Orchestrating optimally IT and network resource allocations for stringent distributed applications over ultrahigh bit rate transmission networks

Networks for IT: A new Opportunity for Optical Network Technologies

ECOC'2007 – Berlin Germany

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Alcatel-Lucent Research & Innovation

September 16th 2007

Contents

Introduction: Context & Motivations

Increasing interests of Utility Computing deployed in Business environments

New solutions for utility services in a new and emerging market towards the industry sectors are catalyst for Network Operators, the reasons are:

- Reduced IT infrastructure fixed costs of their Business Consumers
- Going toward "Utility computing" and, ubiquitous aggregated service availability
- Practices and service implementation for “Virtual Enterprise”
- Collaborative services under short time constraints of Business Project

Towards Network Services definition:

Needs for an Open Service Architecture positioning Network Services

Utility Computing supported by Grid Service Architectures

- Business Collaborations put new requirements on network infrastructure uses:
  - (i) Performance (specified in the SLA)
  - (ii) Control and managements of two-way flows of Grid application data
  - (iii) Higher dynamic on the optical backplane for (re)configuration
  - (iv) End-to-end security
- Network Service deliveries will have to be part of an Open Grid Service infrastructure to enable:
  - Bandwidth Provisioning per different Grid Application classes → Workflows
  - Services defined from Virtualized Resources
  - Cross-optimization through different types of resources.

New Level of Resource Virtualization is required

Grid Application Requirements on Network Infrastructures

Needs for Interactions for suitable Network Service configurations

In Most of the cases Grid applications are overlaid on the Network infrastructure and can not communicate their requirements:

- Dedicated infrastructure or over-provisioning are required to sustain the highest value of the connectivity requirements needed
- Shared resources and no control on the requirements (best-effort)
- No interactions → Network (re)configurations are achieved manually

Enhancements of Grid Application ↔ Network interactions are required to:

- Allow network management/control plane to deliver the right connectivity service with the correct requirements (performance, QoS, security)
- Configure Network according to Grid application needs, (re)configuration should be fast, accurate and automatic (can not be manual).
- End-to-end Orchestration for better resources usages where cross-optimization can be deployed

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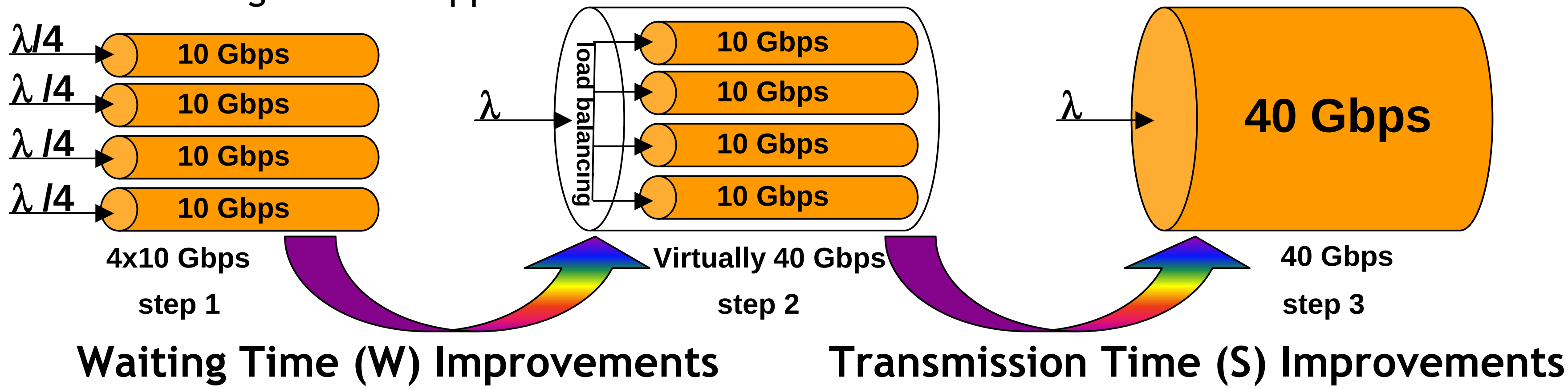
Combination of Computational and Transmission System

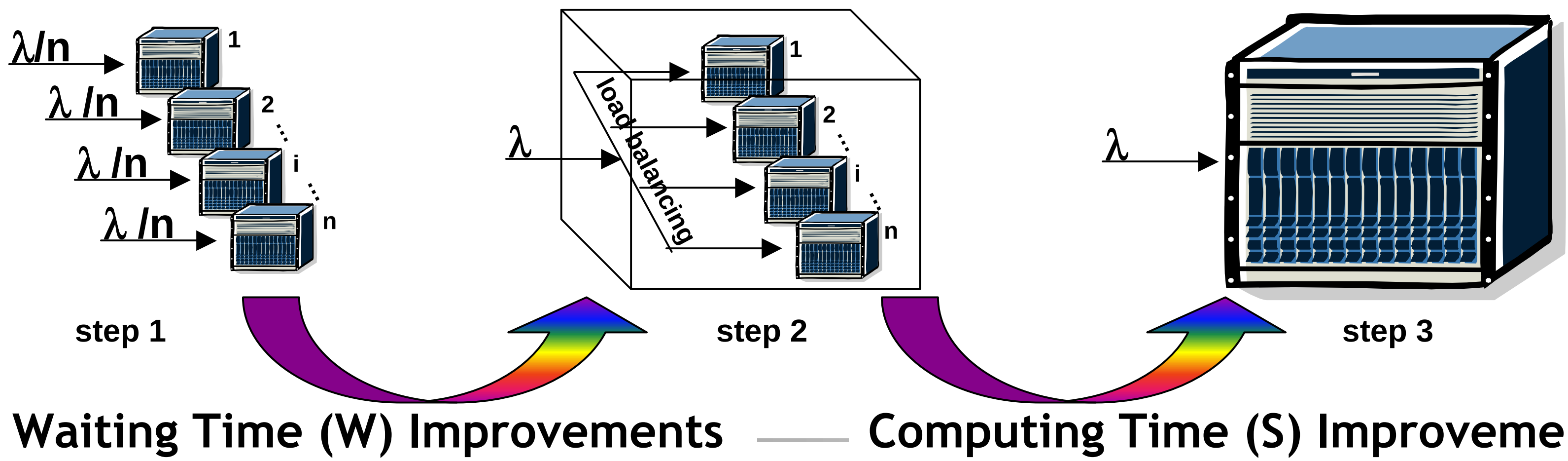
Network Service Response Times:

- λ: average rate of Application Data Traffic flows to be transferred



Computational Service Response Times:

- λ: average rate of Application Jobs to be computed



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Different levels of Grid Application / Network interactions

Compendium of architectures with three alternatives:

Case 1: Application - Network Resource Control/Management are disjoint:

- End-Hosts solely drive the Grid applications operations on full provisioned and static networks – performance rarely match Application requirements
- Restricted level of automations of the Network configuration

Case 2: Management "Gateway" system: GMS – NMS interactions

- Abstracted models: Public info/data model + Restricted info/data model
- Connection requests are sent on a centralized Network Service component
- Rules and Policies should be defined based on Service Requests and Deliveries

Case 3: Application Control functions – Network Control functions interactions:

- Worflow / Connection Controls are processed by Active nodes
- Full exchanges of Control/Management information facilitate X-optimization
- Require new contributions to standardize extensions of protocol engines

