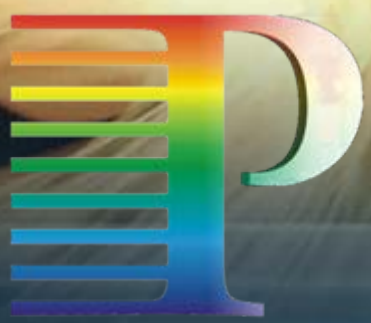


PHOSPHORUS

PHOSPHORUS

Lambda User Controlled Infrastructure for European Research

PHOSPHORUS OVERVIEW

- Instrument: Integrated Project under FP6
- Activity: IST-2005-2.5.6 – research networking test-beds
- Project duration 30 months
- Project started 01 October 2006
- Project budget 6 868 969 euro (5 125 098 euro EC contribution)
- Project resources 814 personmonths
- http://www.ist-phosphorus.eu

PHOSPHORUS PROJECT

- **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, GÈANT2, Cross Border Dark Fibre and GLIF

MEMBERS OF THE CONSORTIUM

NRENs & RON:

- CESNET
- Poznan Supercomputing and Networking Center
- 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 Wales Swansea

PHOSPHORUS


Communications Research Centre
NORTEL Networks
MCNC
UESSEX
UWS
UvA
SARA
SURFnet
IBBT
UniBonn
ADVA
FHG
FZJ
PSNC
CESNET
Hitachi Europe SAS
Nextworks
I2CAT
RACTI
AIT

PROJECT KEY FEATURES 1/3

- **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)

