Lambda User Controlled Infrastructure For European Research

PHOSPHORUS

Cees de Laat (University of Amsterdam)
on behalf of the Phosphorus collaboration.

- 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 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, GÈANT2, Cross Border Dark Fibre and GLIF connectivity infrastructures
- EU Research Networking Test-beds IST program
  - 30 months project, to begin october 2006
- For this project we have assembled a European and Global alliance of partners to develop advanced solutions of application-level middleware and underlying management and control plane technologies

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The problem

phosphorus Team Members

- **The phosphorus consortium includes 21 partners from 12 countries :**
  - **Project coordinator:** PSNC
  - **NRENs:** CESNET (Czech Republic), PIONIER (Poland), SURFnet (Netherlands)
  - **National Test-beds:** Viola, OptiCAT, UKLight
  - **Vendors:** ADVA, Hitachi, Nortel
  - **SMEs:** NextWorks - Consorzio Pisa Ricerche (CPR)
  - **Research Centres and Universities:** Athens Information Technology Institute (AIT-Greece), Fraunhofer SCAI (Germany), Fraunhofer IMK (Germany), Fundaciò i2CAT (Spain), IBBT (Belgium), RACTI (Greece), Research Centre Jülich (Germany), University of Amsterdam (Netherlands), University of Bonn (Germany), University of Essex (UK), University of Wales-Swansea (UK), SARA (Netherlands)
  - **Non-EU participants:** MCNC (USA), CCT@LSU (USA), CRC (Canada)

The phosphorus Project Key Features/Objectives (1)

- 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)

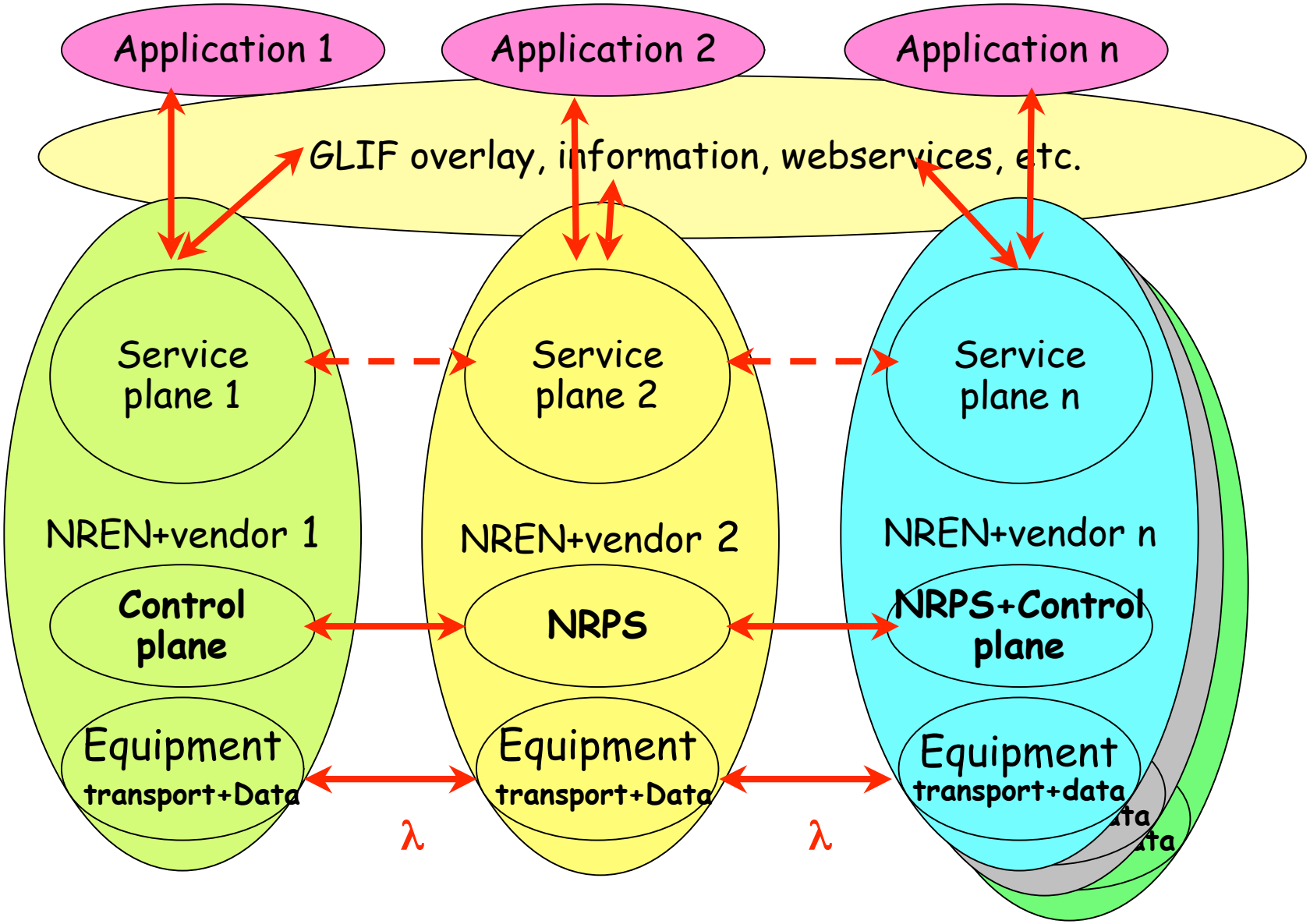
The phosphorus Project Key Features/Objectives (2)