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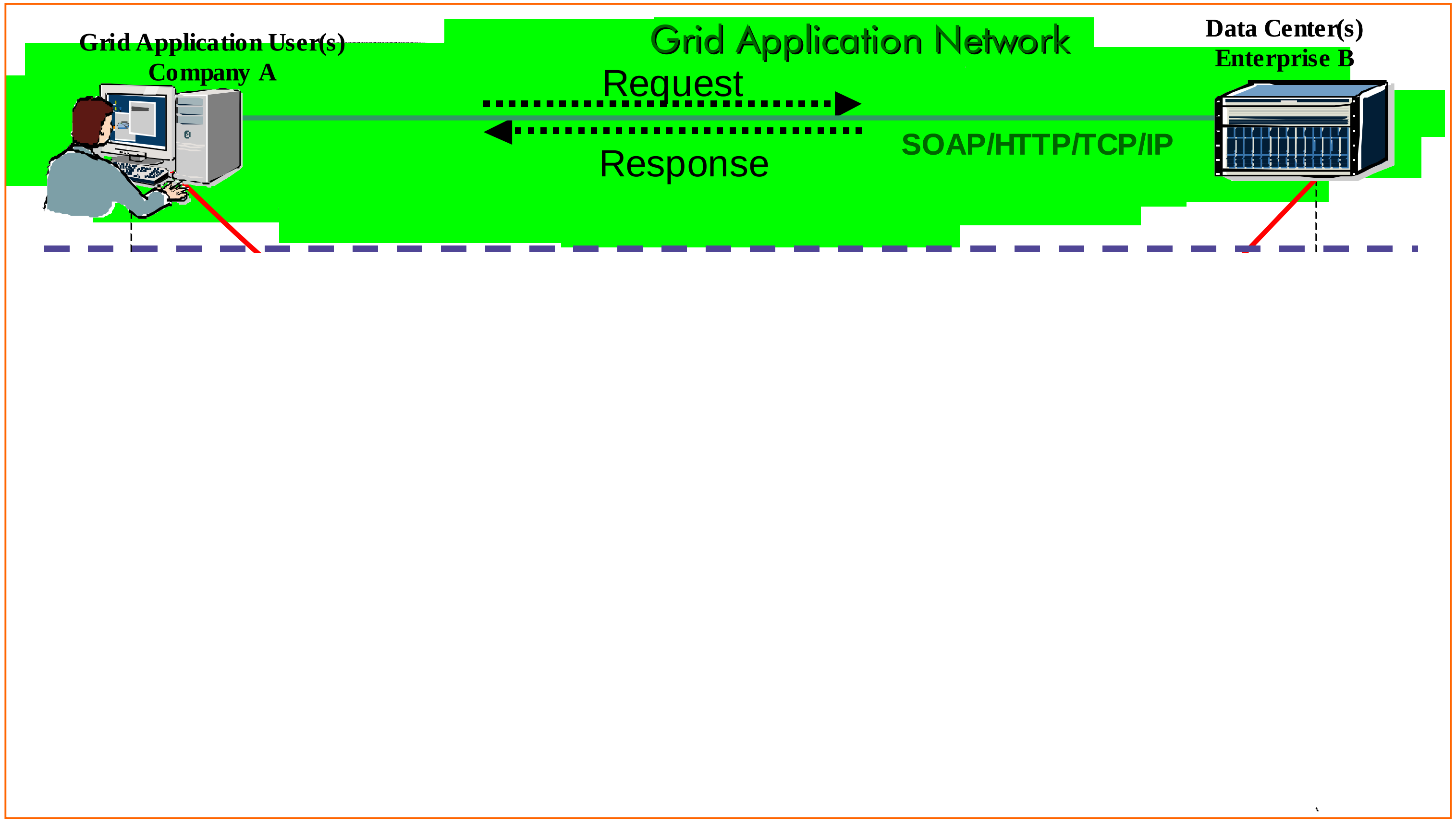
Case 1: Example of Current Practices

Grid Services Overlaid on the Transport Networks



✓Network operates independently of the overlying grid applications,

✓Automatic network (re)configuration capabilities are not exploited (at the best it is a manual operation) for the application workflow needs.

Case 2: Specifications for Grid Applications to interact with Transport Network

Scheduling – Reconfiguration and Virtualization (**SRV**) service

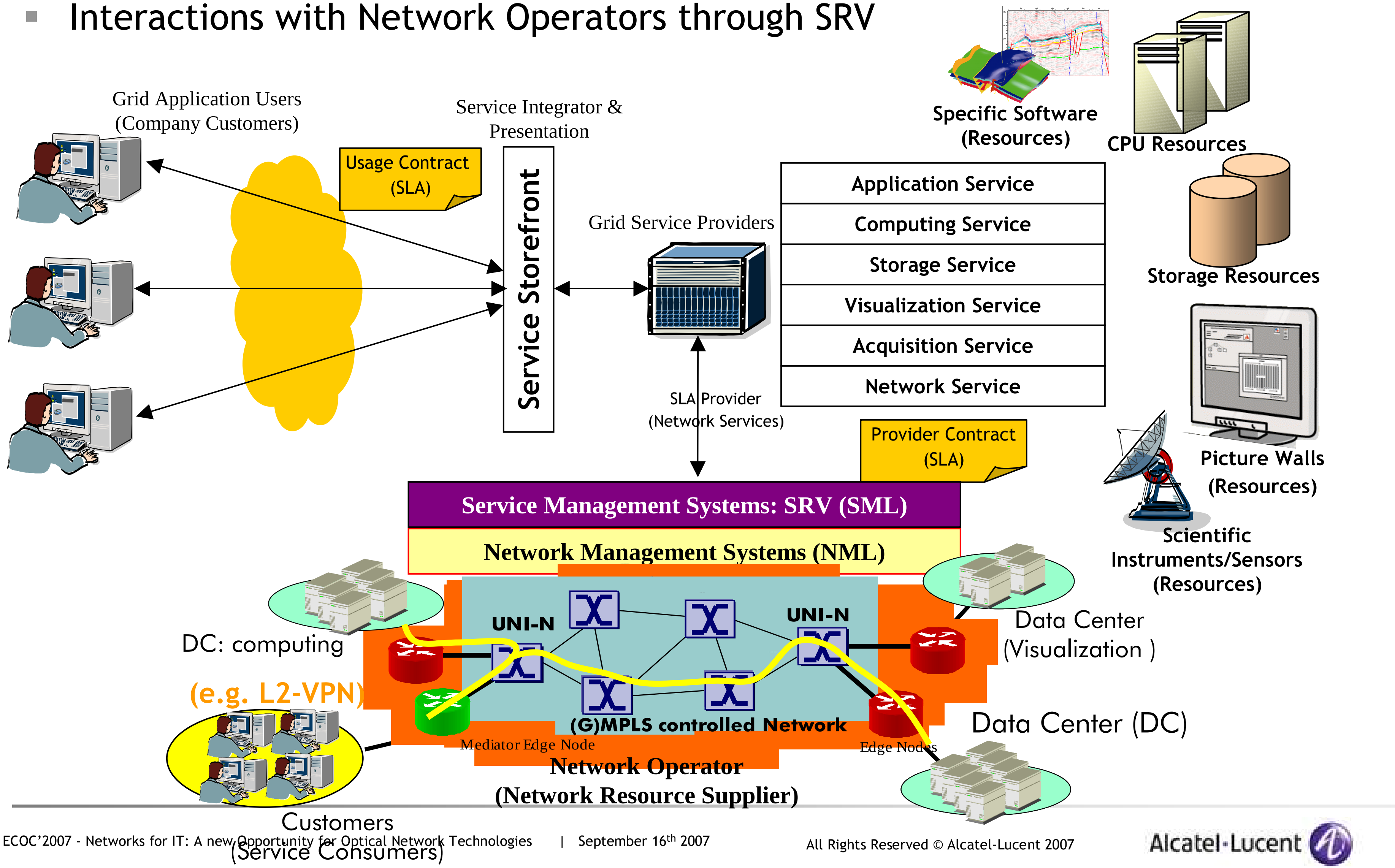
- Shared carrier network can intercept the connectivity requirements of Grid application workflow(s)
- Protocol Gateway functions for Service Discovery, Selection and Signaling
  - Just-In Time Bandwidth Provisioning
- Arbitration of Resource Requests for the Network Services to be delivered
- Virtualization for Network Resources. Different patterns can be used to deliver the network services
- End-to-end resource cross optimization can be enabled:

Grid Management ↔ Network Management

Case 2: The Multi Service Provider environment

Network Operators, Grid Resource Manager, Grid Service Providers and Customers

- Entities considered for Dynamic SLA Negotiation and Contract establishments
- Interactions with Network Operators through SRV



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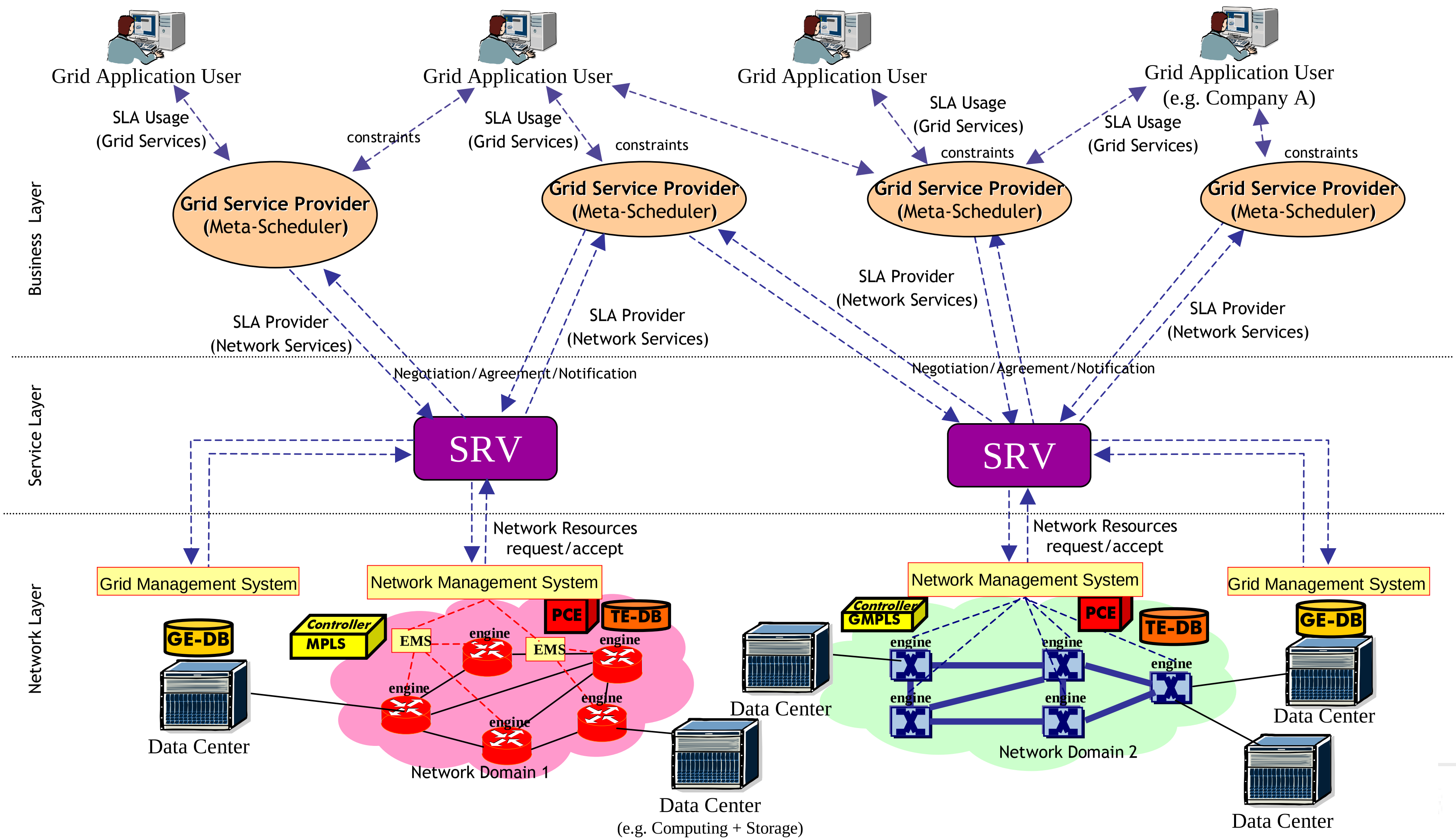
Case 2: SRV Services and Interfaces with possible extensions

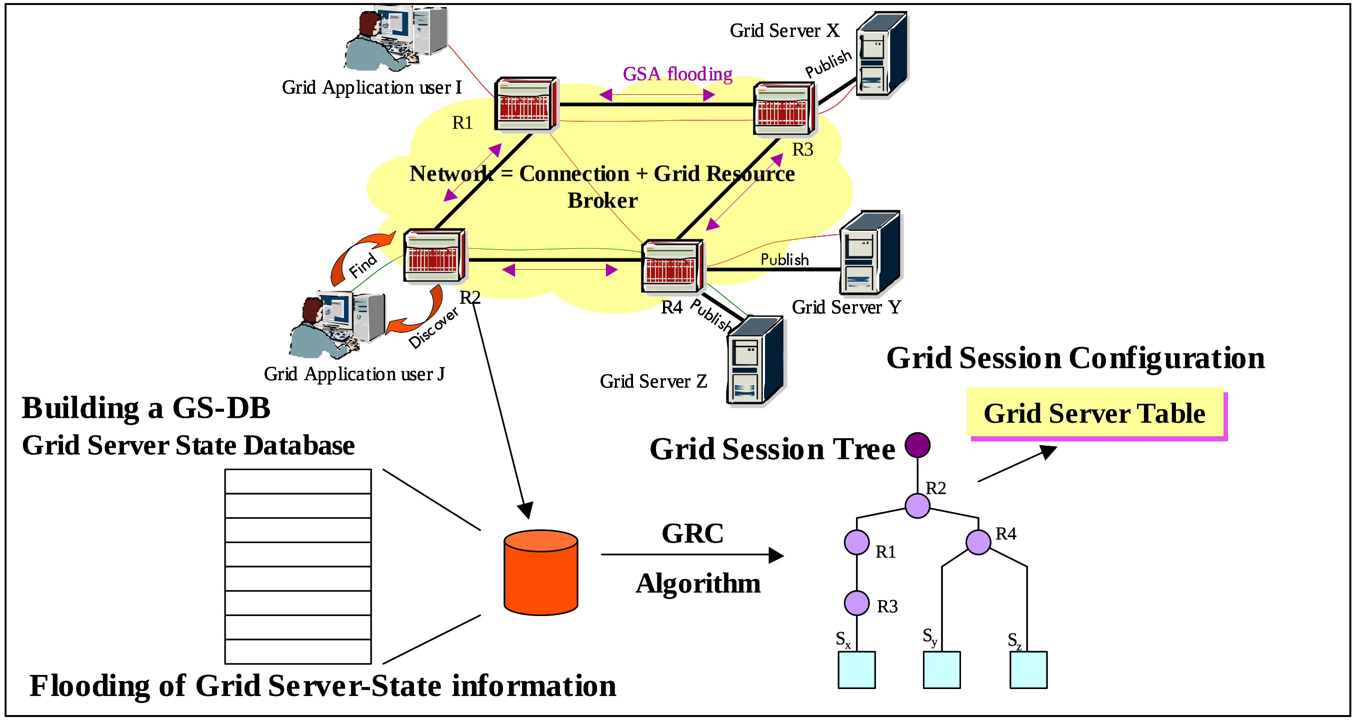
- **SRV has access to all network information, SRV is an extension of the NMS**
- **SRV may access to information of GMS through Interface towards Grid-Engineering DB**