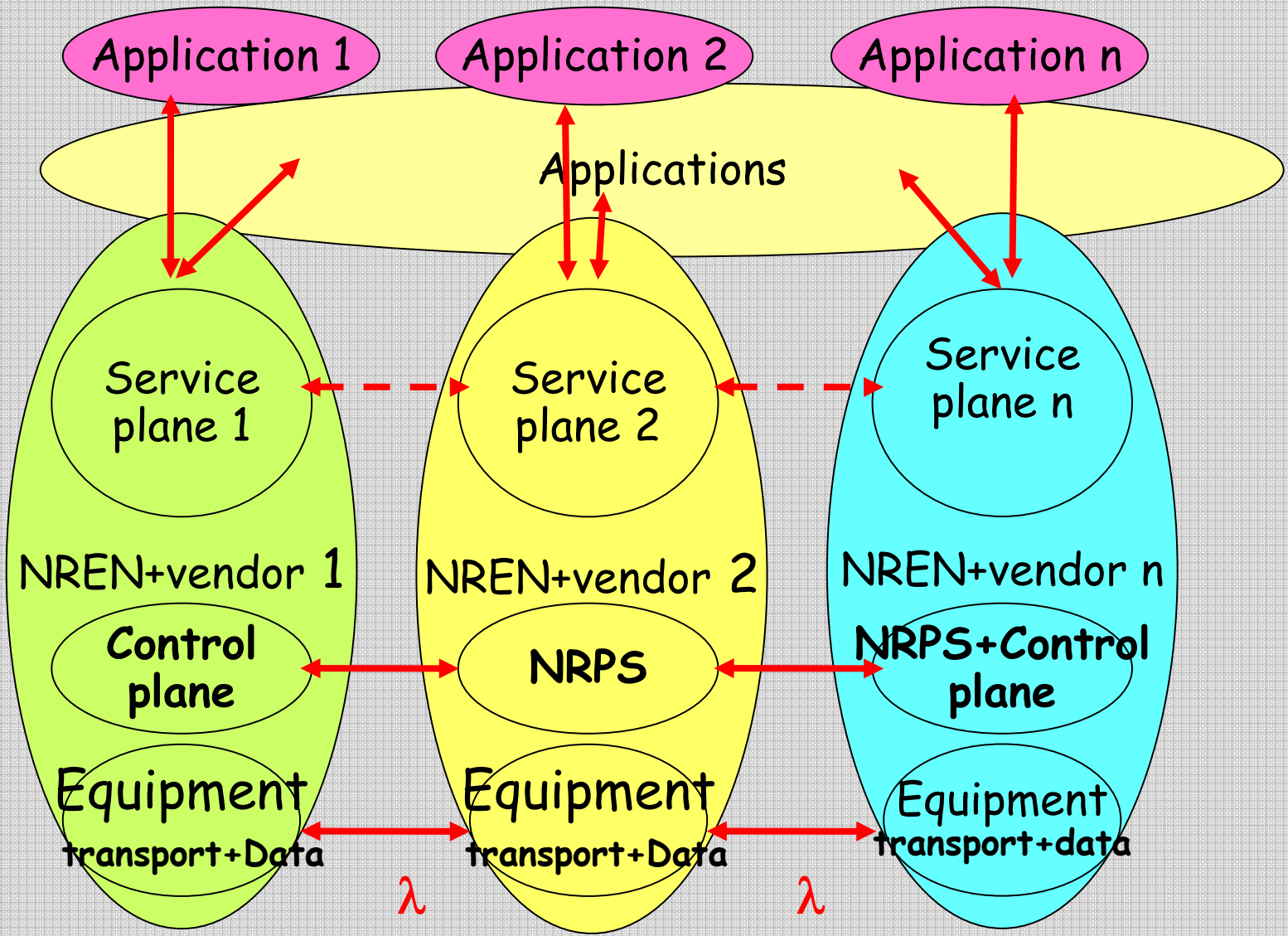
PROJECT KEY FEATURES 2/3

- 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 (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