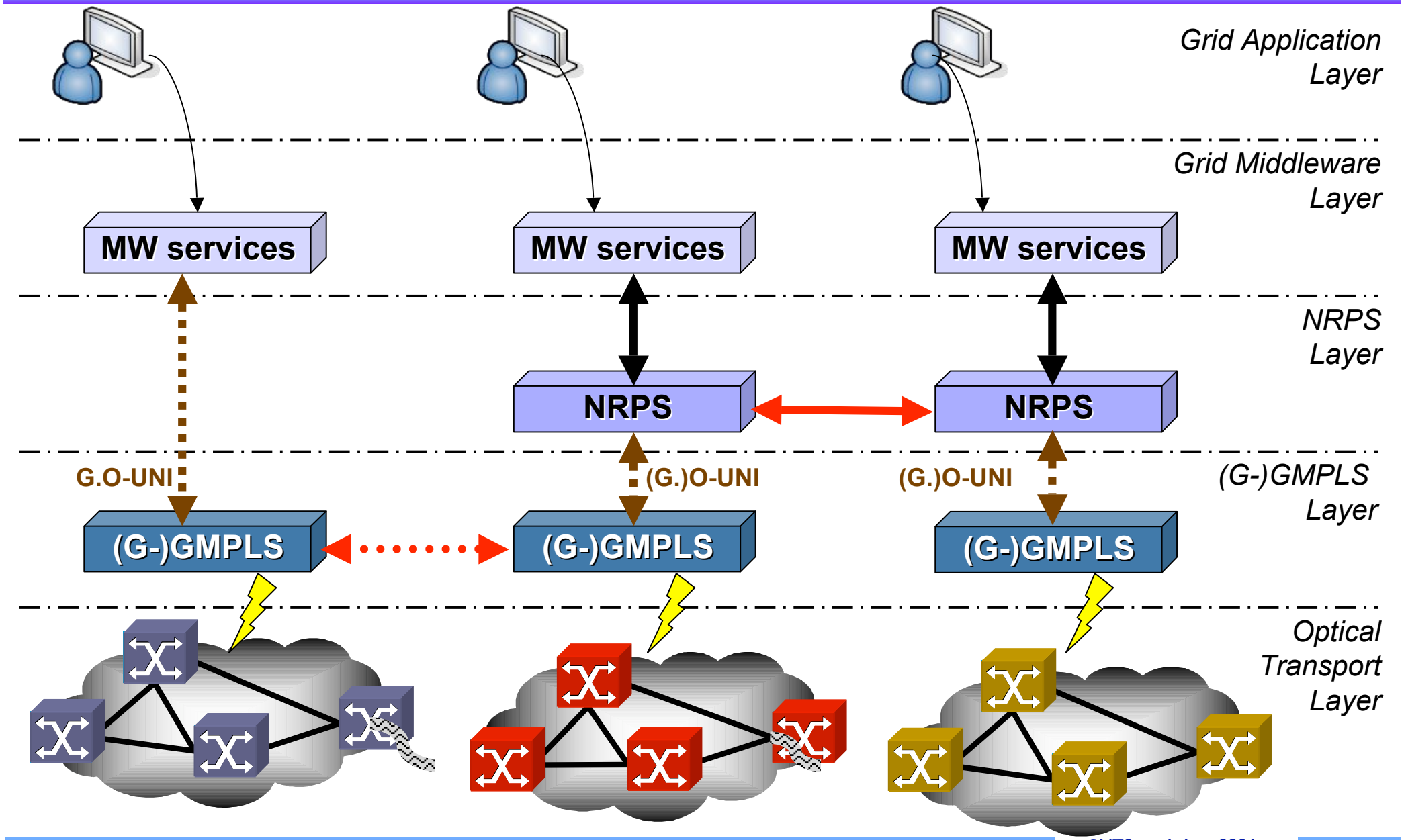
- Develop integration between application middleware and transport networks, based on three planes:
  - Service plane:
    - Middleware extensions and APIs to expose network and Grid resources and make reservations of those resources
    - Policy mechanisms (AAA) for networks participating in a global 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's resource reservation system
  - Control plane:
    - Enhancements of the GMPLS Control Plane (G^2MPLS) to provide optical network resources as first-class Grid resource
    - Interworking of GMPLS-controlled network domains with NRPS-based domains, i.e. interoperability between G^2MPLS and UCLP, DRAC and ARGON