Case 3: Vision on Uniform Grid + Network Control functions

Grid + Network Service Discovery

- Joint Grid + Network Resource Engineering Advertisements
- Generalized sequences for finding and registering Network Services and their related Grid Services within a uniform Service Registry and mechanisms to access them
- New criteria can be integrated within Routing functions



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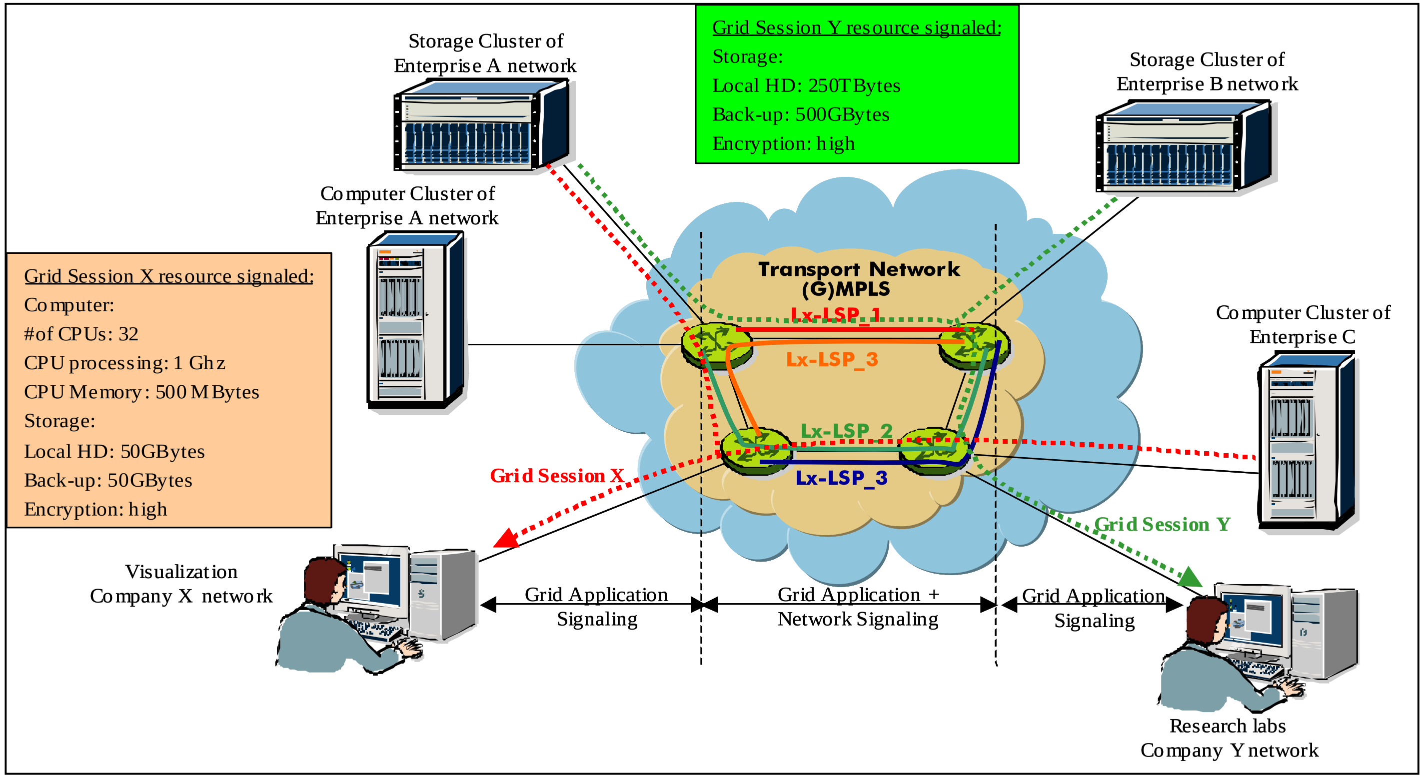
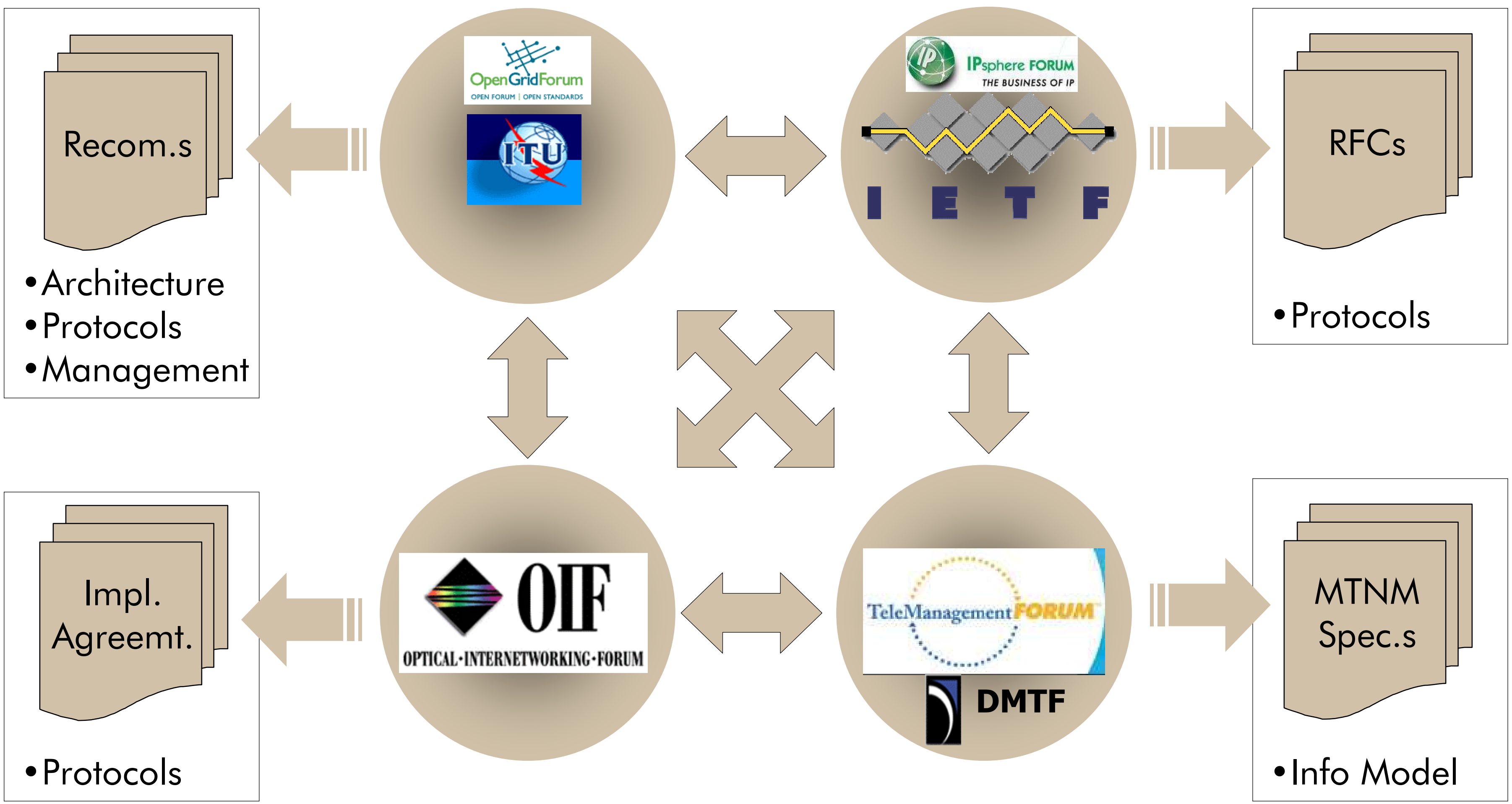
Case 3 Uniform Grid+Network Control functions (2)