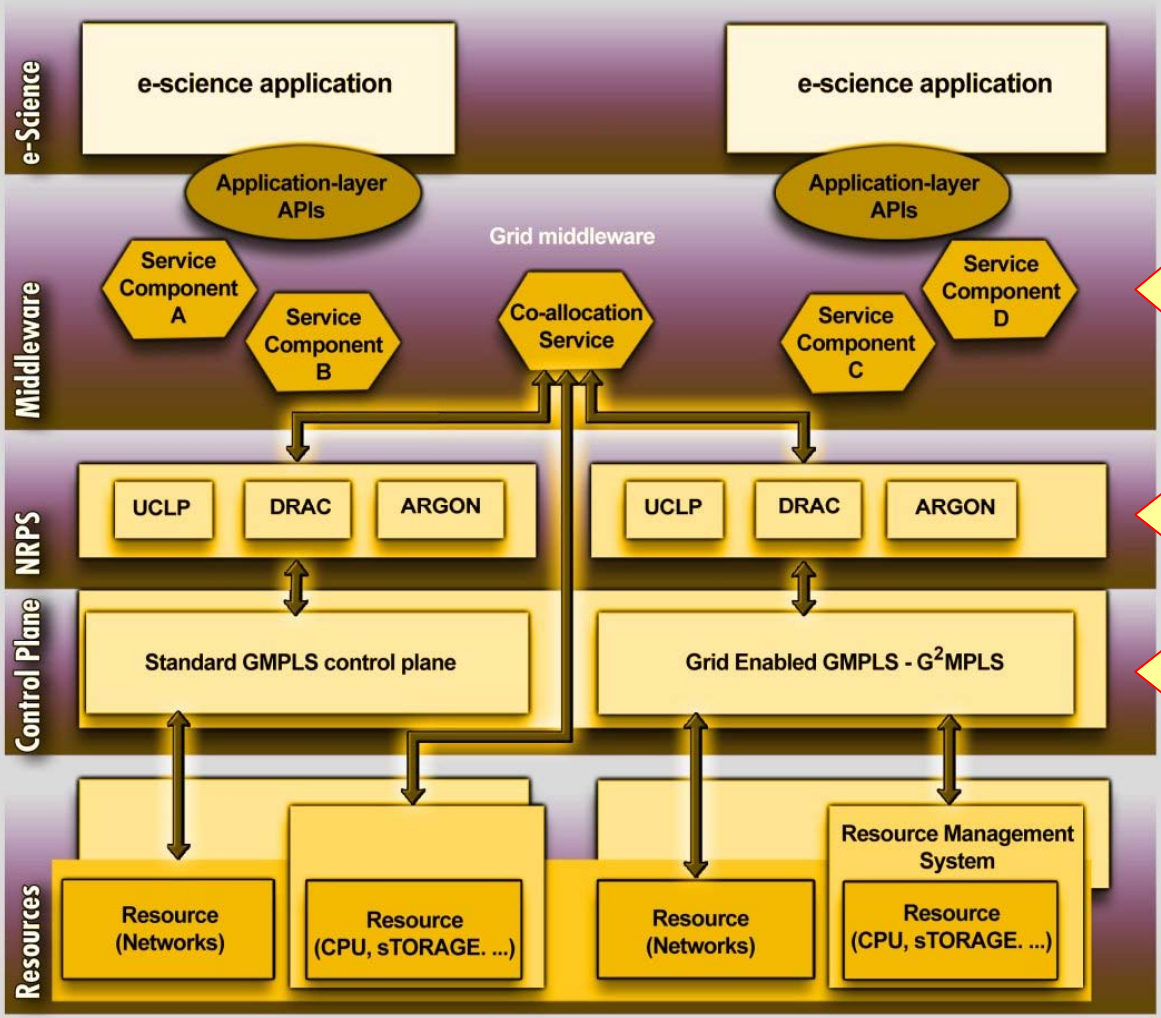
PROJECT KEY FEATURES 3/3

- 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 NETWORK SCENARIO



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*)

