



PHOSPHORUS

Solving End-to-End connectivity with GMPLS

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- **European and Global alliance of partners to develop advanced solution of application-level middleware and underlying management and control plane technologies**
- **Project Vision and Mission**
 - The project will address some of the key technical challenges in enabling on-demand end-to-end network services across multiple heterogenous domains
 - In the Phosphorus' implementation the underlying network will be treated as first class Grid resource
 - Phosphorus will demonstrate solutions and functionalities across a test-bed involving European NRENs, GÉANT2, Cross Border Dark Fibre and GLIF



▪ NRENs & RON:

- CESNET
- PSNC
- SURFnet
- MCNC

▪ Manufacturers:

- ADVA Optical Networking
- Hitachi Europe Ltd.
- NORTEL

▪ SMEs:

- Nextworks

▪ Universities and Research Institutions:

- Communication Research Centre
- Fraunhofer-Gesellschaft
- Fundació I2CAT
- Forschungszentrum Jülich
- Interdisciplinair instituut voor BreedBand Technologie
- Research Academic Computer Technology Institute
- Research and Education Society in Information Technology
- SARA Computing and Networking Services
- University of Bonn
- University of Amsterdam
- University of Essex
- University of Leeds



- **Demonstrate on demand service delivery across multi-domain/multi-vendor research network test-beds on a European and Worldwide scale. The test-bed will include:**
 - EU NRENs: SURFnet, CESNET, PIONIER as well national test-beds (VIOLA, OptiCAT, UKLight)
 - GN2, GLIF and Cross Border Dark Fibre connectivity infrastructure
 - GMPLS, UCLP, DRAC and ARGON control and management planes
 - Multi-vendor equipment environment (ADVA, HITACHI, NORTEL, Vendor's equipment in the participating NREN infrastructure)

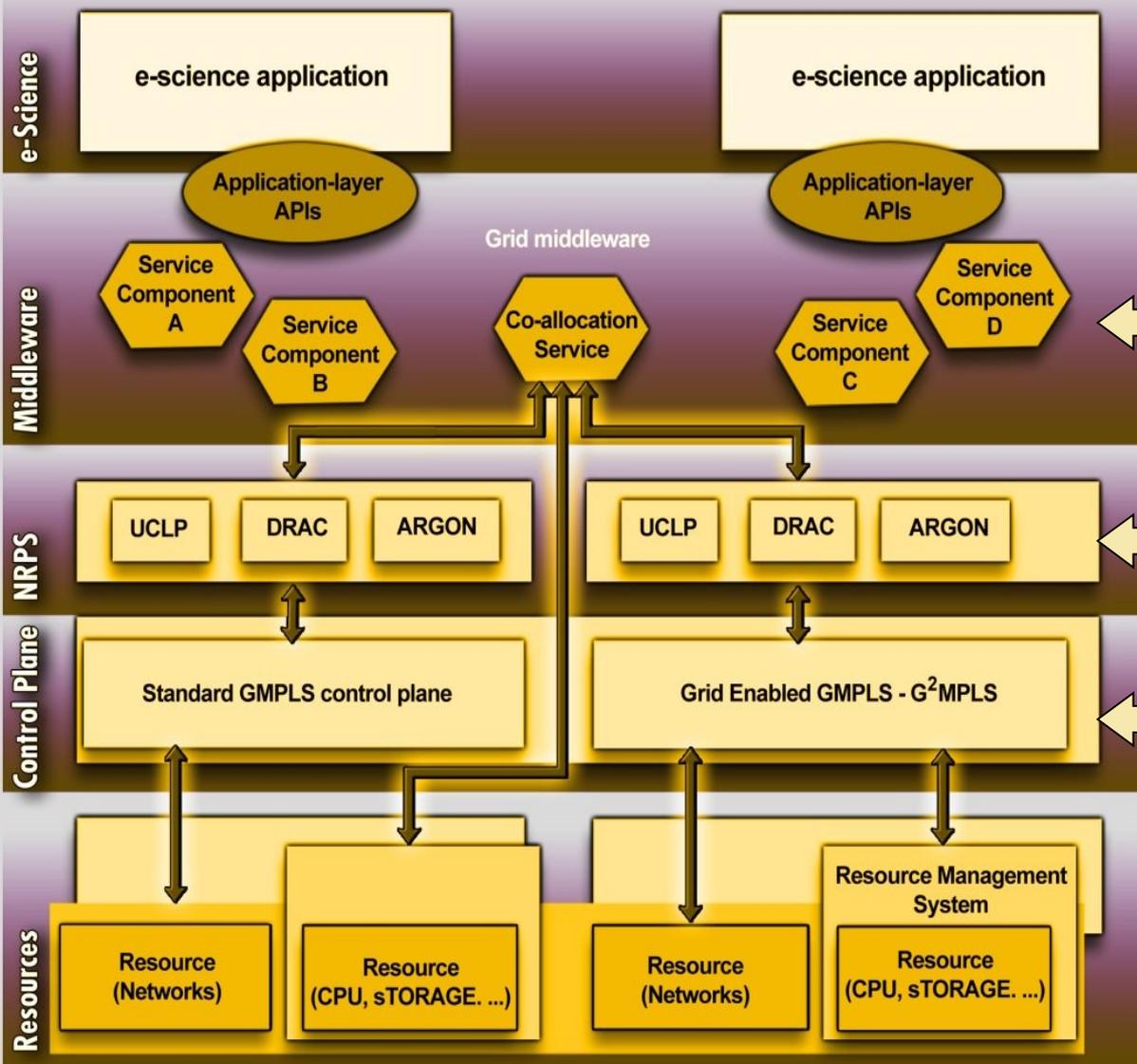


- Develop integration between application middleware and transport networks, based on three planes:
 - Service plane:
 - Middleware extensions and APIs to expose network and Grid resources and make reservations of those resources
 - Policy mechanisms (AAA) for networks participating in a global hybrid network infrastructure, allowing both network resource owners and applications to have a stake in the decision to allocate specific network resources
 - Network Resource Provisioning plane:
 - Adaptation of existing Network Resource Provisioning Systems (NRPS) to support the framework of the project
 - Implementation of interfaces between different NRPS to allow multi-domain interoperability with Phosphorus' resource reservation system
 - Control plane:
 - Enhancements of the GMPLS Control Plane (G²MPLS) to provide optical network resources as first-class Grid resource
 - Interworking of GMPLS-controlled network domains with NRPS-based domains, i.e. interoperability between G²MPLS and UCLP, DRAC and ARGON