Grid Server aware Network Resource Signaling

- Signaling for Grid + Network Resource Reservation during a session life
- Signaling protocol engines should accommodate higher level of Resource Request / Reserve message exchanges
- Reservation Sequences of Resource Servers have different constraints
  - Network, Computational, Storage, Visualization and Acquisition



Standards Organizations and Fora



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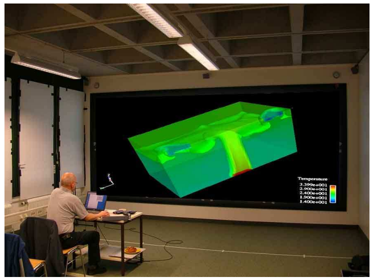
1 CARRIOCAS:

Grid Computing services offered by Internet Optical Network with Ultra-high transmission Capacity

CARRIOCAS Challenges

- To research, design and implement a ultra-high bit rate network reconfigurable for grid applications connectivity requirements
  - ***Transmission capacity 40Gbit/s per wavelength***
  - **Enhanced application-network interactions with SRV**
  - Guarantied network service deliveries according to Application QoS requirements.



- To develop new **Services** & **Usages**
  - collaborative engineering on virtual prototypes
  - Computing Intensive Simulation Applications
  - interactive visualization

From physical to application layer

CARRIOCAS consortium

Industrials	SME's	Academia
Alcatel·Lucent III-V lab ALCATEL-THALES Draka Comteq hp invent CGG MARBEN™ Products france telecom EDF Bull RENAULT	M.E.D.I.T. Molecular Extended Distribution in Information Technology kYLia Oxalya N2Nsoft	INRIA INT Supélec UNIVERSITÉ PARIS-SUD 11 IEF cea CNRS CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE LAL LPN cea LIST CENTRALE PARIS UNIVERSITÉ DE VERSAILLES SAINT-QUENTIN-EN-YVELINES PRiSM get get

Oct. 2006-Sept. 2009

Funding partners:

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MINISTÈRE DE L'ÉCONOMIE DES FINANCES ET DE L'INDUSTRIE

MAIRIE DE PARIS

Essonne LE CONSEIL GÉNÉRAL

92 CONSEIL GENERAL DES HAUTS DE SEINE

CARRIOCAS Project 1: 40 Gbps transmission systems

CARRIOCAS objective

Equipment & Integration

Rack

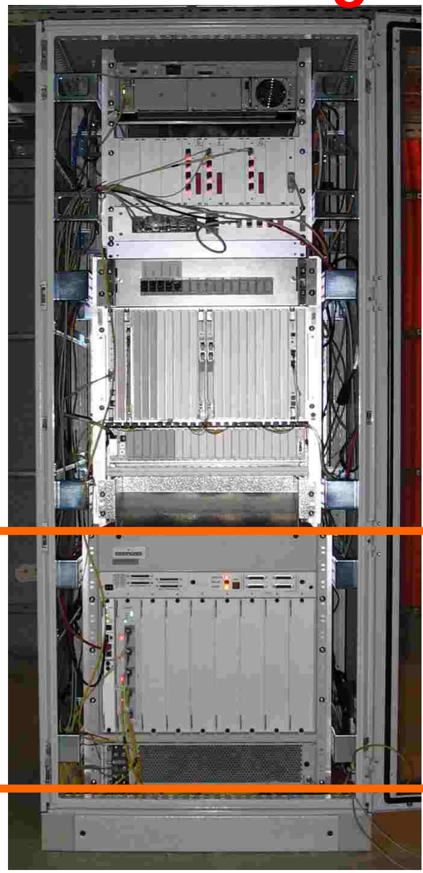
80cm x 80cm x 210cm

19“

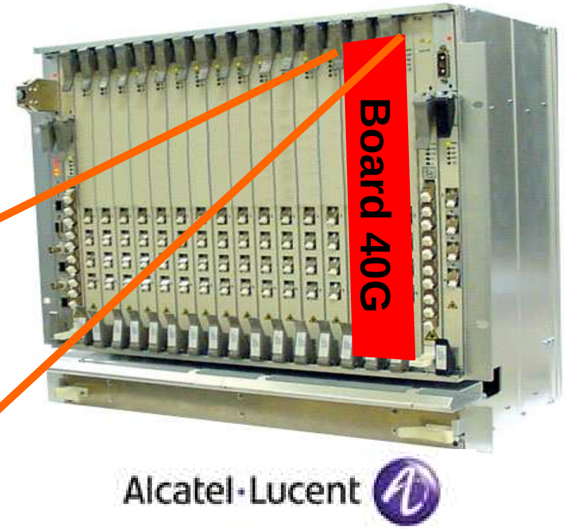
21“

23“

40Gb/s Transponder boards



Integration into an existing 10Gb/s platform



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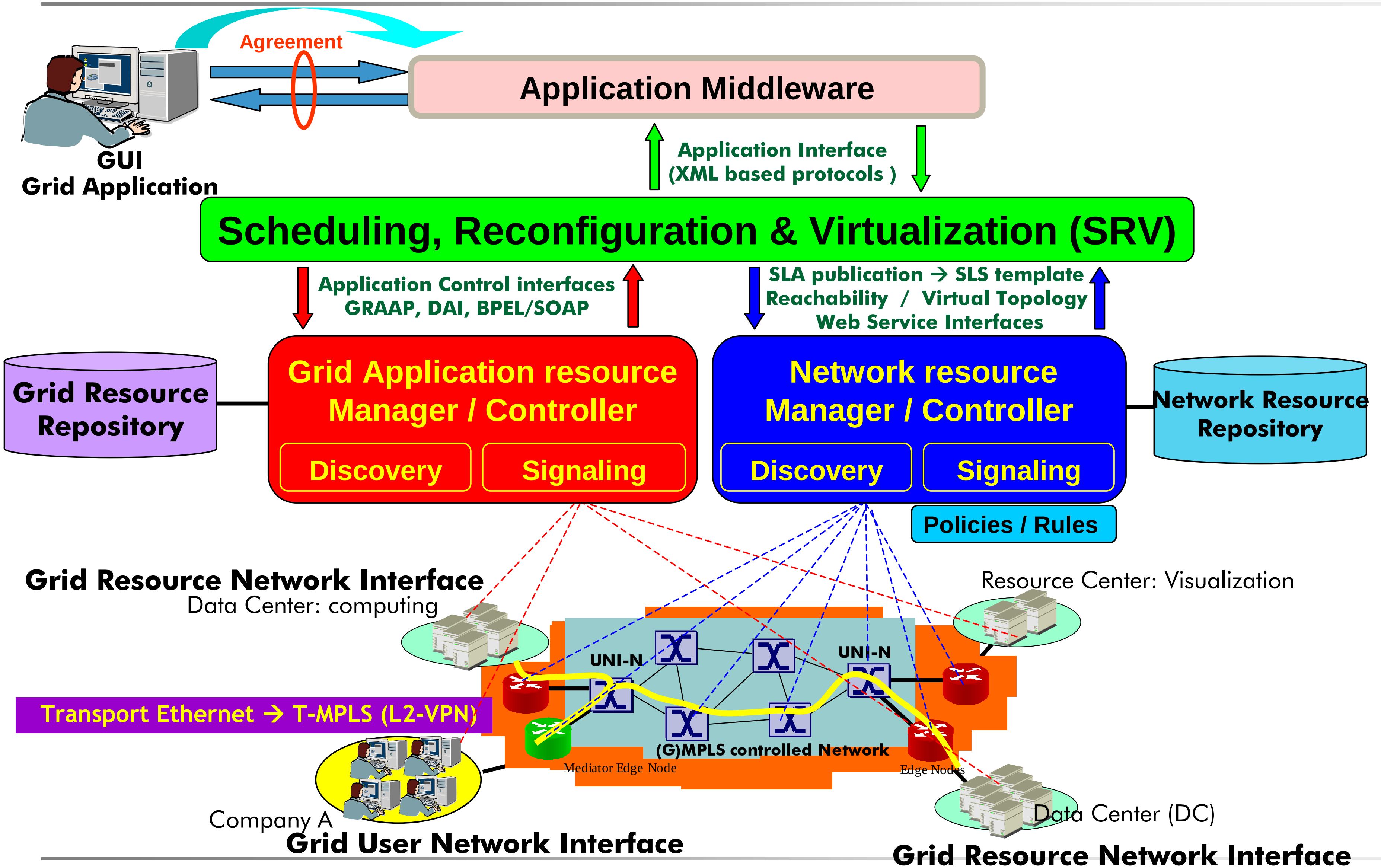
CARRIOCAS Project 2: Network Management & Control Protocols