The phosphorus Project Key Features/Objectives (3 & 4)

- 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 EU NRENs and their users, such as Supercomputing centres

phosphorus Architecture




Grid Application Layer
Grid Middleware Layer
MW services
MW services
MW services
NRPS Layer
NRPS
NRPS
G.O-UNI
(G.)O-UNI
(G.)O-UNI
(G-)GMPLS Layer
(G-)GMPLS
(G-)GMPLS
(G-)GMPLS
Optical Transport Layer

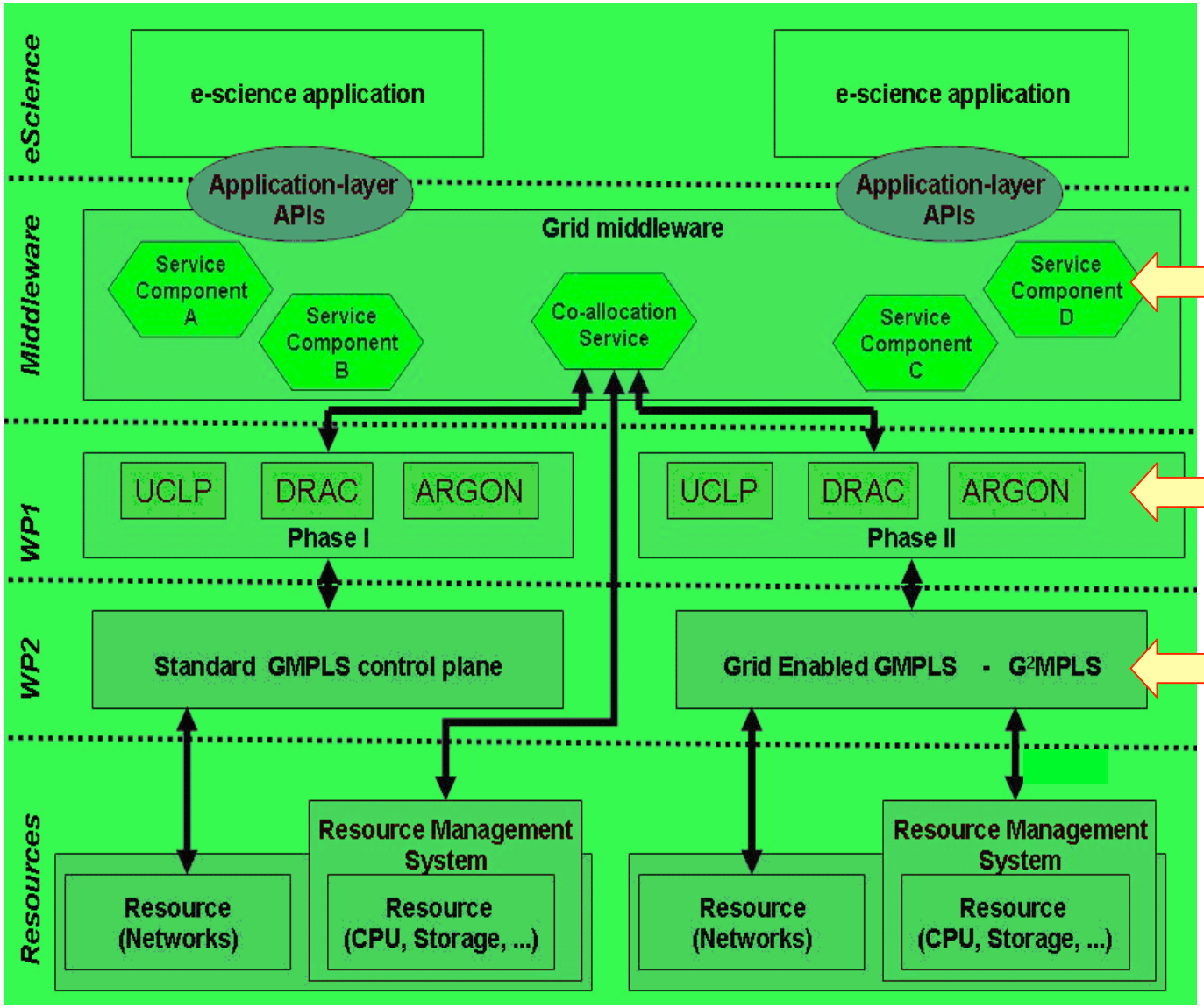
The System Chain

Phase I: *Grid App. ⇔ Grid Middle Ware ⇔* { *NRPS ⇔ OUNI ⇔ GMPLS ⇔ Optical Network* ; *Grid Resource* }

Phase II: *Grid App. ⇔ Grid Middle Ware ⇔ NPRS ⇔ G-OUNI ⇔ G²MPLS ⇔ Optical Network ⇔ Grid Resource*

- **This solution will be finalized progressively during the project:**
  - starting from existing Grid applications, middleware, NRPS & NCP, we will develop an e2e user-controlled environment over heterogeneous infrastructure deploying two *mutually unaware* layers (i.e. Grid and network)
  - G^2MPLS Control Plane is the evolution of the previous approach, making the NCP Grid-aware
- phosphorus will provide GMPLS and G^2MPLS Control Plane prototypes to be attached upon the commercial equipments at NRENs:
  - An important role of the equipment vendors into the consortium and with vendors involved with participating NRENs is to facilitate interfacing with their equipment
  - This is a practical solution for an experimental proof-of-concept RN test-bed
  - No direct commercial product dependency but useful feedback for their commercial deployment
  - The simplest and open way to interact with NRPS and Grid-middleware