THE PHOSPHORUS DEVELOPMENT CHAIN

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

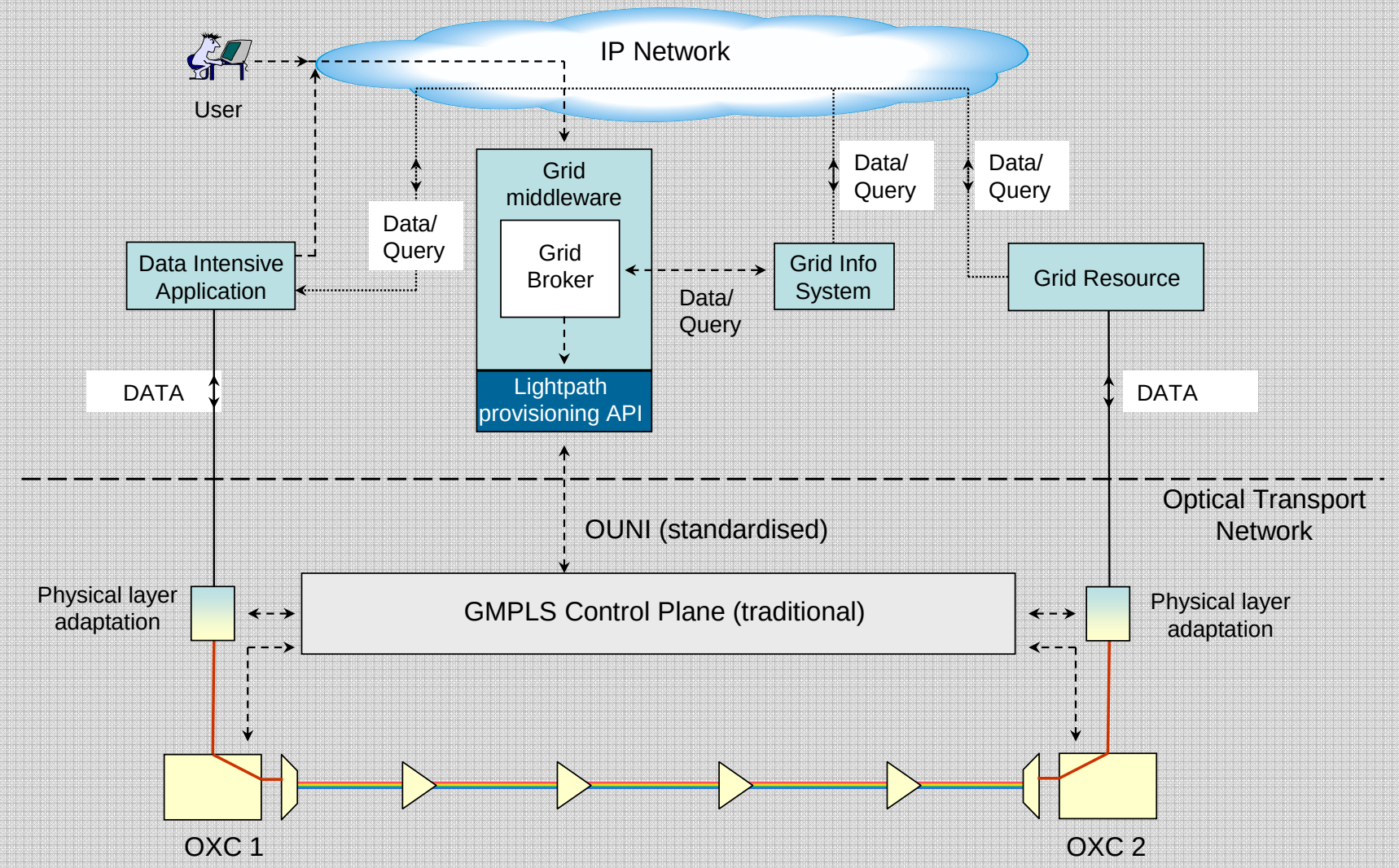
Phase II: *Grid App. ⇔ Grid Middle Ware ⇔ NPRS ⇔ G-OUNI ⇔ G²MPLS ⇔ Optical Network ⇔ Grid Resource*