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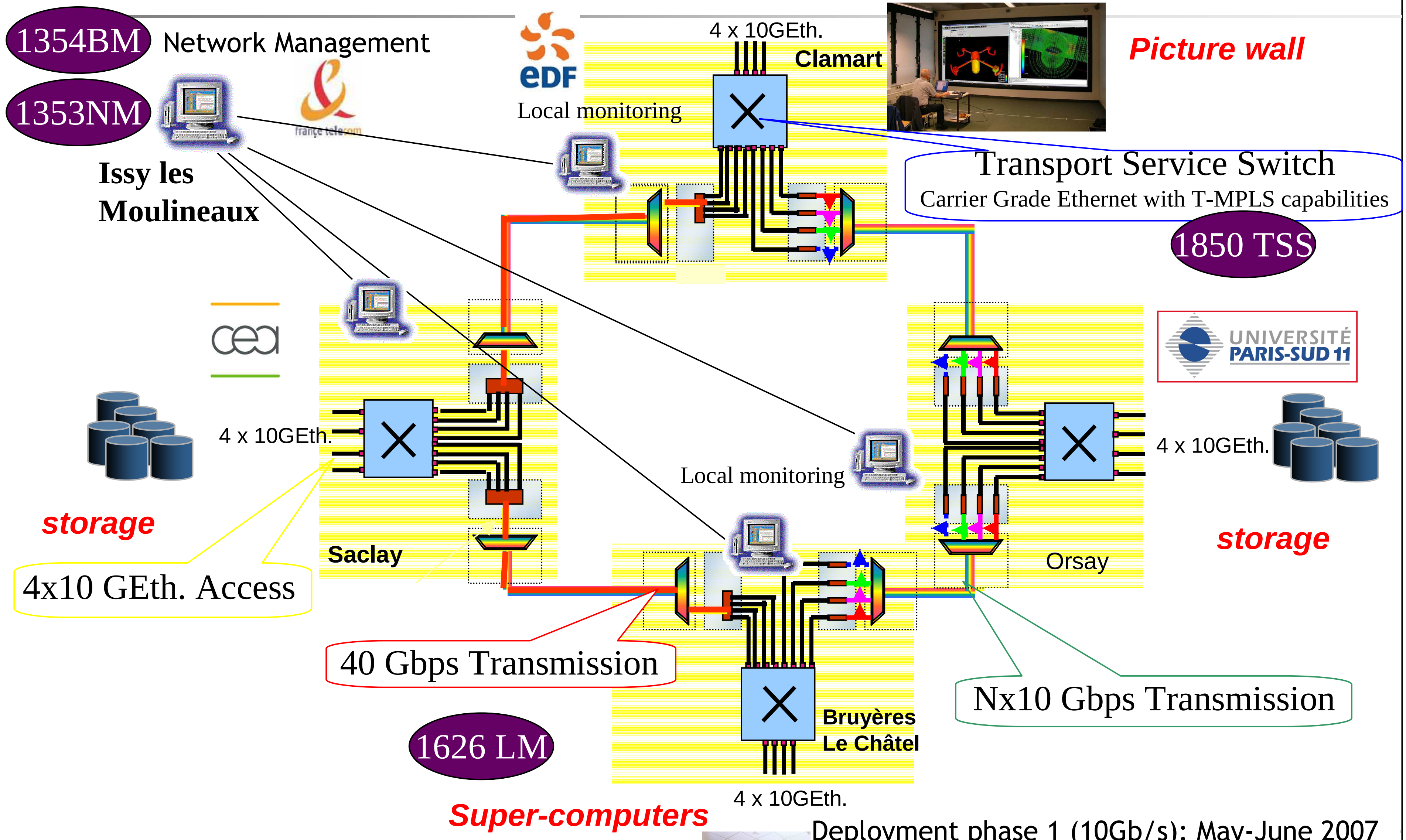
CARRIOCAS Project 3: Network Topology, configuration and experimental test bed



Deployment phase 1 (10Gb/s): May-June 2007
Deployment phase 2 (40Gb/s): April 2008