- Studies to investigate and evaluate further the project outcomes :
 - Study resource management and job scheduling algorithms incorporating network-awareness, constraint based routing and advance reservation techniques
 - Develop a simulation environment, supporting the Phosphorus network scenario
- Disseminate the project experience and outcomes, toolkits and middleware to NRENs and their users, such as Supercomputing centres

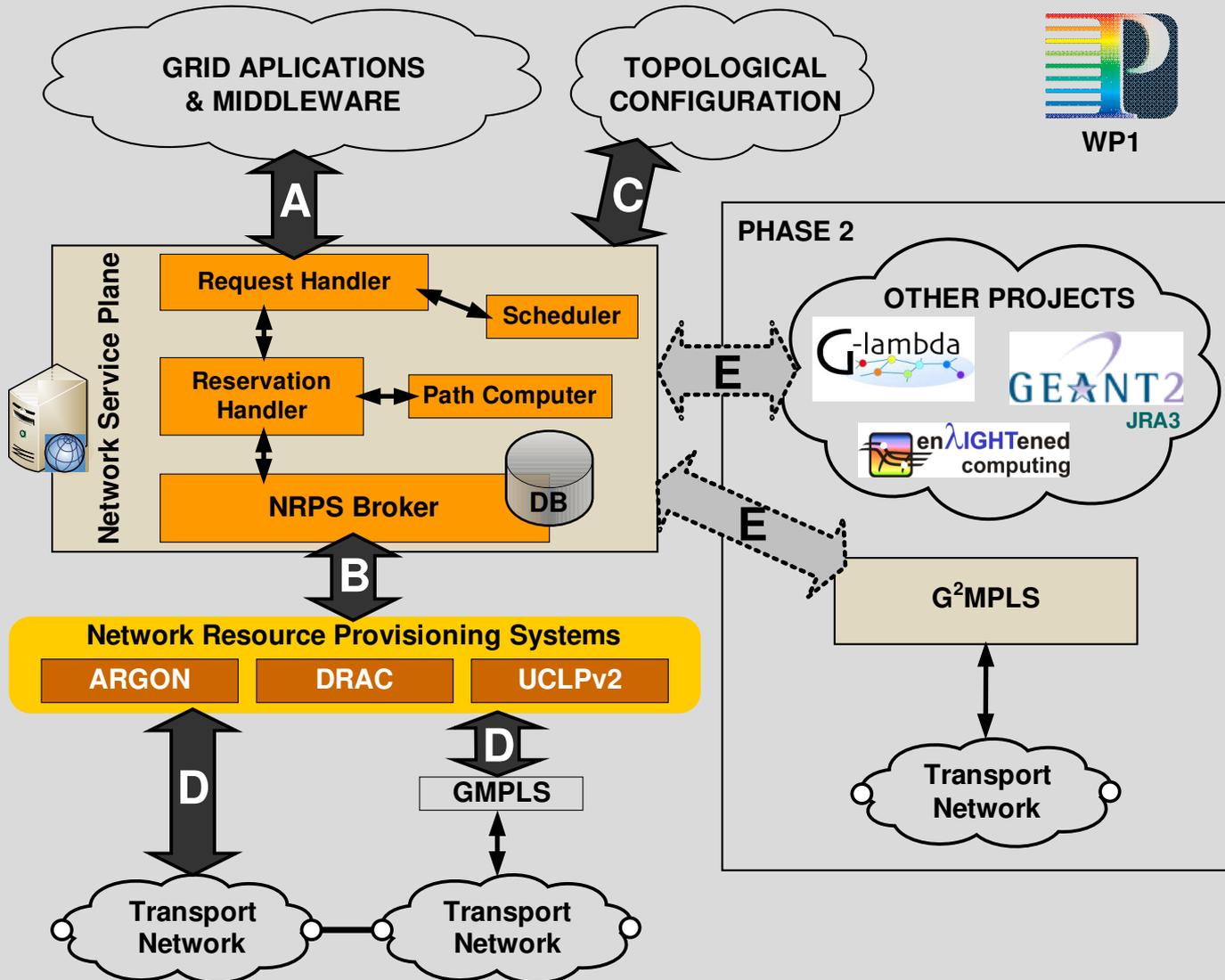
PHOSPHORUS ARCHITECTURE



The different domains of the **Phosphorus** test-bed will have:

- Grid middleware
 - UNICORE as a reference point
 - AAA policies
- Three types of NRPS:
 - UCLP
 - DRAC
 - ARGON
- Two “flavours” of GMPLS
 - standard (*Ph. 1*)
 - Grid-enabled (*Ph. 2*)

System overview



A) Northbound IF:

It receives the reservation requests from the GRID Middleware.

B) East-West IF:

It is in charge of the communication between NRPSs.

C) Topological IF:

It is used to indicate to the NSP which are the resources under control (NRPSs, endpoints, links).