- **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)
  - G²MPLS Control Plane is the evolution of the previous approach, making the NCP Grid-aware
- PHOSPHORUS will provide GMPLS and G²MPLS 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

OVERLAY MECHANISM FOR GRID - PH. 1

- Assumptions:
  - The Grid broker discovery and selection process handle only traditional compute and storage resources
  - The connection between the Grid user and the optical network is implemented through the Optical User Network Interface (OUNI).
- Actions:
  - The Grid client submits its service request to the Grid middleware, which processes and forwards it to the Grid broker.
  - The Grid broker discovers available services and selects the Grid cluster to perform the request.
  - The Grid middleware forwards the request to the light-path provisioning device
  - The connection between the Grid user and the Grid cluster through lightpath set up in the optical transport layer
  - The service request is sent to the Grid cluster though the selected light-path, the request is performed and the response is returned by the Grid cluster.

THE OVERLAY MODEL



INTEGRATED MECHANISM FOR GRID - PH. 2

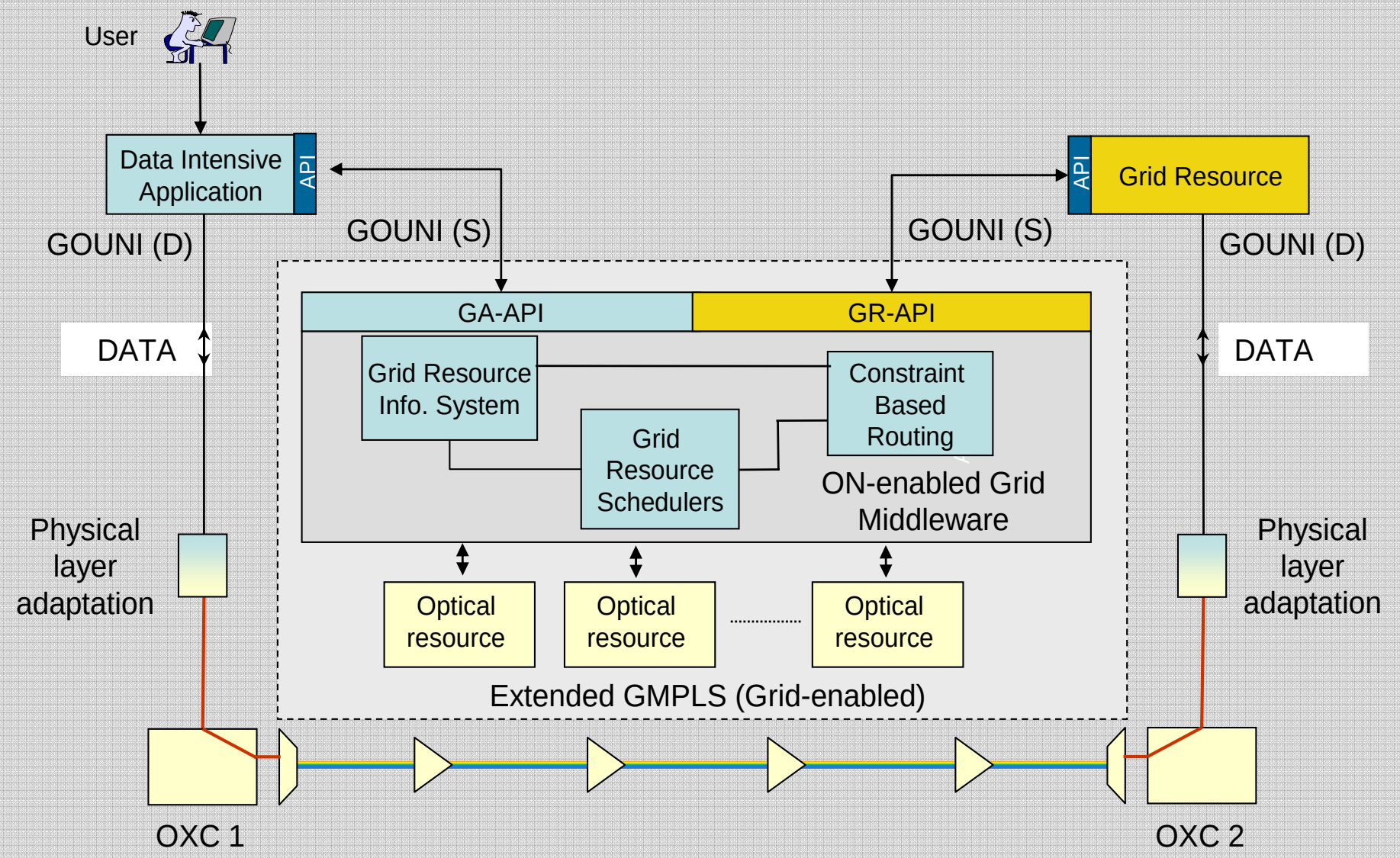
The integrated approach:

- Network resources is treated as “first class” Grid resource
  - The same way as storage and processing resource
- New approach to control and network architectures
  - GMPLS signalling which can be extended for Grid resources (G^2MPLS):
    - Extension to GMPLS signalling is feasible to accommodate the Grid information in exchanging messages

A NEW MECHANISM FOR GRID RESOURCE BROKERING

- Assumptions:
  - A direct connection between the Grid (applications and resources) and the optical network is done through the Grid Optical User Network Interface (G-OUNI), which is implemented on a Grid edge device.
  - The Grid info system is integrated with the GMPLS control (G^2MPLS) which contains information regarding the optical network resources. As a result, the discovery and selection process manages “traditional” compute, storage, etc. resources/services and optical network resources.
  - The Grid edge device initiates and performs the co-ordinated establishment of the chosen optical path and the Grid cluster.
- Actions:
  - The Grid client submits its service request to Grid middleware, which processes it and forwards it to the Grid edge device.
  - The Grid edge device requests connection between the Grid client and a Grid cluster through the Optical Control Plane
  - The Optical Control Plane performs discovery of Grid resources coupled together with optical network resources and returns the results with their associated costs to the Grid broker
  - The Grid broker chooses the most suitable resource and a light-path is set-up using GMPLS signaling