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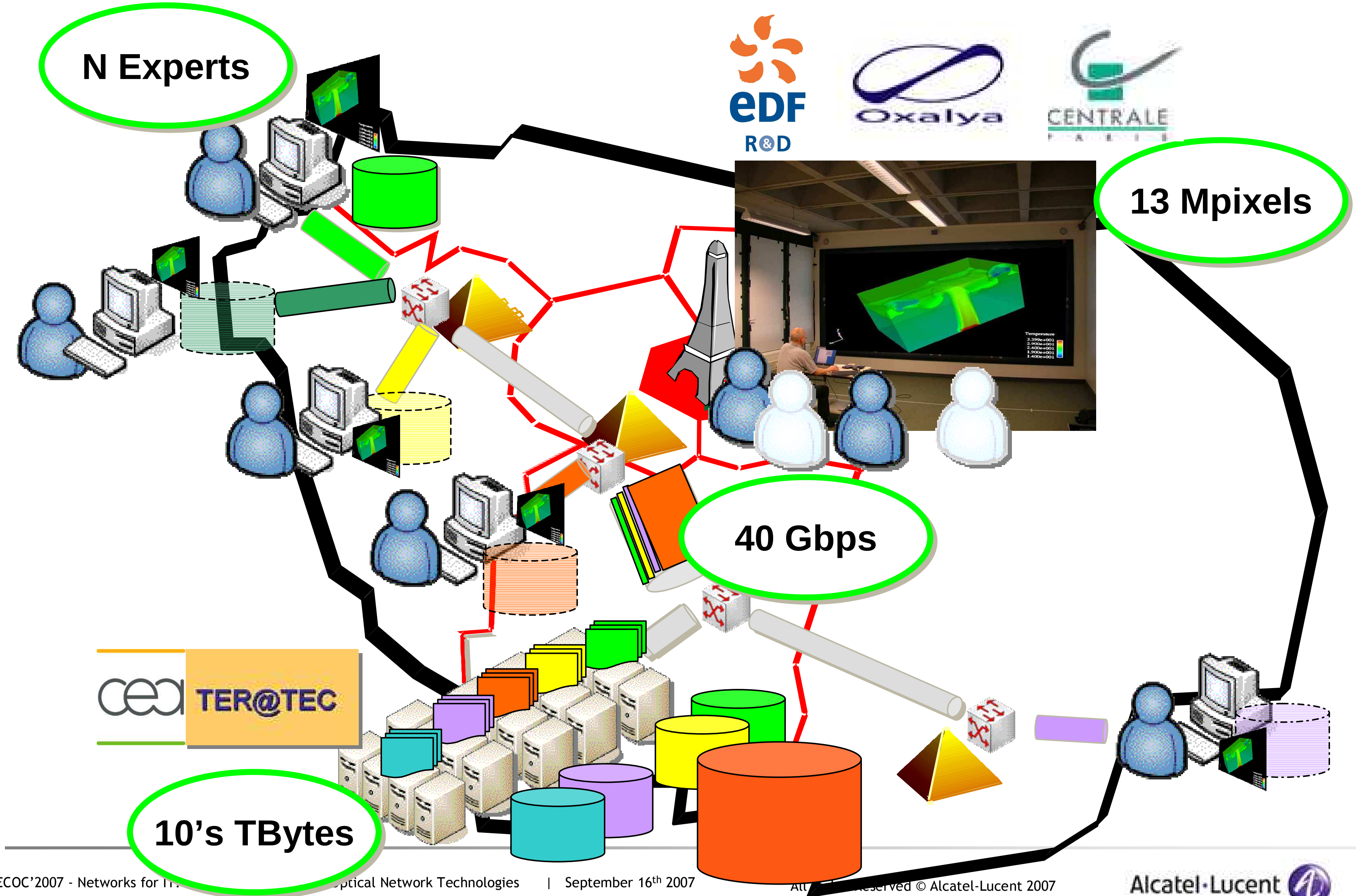
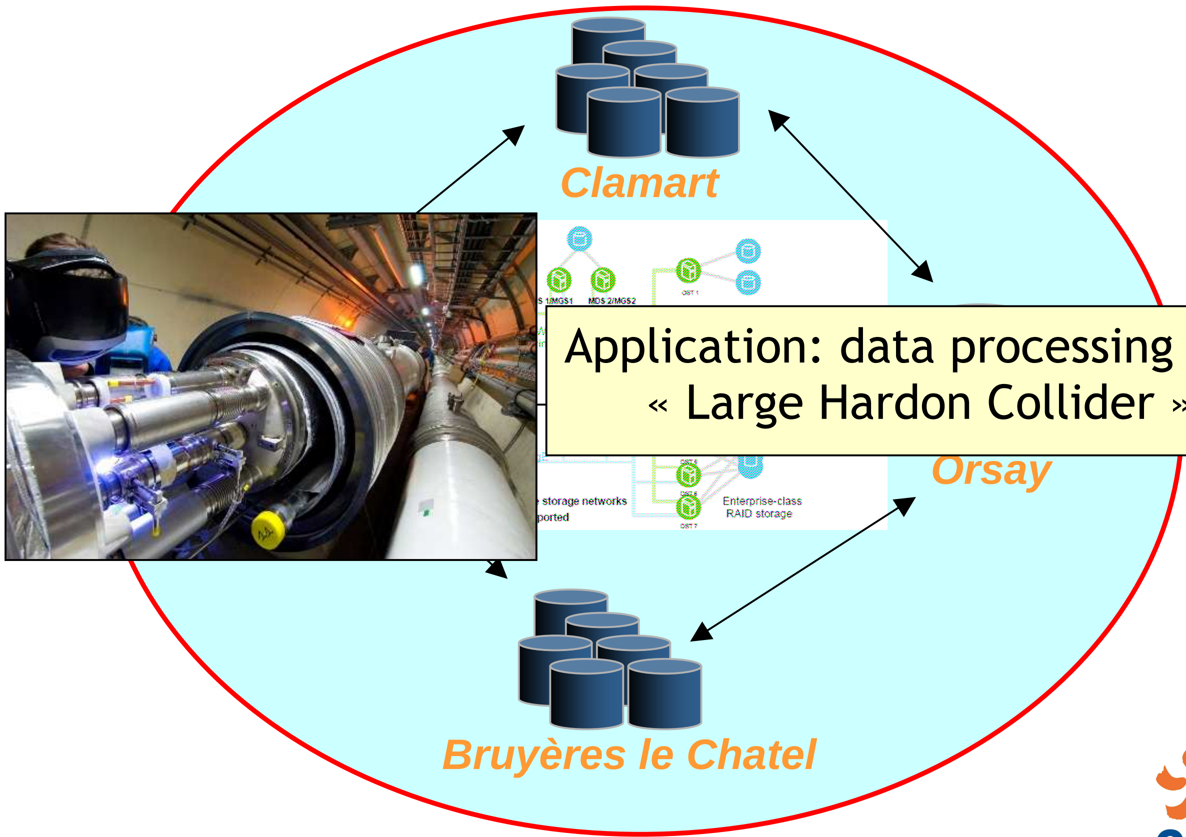
CARRIOCAS Project 4: Grid Applications with Stringent Nertwork Services

High resolution remote collaborative vizualisation



CARRIOCAS Project 4: Distributed storage of massive volume transfers of data

Massive measured Data distributed in Different Storage Centers Virtualized with a Distributed File System based on LUSTRE extensions



Application: data processing and transfer from « Large Hardon Collider » CERN experiments

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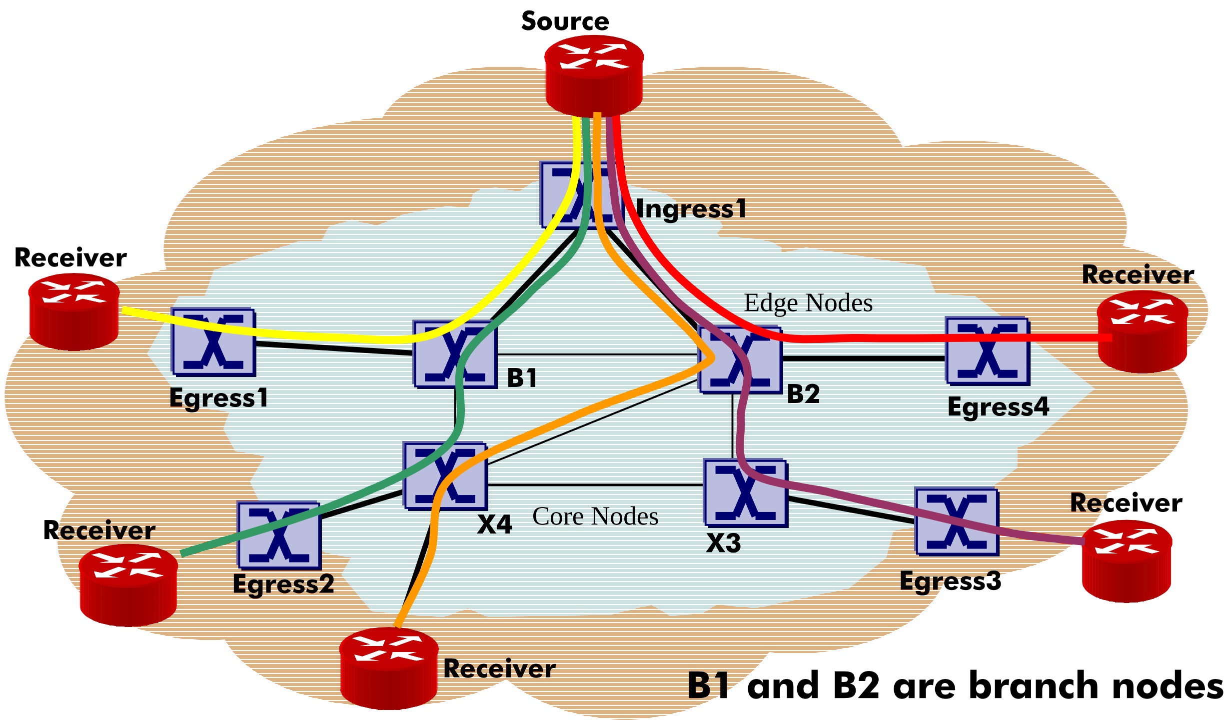
Many Thanks to:

the French Ministry of Industry,
Essonnes, Haut-de-Seines and Paris General Council
for their supports on CARRIOCAS project
http://www.carriocas.org

e-Photon/ONe+ and PHOSPHORUS projects for this first event at ECOC'2007

Point-to-Point connections (P2P)

- P2P LSP is composed by different nodes: 1 Ingress, 1 Egress, 0, 1 or many Transit nodes. Traffic is never replicated.
- Constraints are based on P2P LSP such as bandwidth requirements, resource class affinities, fast-rerouting and pre-emption.
- End-to-end delay requirements have to be satisfied for each LSP from the source to the receiver.