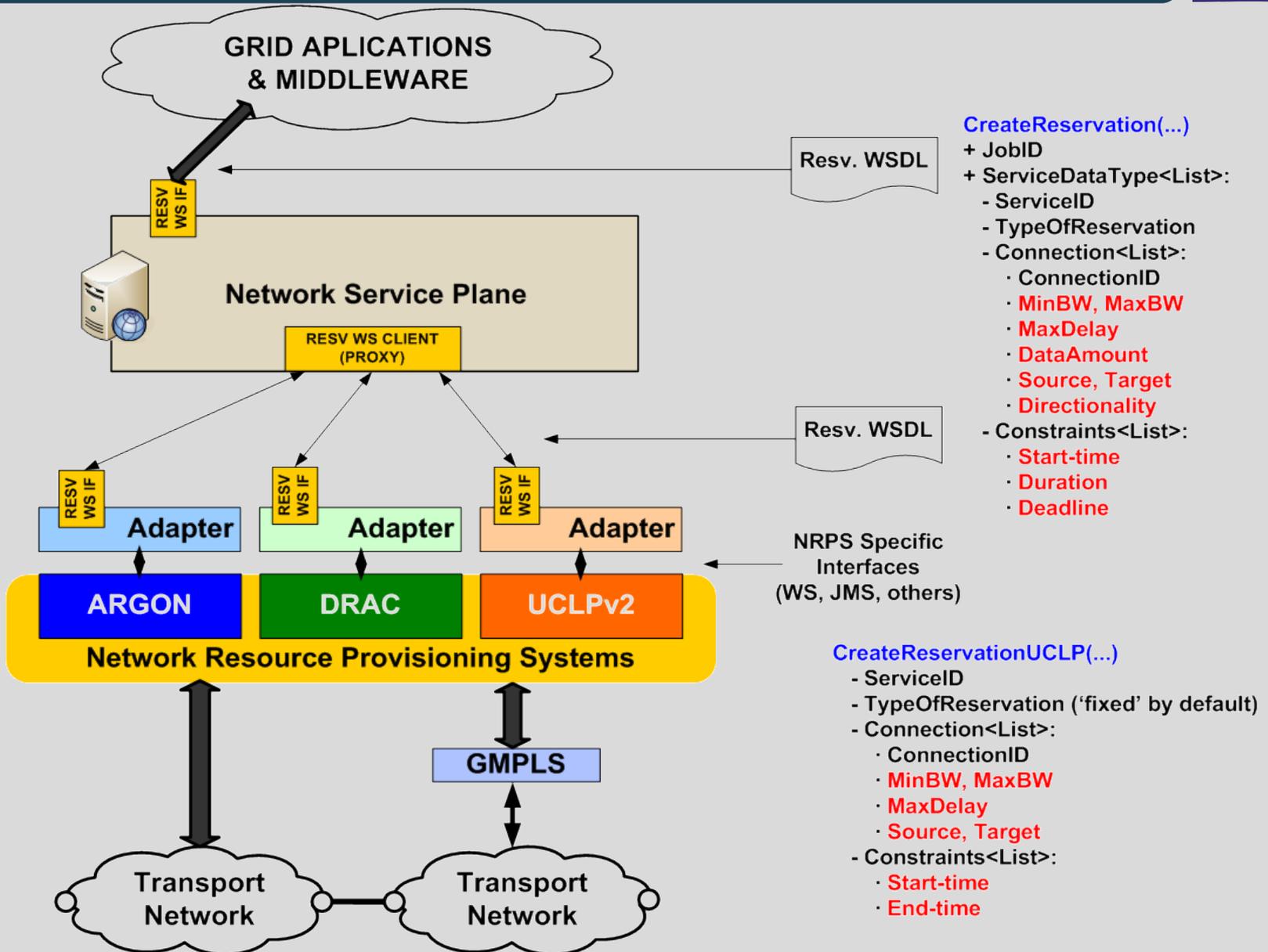
D) Southbound IF:

It Communicates the NRPSs and the lower layers (GMPLS or transport layer).

E) Phase 2 IF:

It provides interoperability between the NSP and the G²MPLS CP or other projects.