THE INTEGRATED MODEL



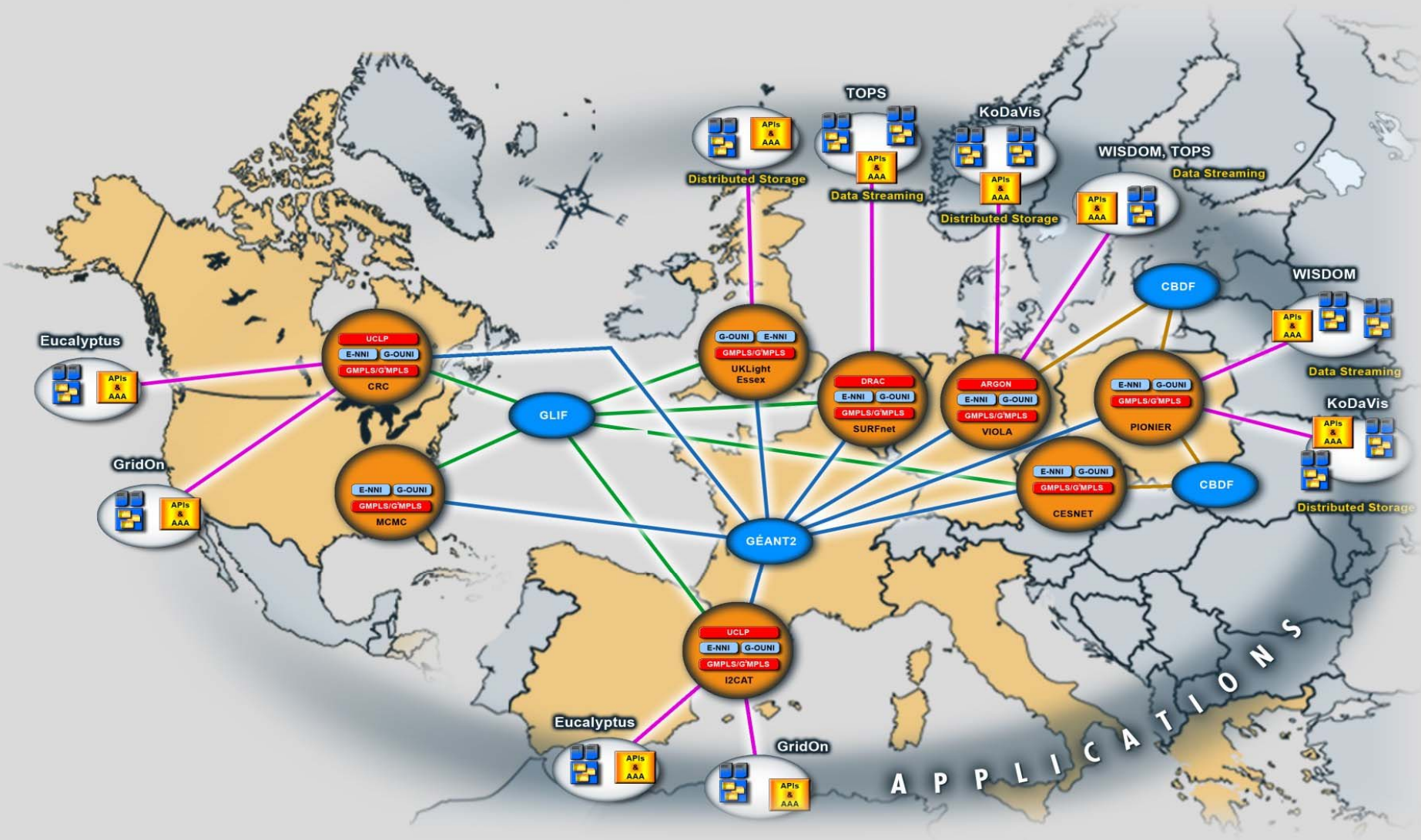
INITIAL APPLICATIONS, PART 1

- 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, UESSEX)
  - The main **objective in Phosphorus is 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

