provisioning Operations?

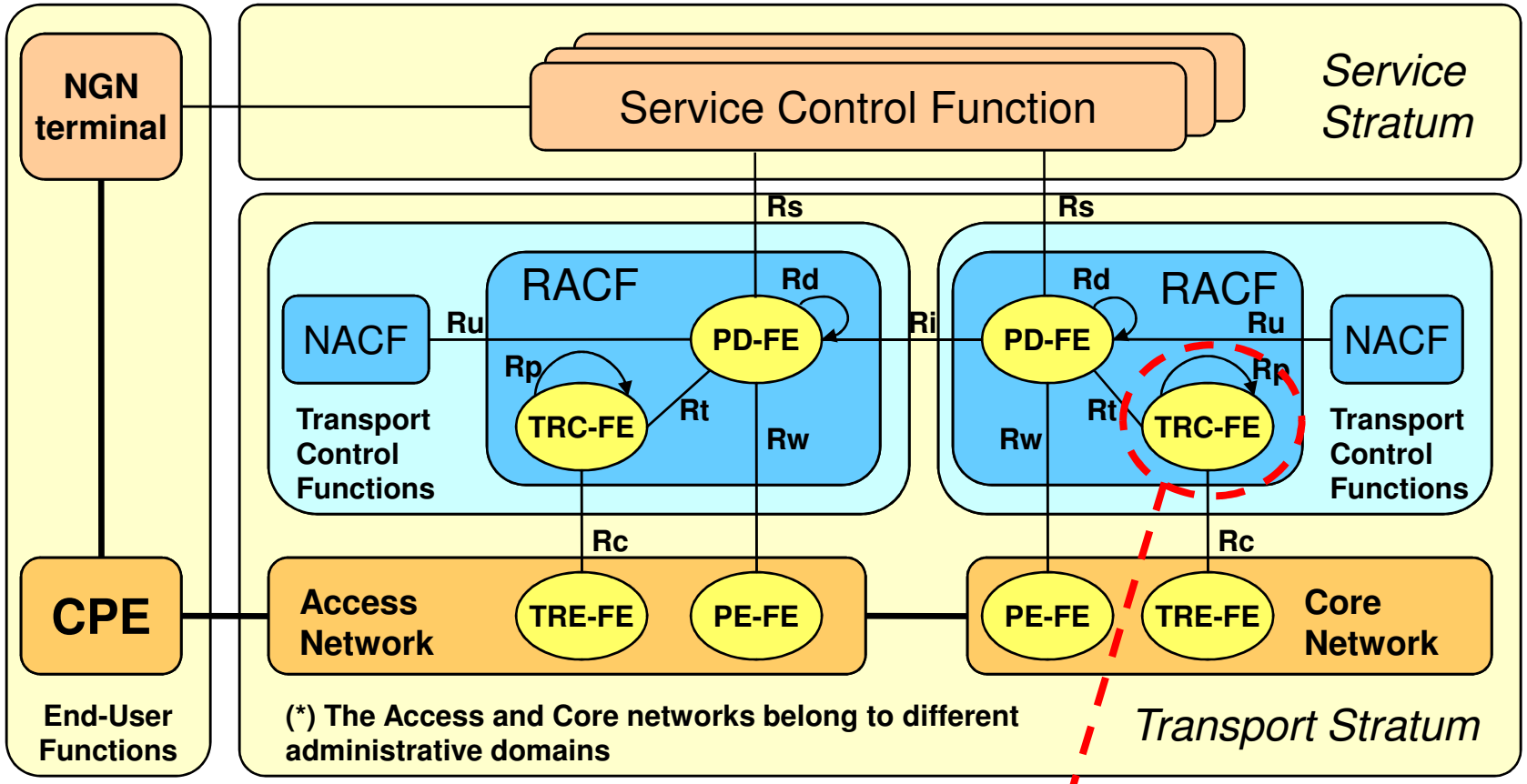
A practical use case – Logical view



A practical use case - VLAN Script



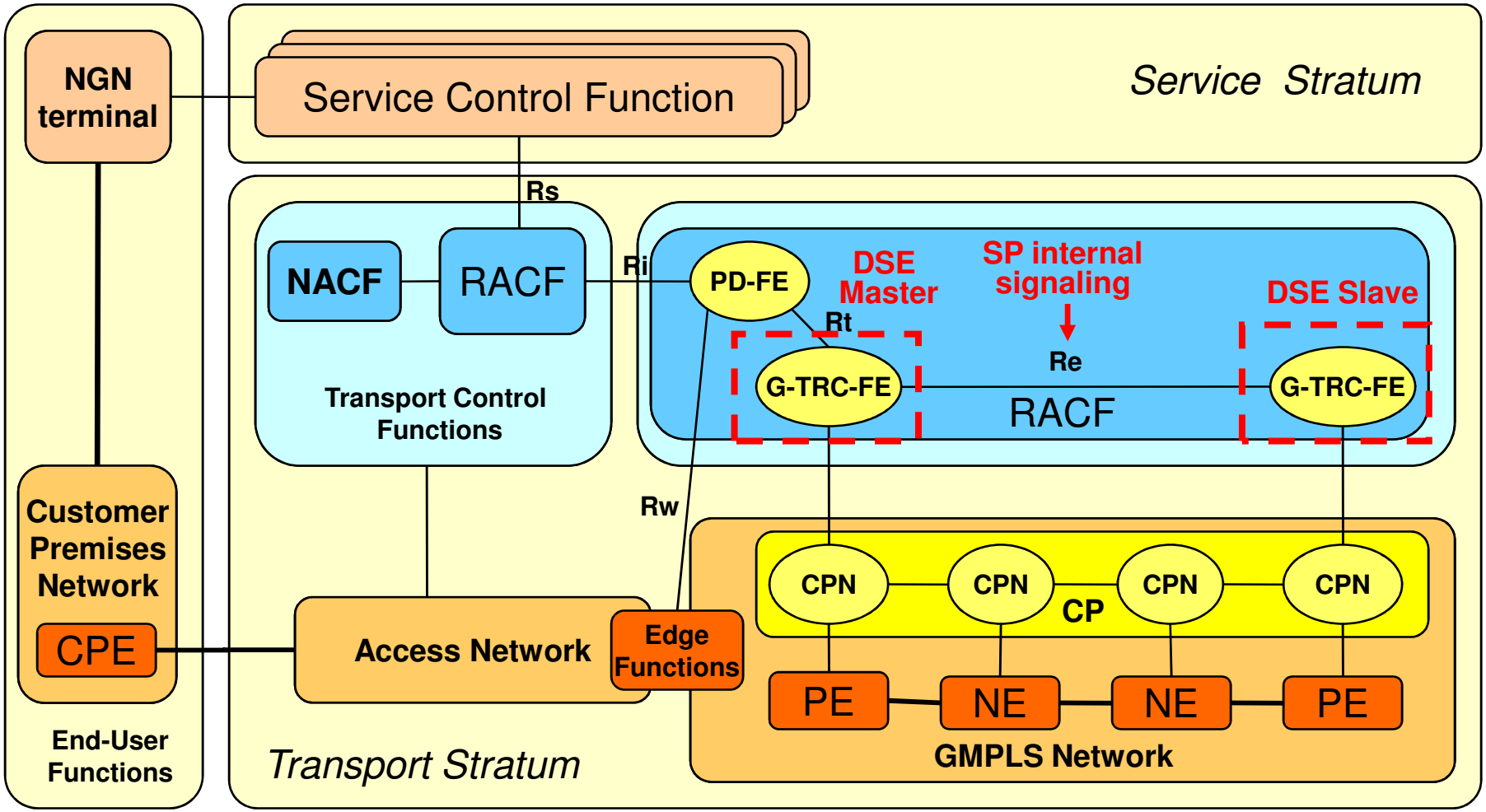
The ITU-T NGN case



NGN = Next Generation Network
PD-FE = Policy Decision Functional Entity
PE-FE = Policy Enforcement Functional Entity
RACF = Resource and Admission Control Function
NACF = Network Attachment Control Function
TRC-FE = Transport Resource Control Functional Entity
TRE-FE = Transport Enforcement Functional Entity
CPE = Customer Premises Equipment