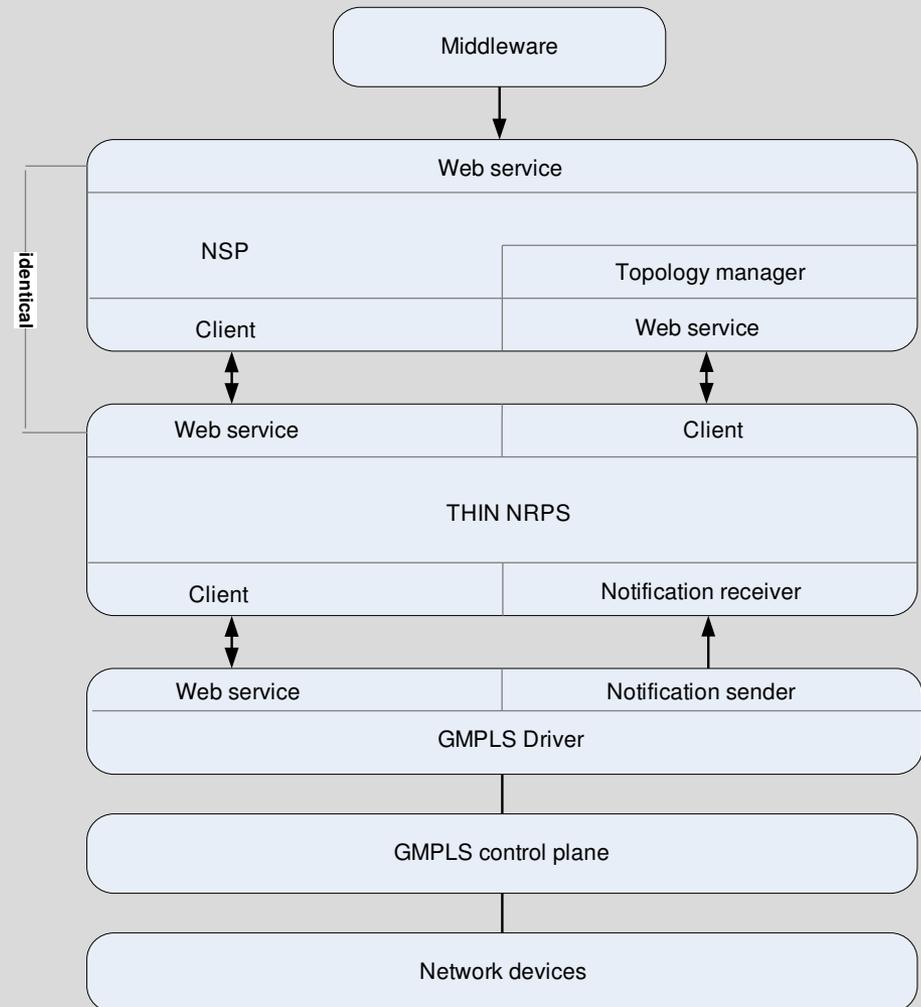
Reservation Handling in Phosphorus





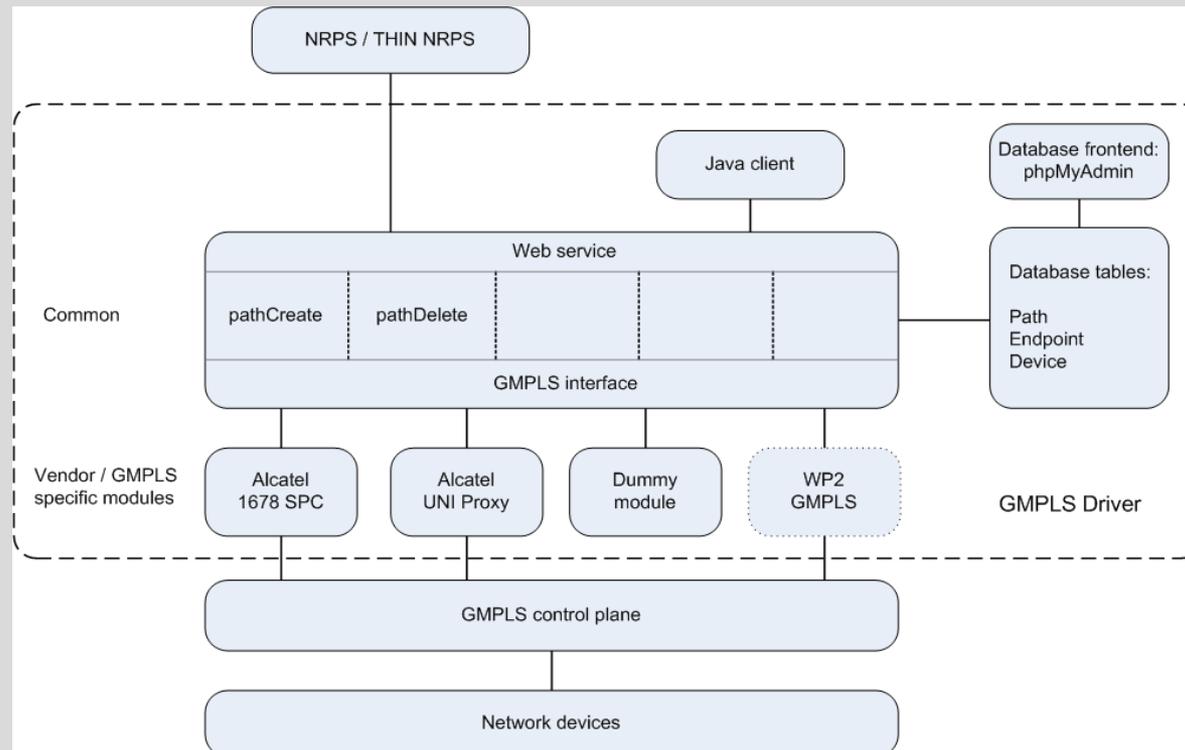
Thin NRPS: is a network resource provisioning system for domains with a GMPLS control plane. It is a NRPS with restricted functionality

- Provides a reservation web service to reserve, create and delete network connections via the GMPLS driver
- Provides advance reservation services (checking end points availability and possible overlapping reservations)
- Provides notifications receiver interface
- Acts as a client of the Topology manager WS of the NSP
- Acts as a client of the GMPLS driver
- Domain registering
- Handles reservation request from NSP





GMPLS driver: an interface between NRPS and the GMPLS CP. It is a general WS to create, delete and monitor paths for different GMPLS implementations, provides a WEB interface for testing the WEB service, Internal data base containing topology, path and status information, modules for accessing vendor specific GMPLS control planes (e.g. Alcatel-Lucent or Nortel) and G⁽²⁾MPLS interface to GMPLS



GMPLS driver services:

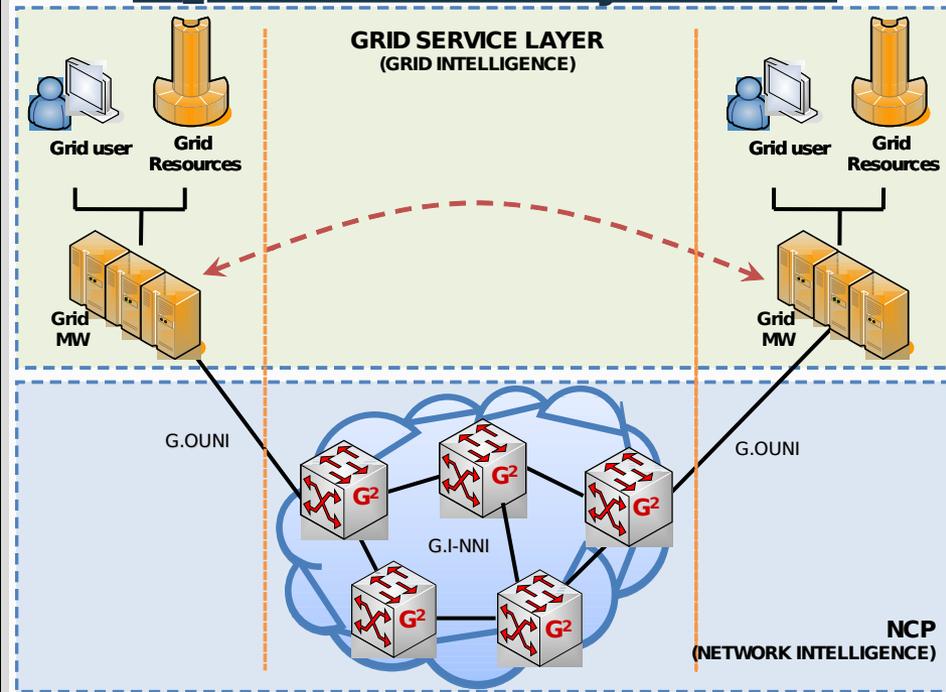
- **Path creation**
- **Path termination**
- **Path monitoring**
- **Path discovery**
- **Endpoint discovery**
- **Registration service**
- **Path delete notification**
- **EndPoint update notification**