Inter-domain issues and solutions

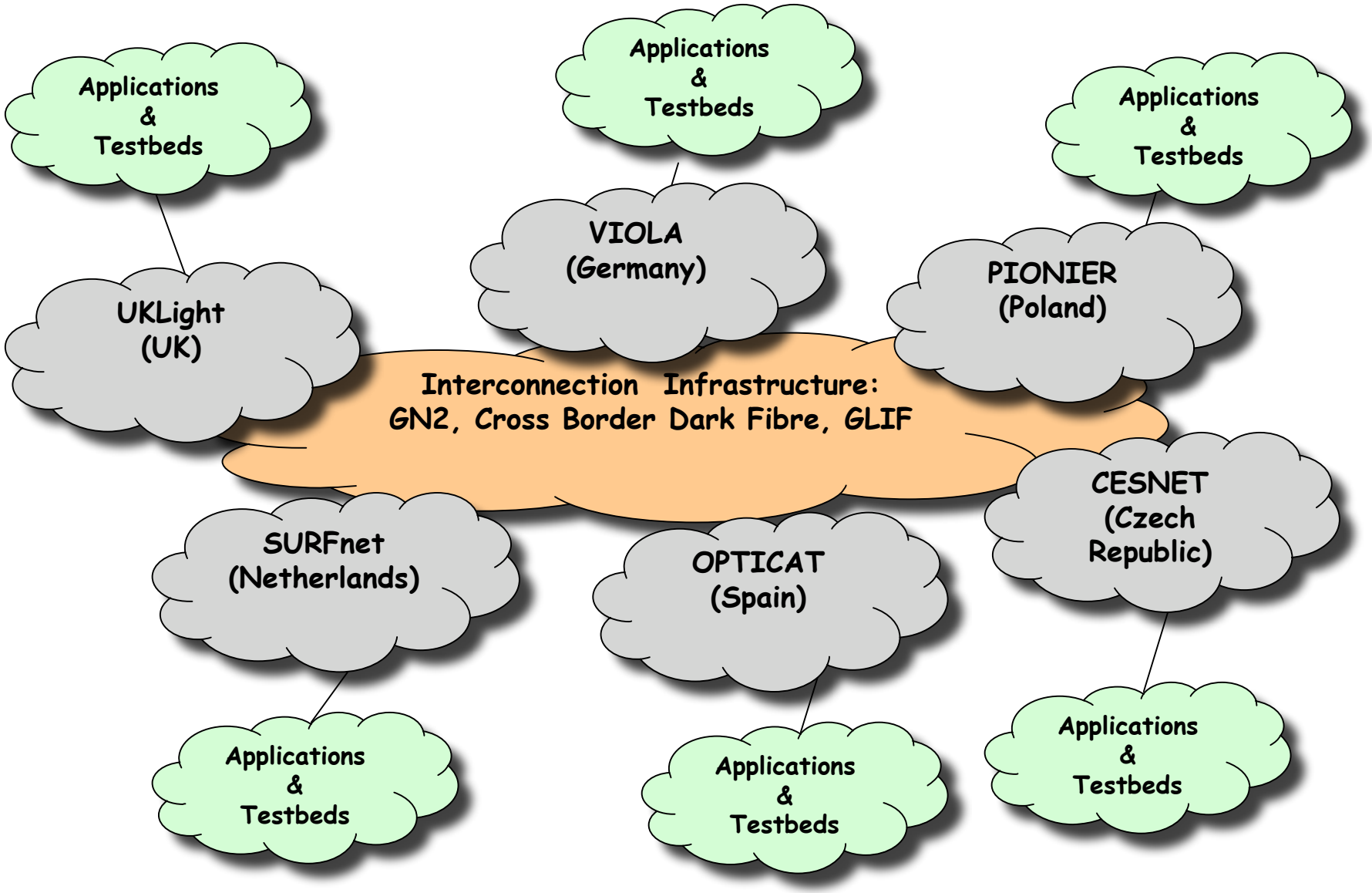


The different domains of the **phosphorus** test-bed will have:

- 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*)

- WISDOM - Wide In Silica Docking On Malaria:
  - large scale molecular docking on malaria to compute million of compounds with different software and parameter settings (in silico experimentation)
  - The **goal within phosphorus** is the deployment of a CPU-intensive application generating large data flows to test the Grid infrastructure, compute and network services
- KoDaVis – Distributed visualisation (FZJ, PSNC)
  - **To adapt KoDaVis to the phosphorus environment to make scheduled synchronous reservations of its resources via the UNICORE middleware**:
    - Compute capacity on the data server and the visualisation clients
    - Allocate network bandwidth and QoS between server and clients
- Streaming of Ultra High Resolution Data Sets over Lambda Networks (FHG, SARA)
- Distributed Data Storage System (PSNC, HEL, FZJ, FHG)