B1 and B2 are branch nodes

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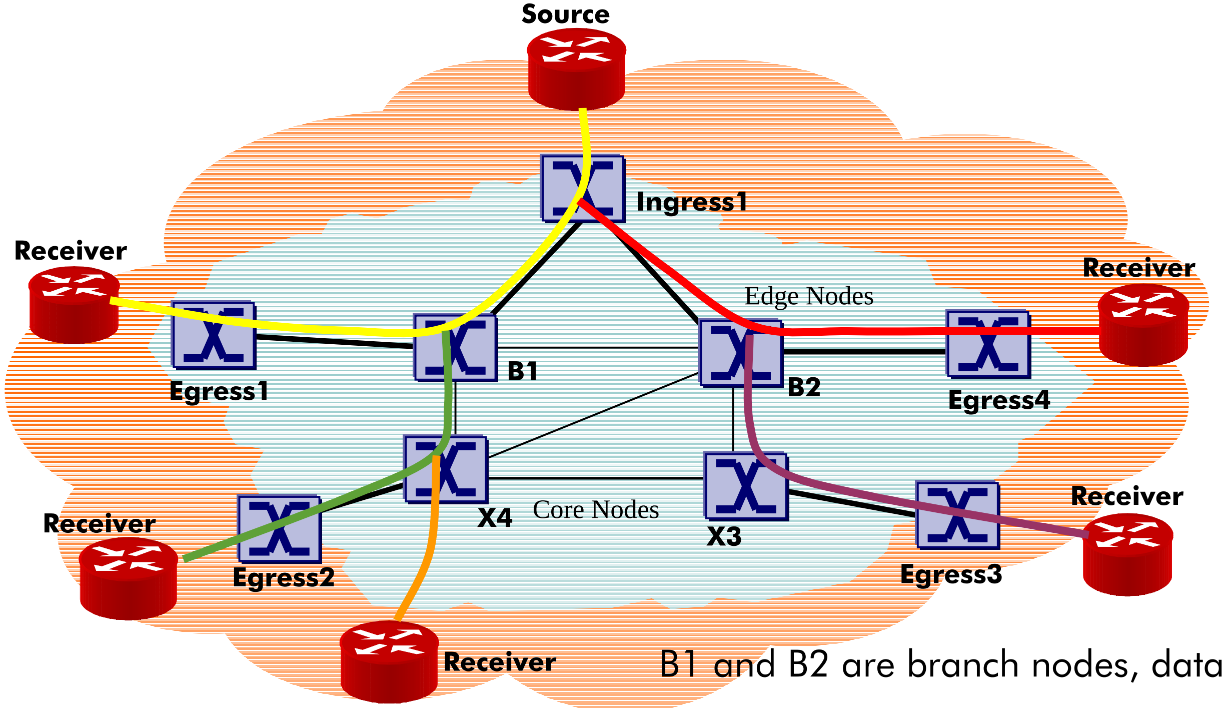
Point-to-Multipoint connections (P2MP)

- P2MP LSP is composed by different nodes: 1 Ingress, N Egresses, Branch nodes, Transit nodes. Branch nodes replicates traffic.
- X4 is a bud node i.e. it is Egress node and has one or more directly connected downstream LSRs
- Constraints are based on P2P LSP such as bandwidth requirements, resource class, fast-rerouting and pre-emption. Path constraints have to decide which LSR should be used as branch LSRs considering the node capabilities to replicate traffic.



B1 and B2 are branch nodes, data replication occurs

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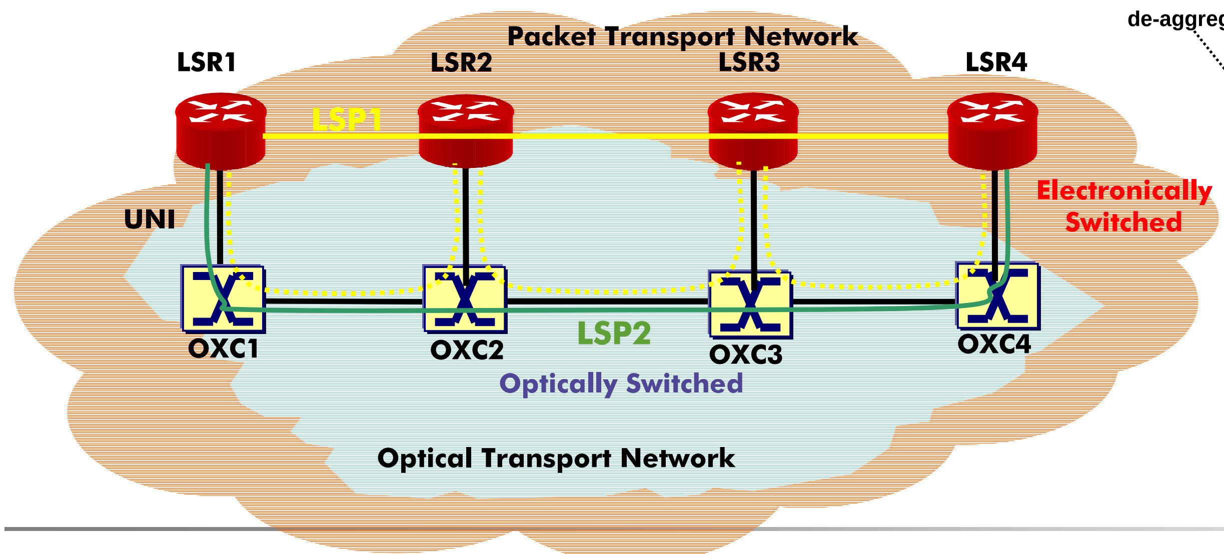
End-to-end delay optimization provided by Reconfiguration functions

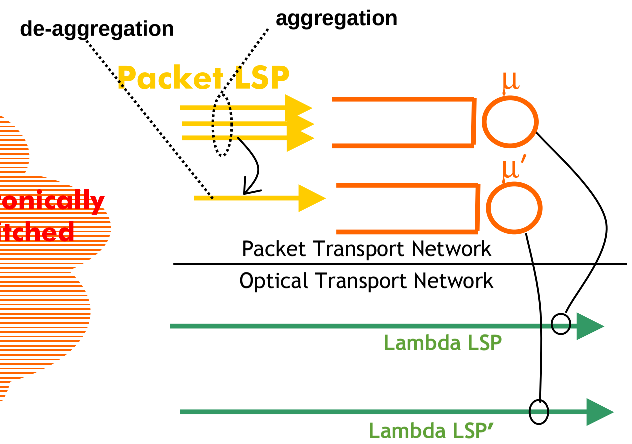
- Transmission over Optical Circuit Switched networks (Lambda switching) present very short transit time delays.

  Application Data Traffic carried by LSP2 (Lambda) transits through OXC2 & OXC3 on Transport Network.

  Application Traffic carried by LSP1 (T-MPLS) transit through OXC2, Router2, OXC3 & Router 3

- The de-aggregation depends of the queuing delay at the node interface.
- The selection of the Packet LSP to be de-aggregated dependent of its SLA including the QoS performance parameters: mean rate, latency and availability





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