G²MPLS Control Plane models

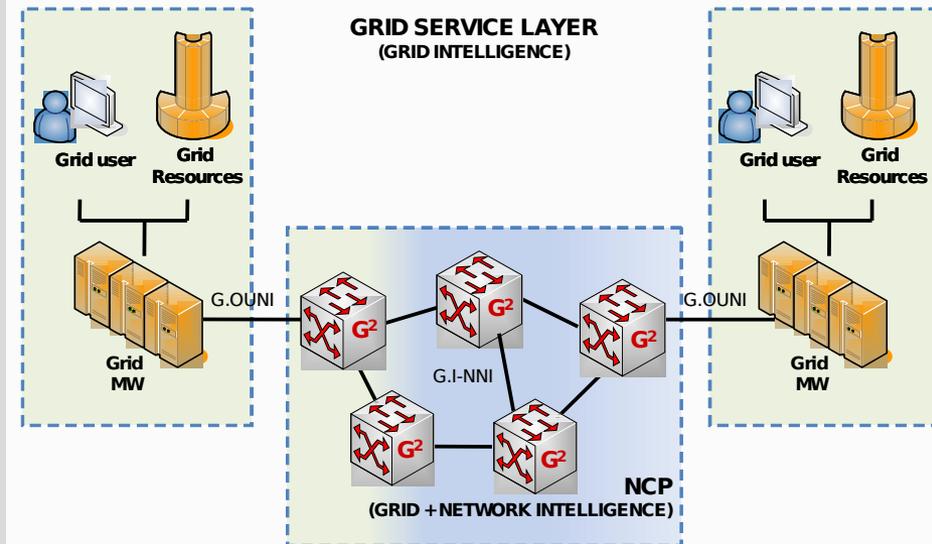


- Two models for the layering between Grid and Network resources

G²MPLS overlay model