ITU-T does not specify how TRC-FE interacts with the GMPLS CP

The ITU-T NGN supporting GMPLS

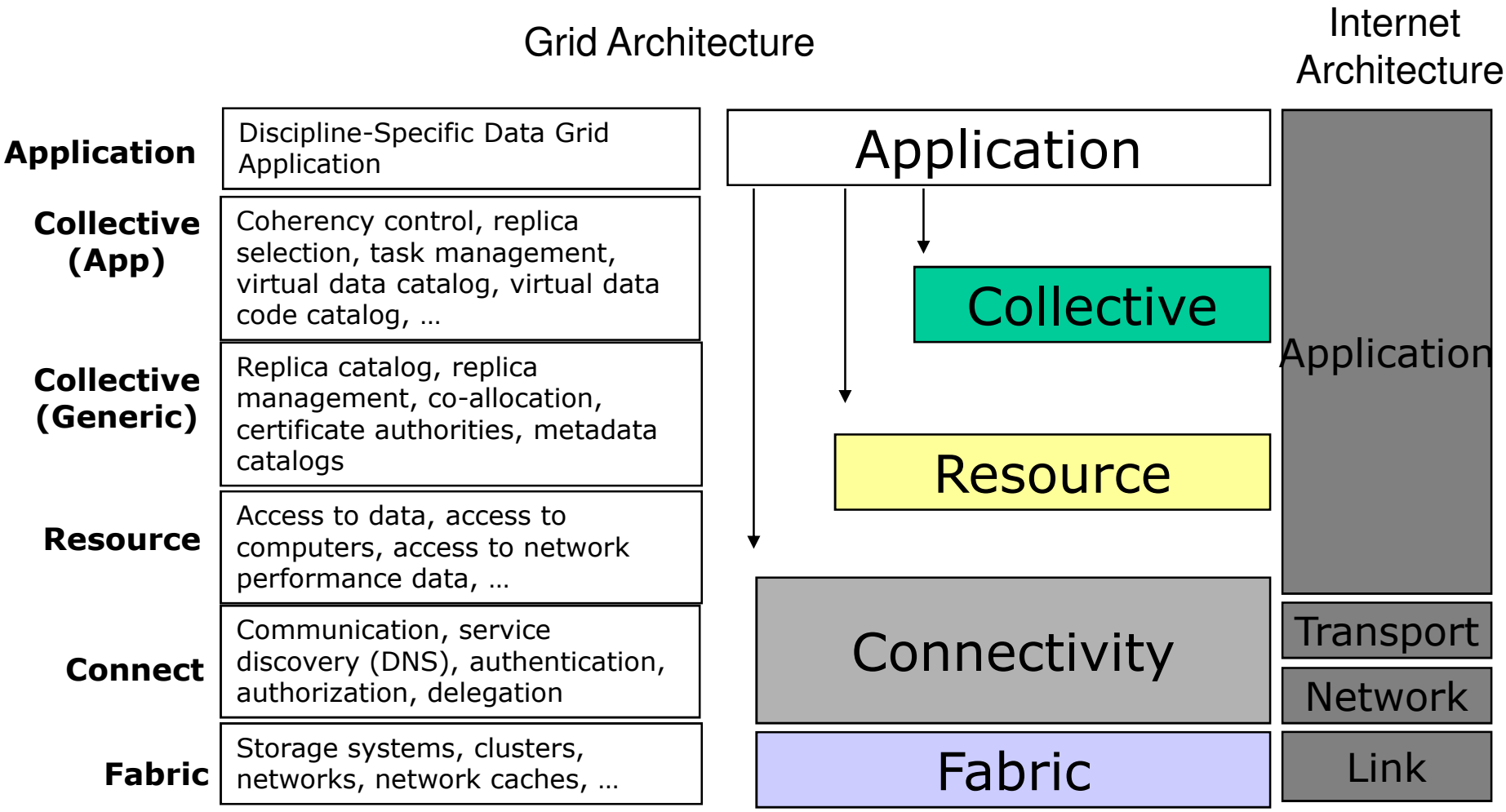


G-TRE-FE = GMPLS Transport Resource Control Functional Entity
CPN = Control Plane Node
UNI-N = User to Network Interface - Network
Edge functions = aggregates traffic from different access networks to core network, and supports QoS and traffic control (e.g., DiffServ Class of Service mapping in LSP).