The phosphorus Test-bed- Existing Infrastructure



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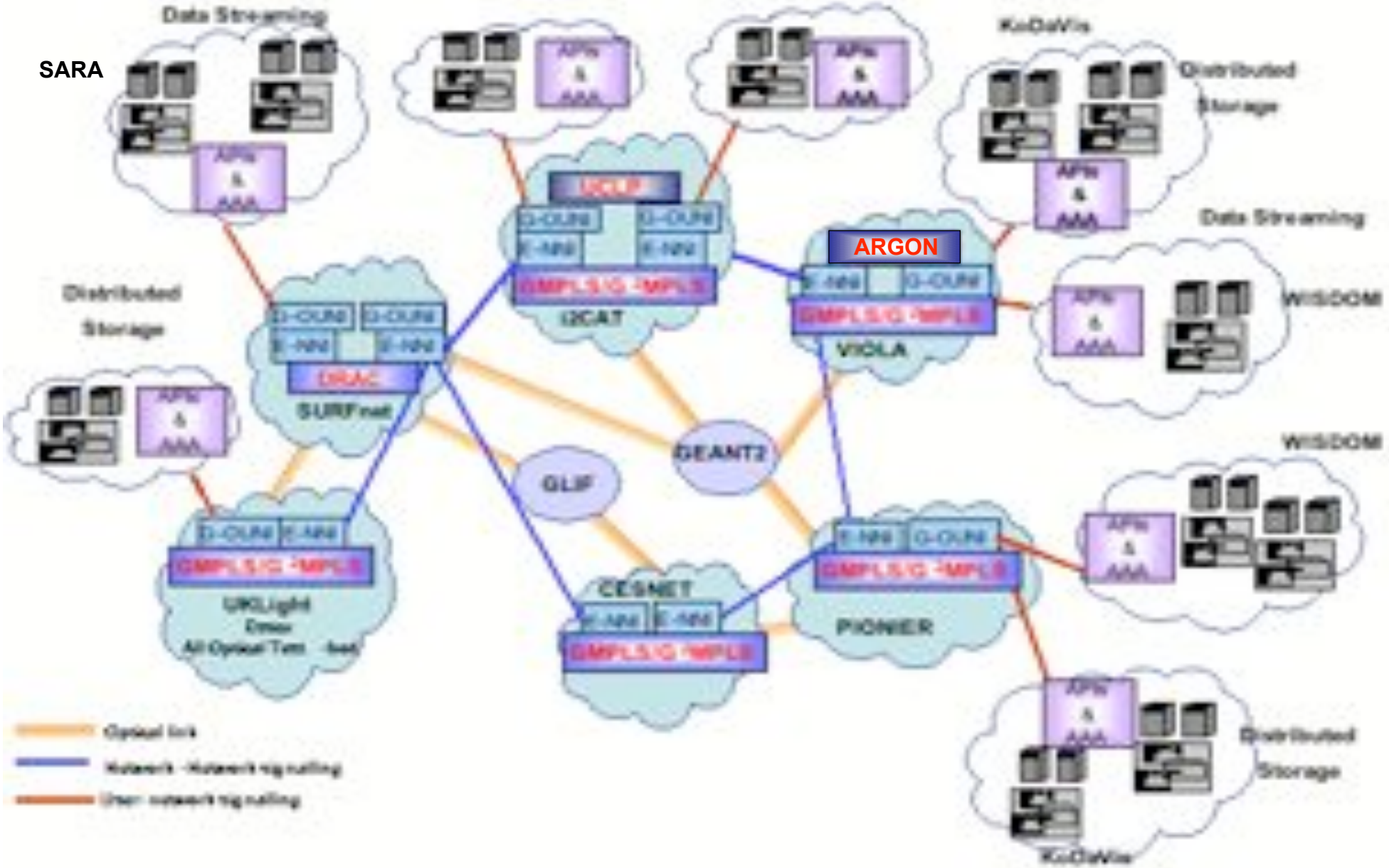
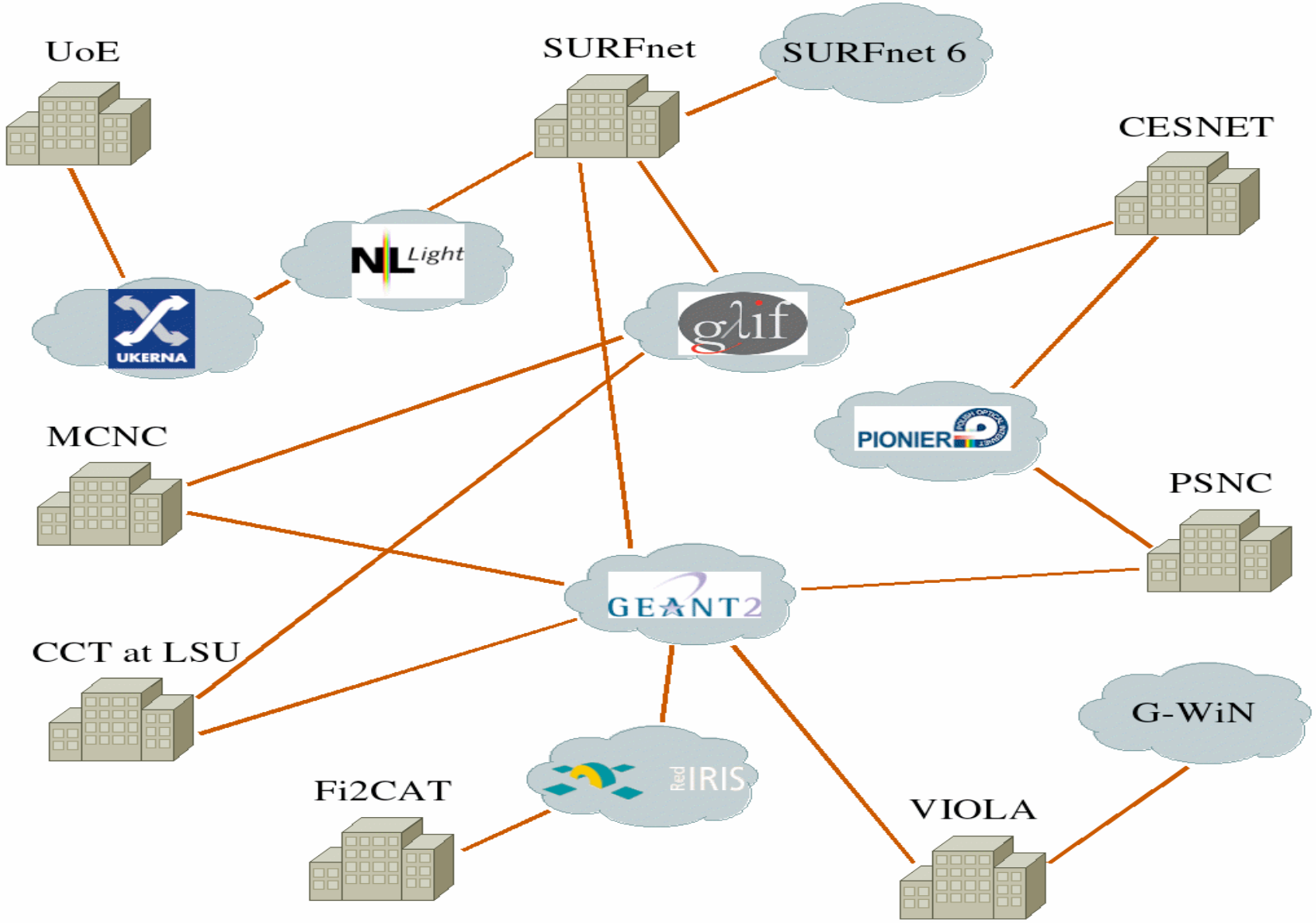
European Multi-Domain Test-Bed Including Phosphorus Planned Developments



The International Extensions



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