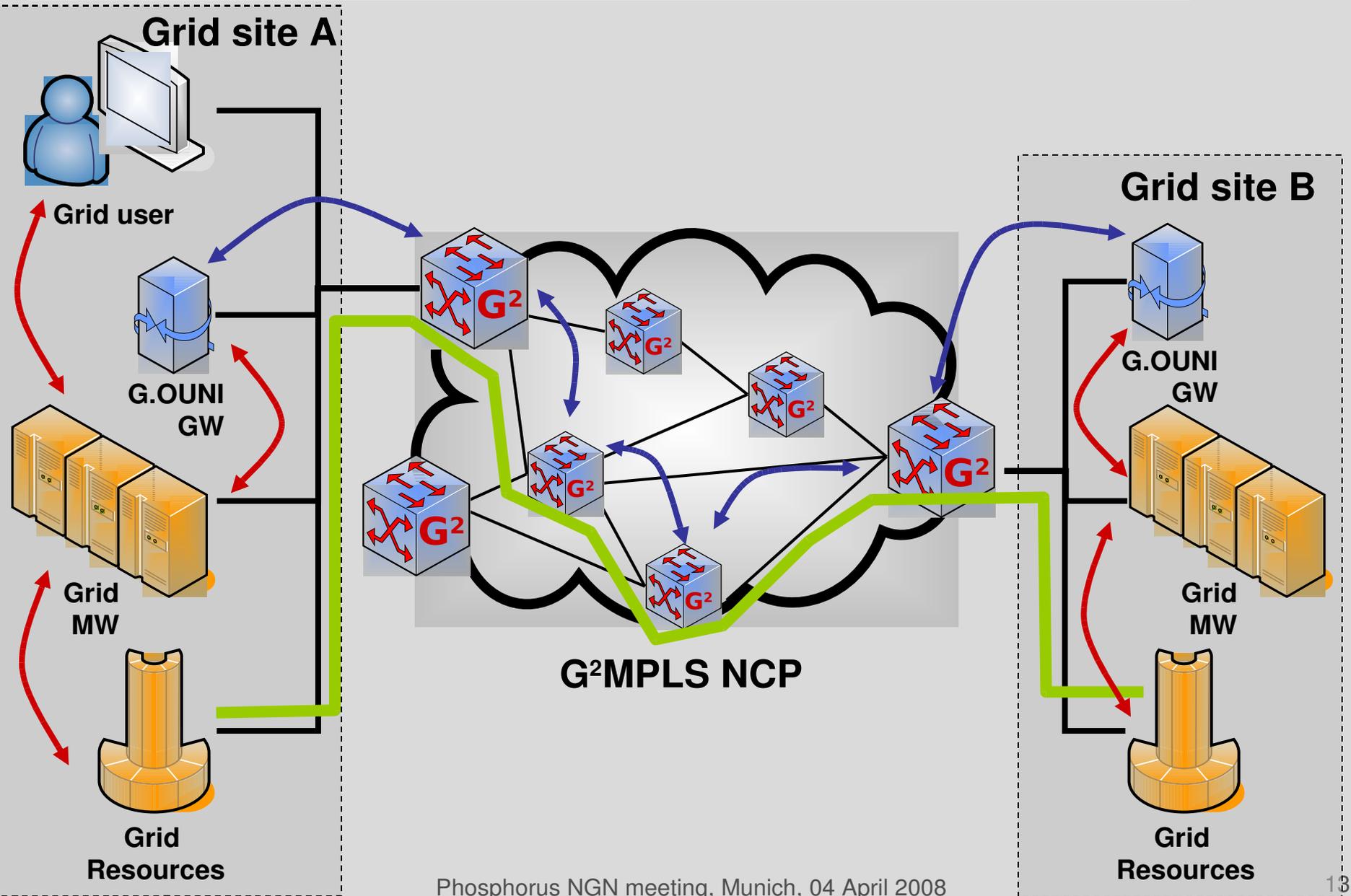


G²MPLS integrated model

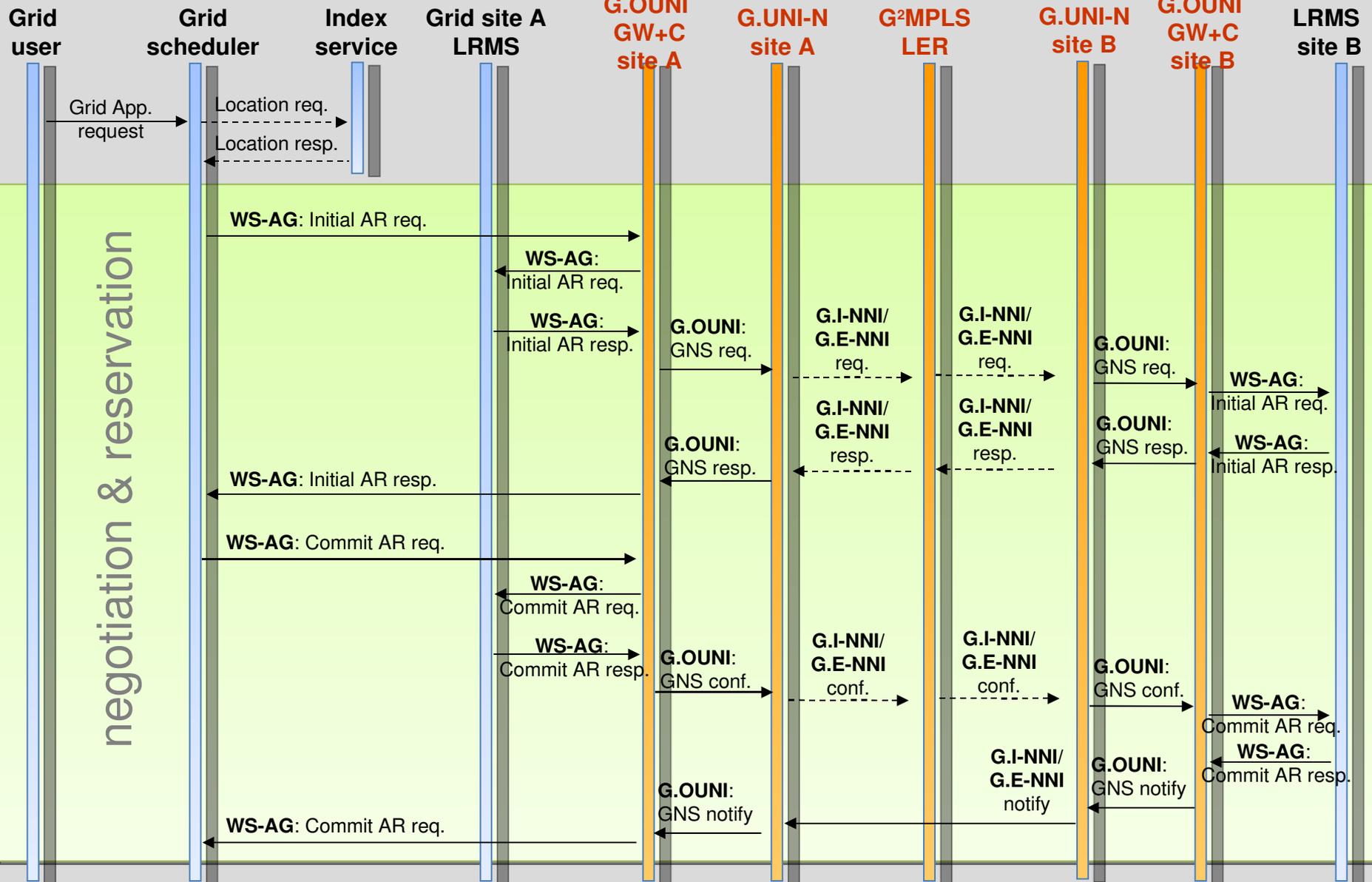


different scope with respect to the IETF GMPLS Overlay & Peer

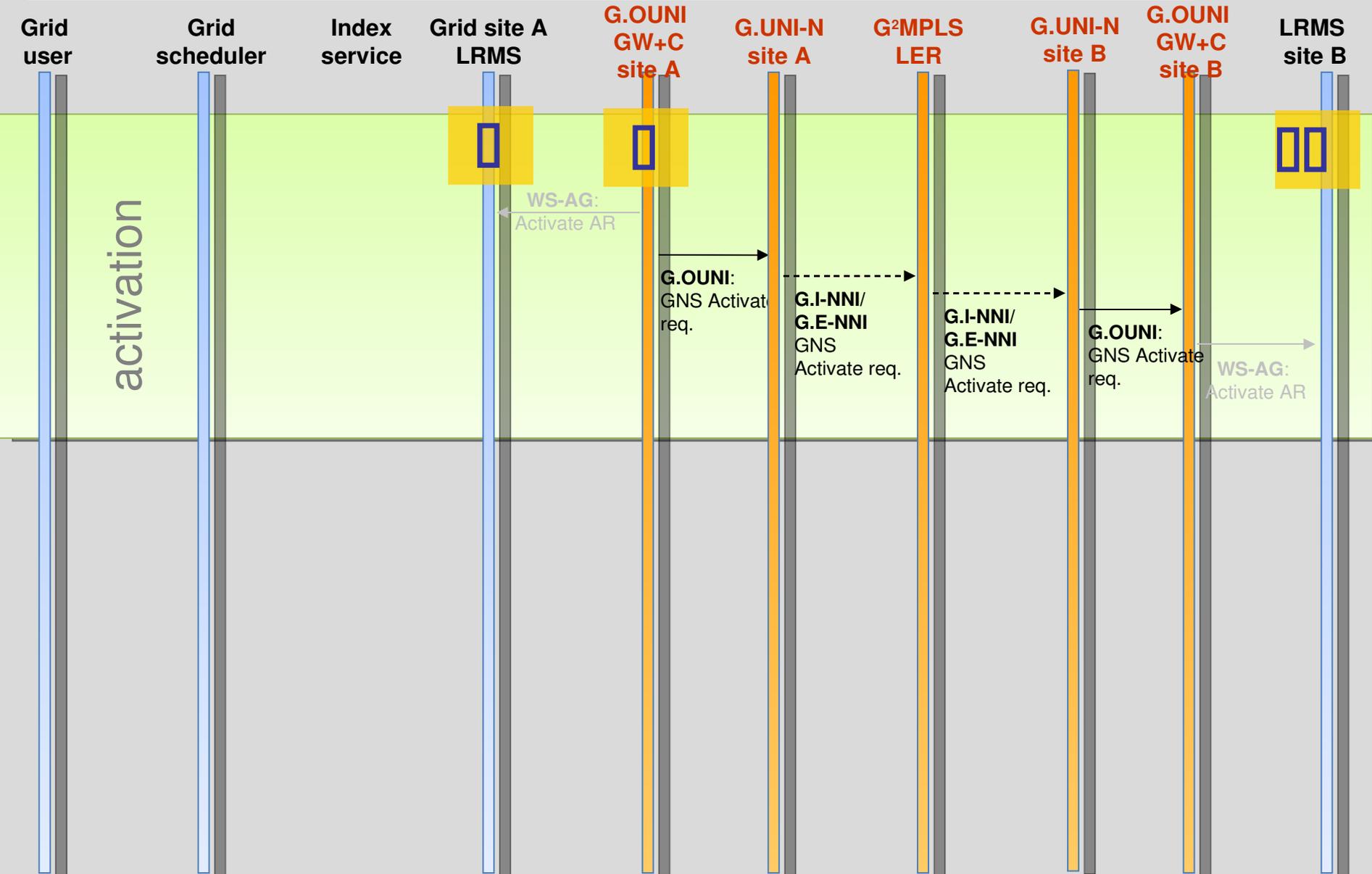