Non-network (IT) resources

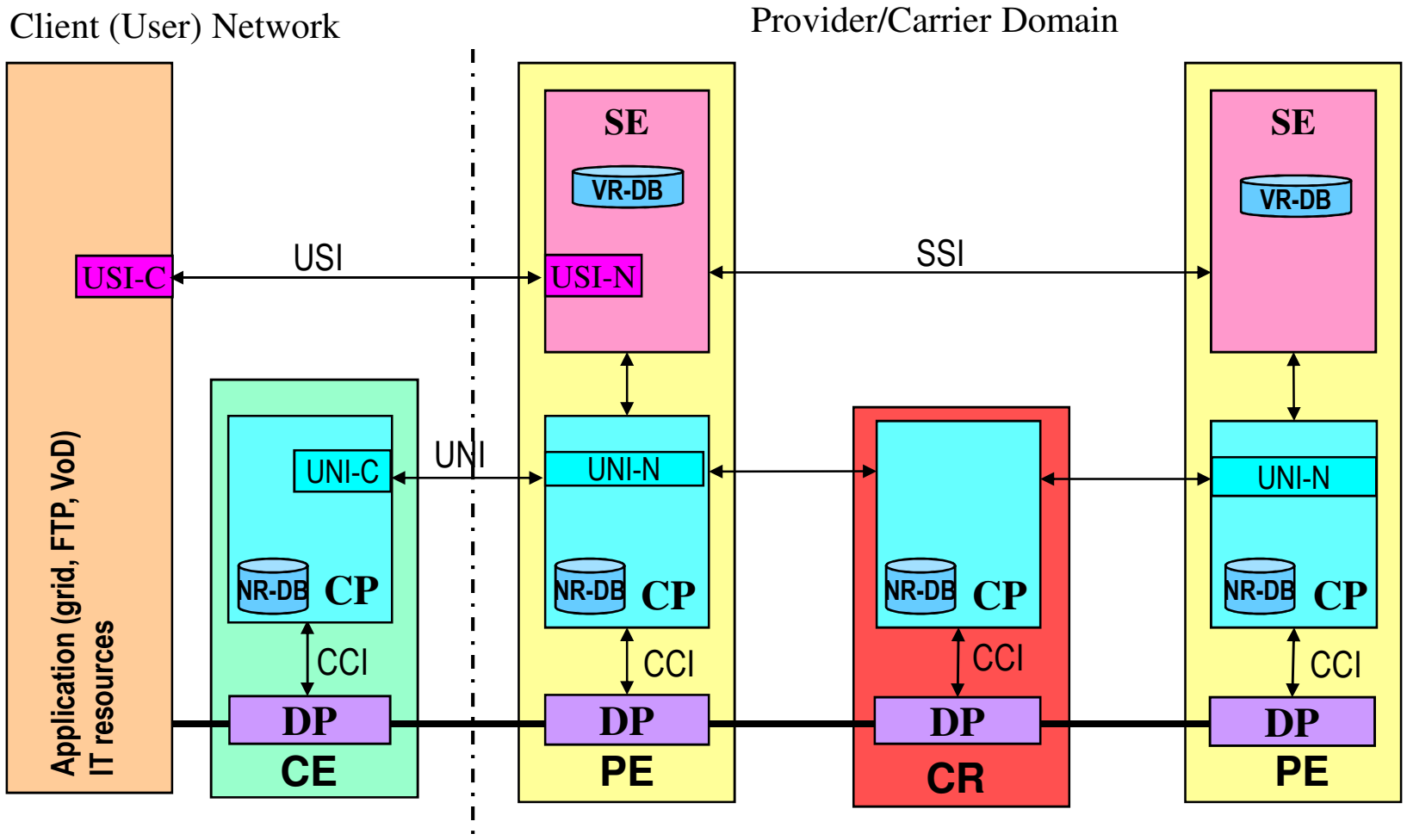
- Issues that differentiate the description and usage of network resources from IT resources
  - Resources are more heterogeneous and lack of a relation of hierarchy
  - Some virtualization effort exist but solutions are heterogeneous (e.g. naming for addressing: Universal Unique Identifier, Universal Resource Identifier, etc)
  - An adequate information model is needed to handle them (discover, publish, etc) that may be resource-dependent
  - Some applications, e.g. grid, already have a well established IT resources virtualization mechanism that do not involve provider networks at all.

Network services vs. IT services
The GRID case



- But grid middleware (i) resides in end hosts and (ii) do not foresee any network resource virtualization.