Example of direct invocation



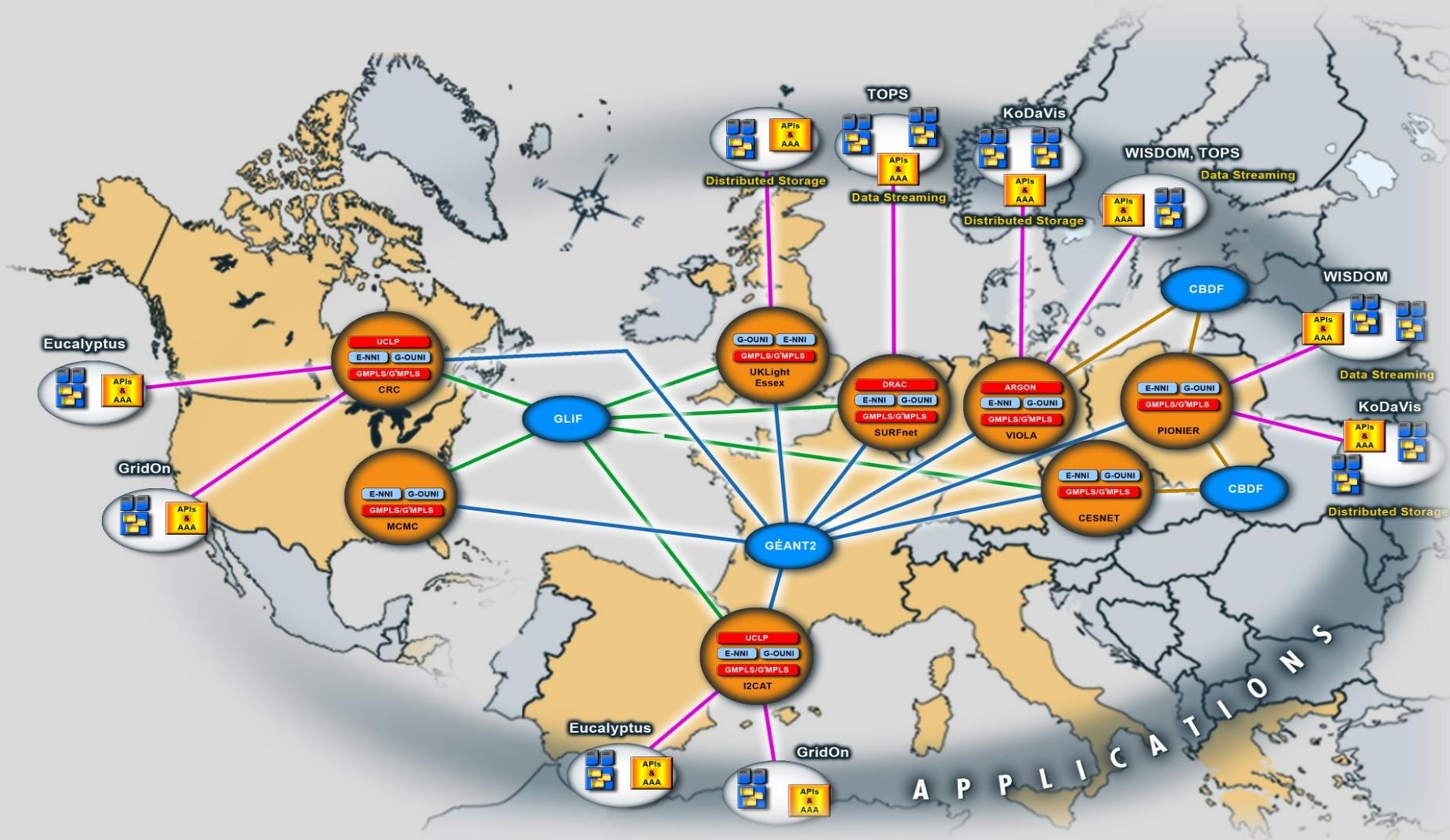
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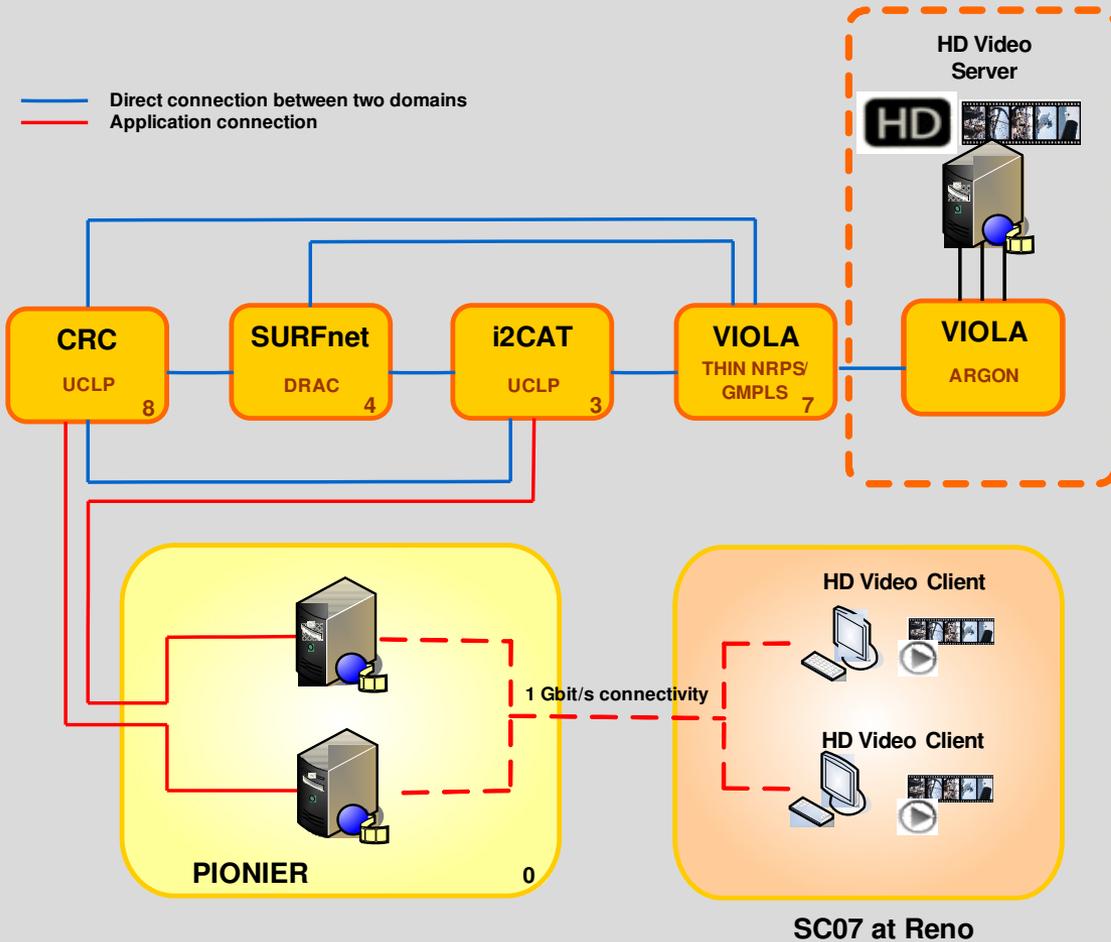