Joint coordination of network and IT resources
Single domain view

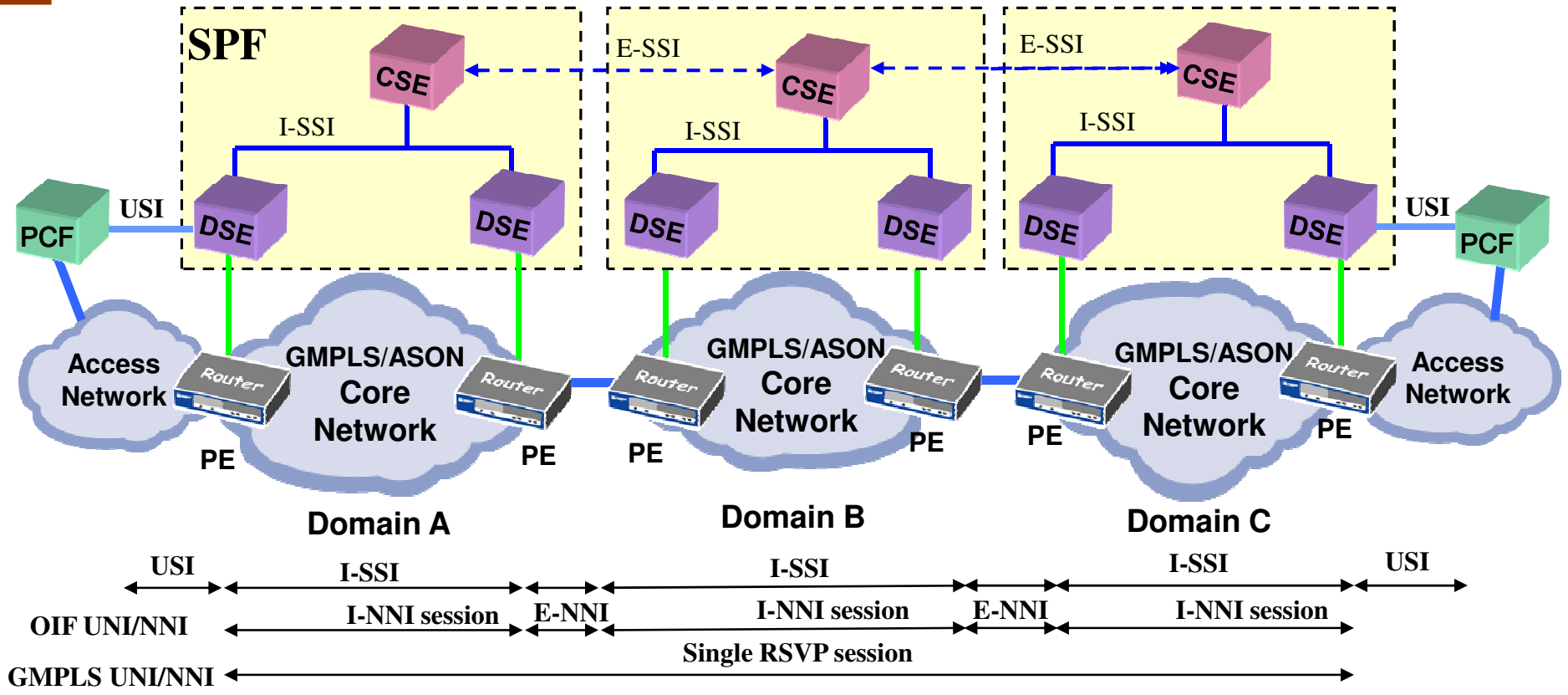


DP: Data Plane
CP: Control Plane
CE: Customer Edge
PE: Provider Edge
CCI: Connection Control Interface
NR-DB: Network Resource Database

USI: User to Service Interface
UNI: User to Network Interface (OIF or GMPLS/IETF)
SE: Service Element
SSI: Service to Service Interface
VR-DB: Virtualized Resource Database

USI-C: User-to-Service Interface (client side)
USI-N: User-to-Service Interface (network side)
UNI-C: User-to-Network Interface (client side)
UNI-N: User-to-Network Interface (network side)

Joint coordination of network and IT resources
Multi-domain view



OIF UNI/NNI = several RSVP sessions → external coordination for each domain is needed for end-to-end service provisioning