Example of direct invocation



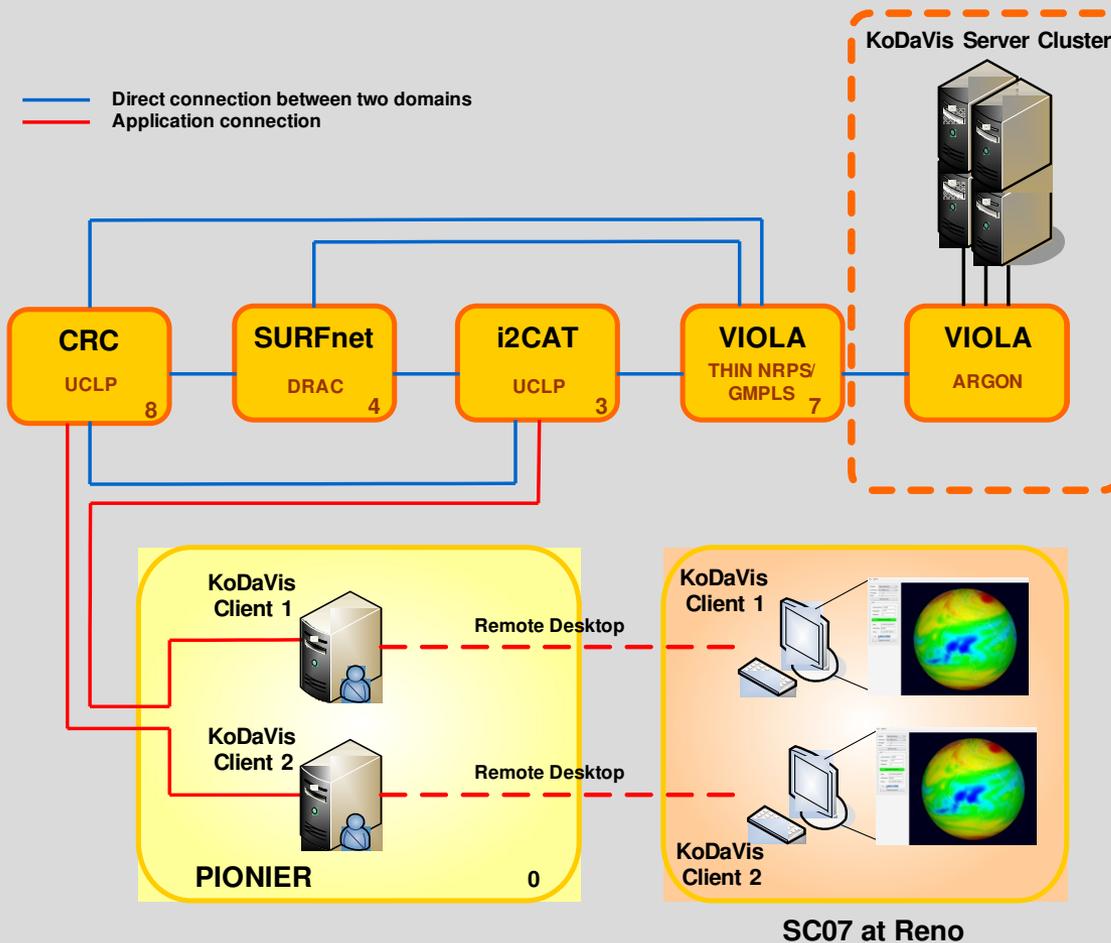
Phosphorus multi-domain testbed





The demonstration shows **the creation of the e2e path** to connect the two servers, one located in PSNC (Poland), and the second one in VIOLA (Germany).

One of them sends an **HD video stream that crosses the domains along Europe and Canada**. When the path is successfully set up, the HD video is shown on the HD Video client machine.



- Data stored on **central data-server** (Jülich, Germany)
- Two visualization clients (located in Reno) **collaboratively retrieve and explore** fragments of the data
- **QoS** in network is required for reliable fluent visualization

KoDaVis - distributed, collaborative visualization system with remote access to huge atmospheric simulation data.



- **Federica-Phosphorus tutorial and workshop (TNC2008)**
 - 18th May 2008, Bruges (Brugge), Belgium
 - Associated with TERENA conference 2008
 - Scope:
 - Discuss architectural solutions for network and IT service integration over high speed network infrastructure
 - Present various implementations of network control and service plane architectures to support the emerging infrastructure-as-a-service model
 - Share collective experiences gained by major research projects and initiatives around the globe and explore common vision, outcomes and synergies



PHOSPHORUS

The End

Thank you for your attention