GMPLS UNI/NNI = single RSVP session → external coordination among the end points is needed for end-to-end service provisioning (e.g., for obtaining bidirectional connections)

The SP allows to obtain the external coordination needed by the different UNI/NNI implementations

DSE = Distributed Service Element; **CSE** = Centralized Service Element; **USI** = User to Service Interface
I-SSI = Internal Service to Service Interface; **E-SSI** = External Service to Service Interface

Conclusion

- Network resource virtualization can be expressed in terms of VPN service abstraction through the usage of service platforms
- Service platforms for network services already exist for the access while they are in their infancy for metro-core networks
- Resource virtualization for IT resources need much work for modeling various application scenarios and joint orchestration with network resources.

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grid.it project

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SERENADE

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Thank you!

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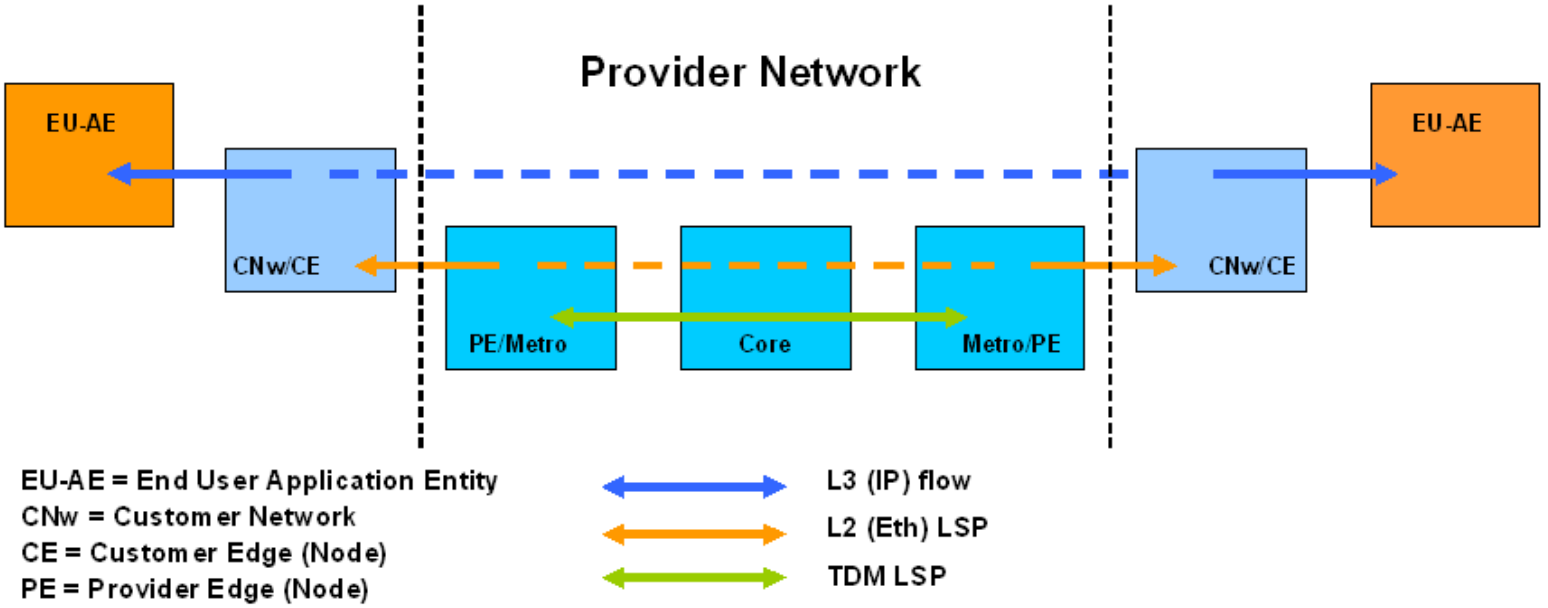
Back-up slides

Network Services
Service Data Traffic flow level



- The EU-AE generates IP traffic that, through the Customer Network, is conveyed into the Provider Network towards a target EU-AE placed in a different Customer Network
- The SPF is not involved in the actual data transfer after the network service is set-up
- The interaction between Customer network and Provider network from a functional point of view involves up to L3 OSI levels.