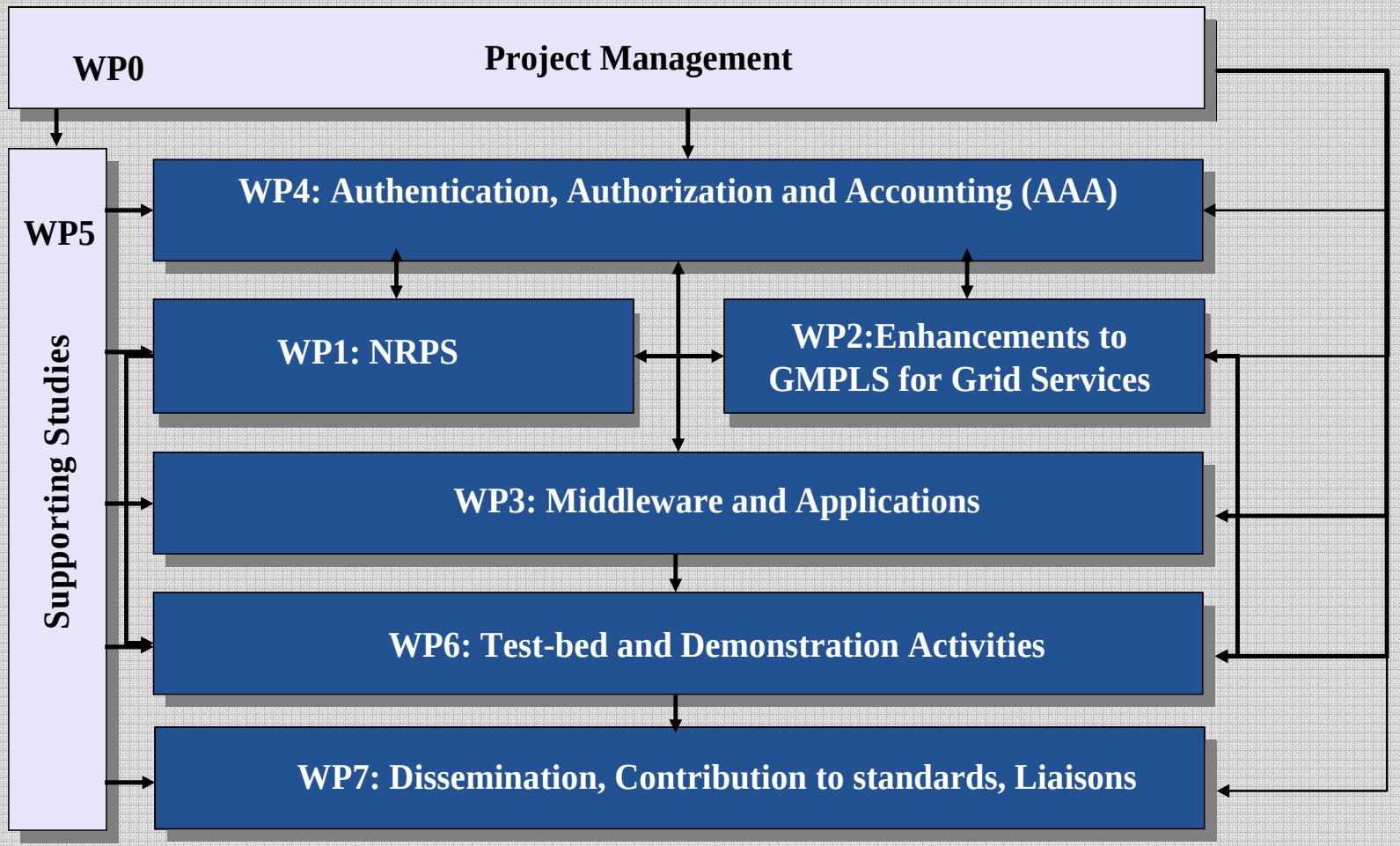
INITIAL APPLICATIONS, PART 2

- TOPS – Technology for Optical Pixel Streaming (FHG, SARA)
  - Streaming of Ultra High Resolution Data Sets over Lambda Networks
  - Adapt the idea of video streaming: constant stream of pixels from renderer to display
  - Use lossy protocols for long distance connectivity: High performance TCP hard to achieve, UDP performance trivial
  - Light weight application – scalable bandwidth usage
- DDSS - Distributed Data Storage System (PSNC, HEL, FZJ, FHG, UESSEX)
  - GridFTP - a high performance, secure, reliable data transfer protocol optimized for high-bandwidth wide-area IP networks.
  - Backup/archive copies with TSM (Tivoli Storage Manager) over the test network
  - possible scenarios of usage
    - data gathering or data distributing
    - backups of large medical data volumes (bandwidth demanding) from one or many clients
    - from one or many clients

MULTI-DOMAIN TESTBED



PHOSPHORUS WORK PACKAGES

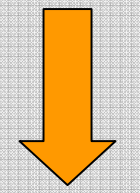


WP 1: NETWORK RESOURCE PROVISIONING SYSTEMS (NRPS) FOR GRID NETWORK SERVICES

1. Definition of NRPS and GMPLS control plane boundaries.

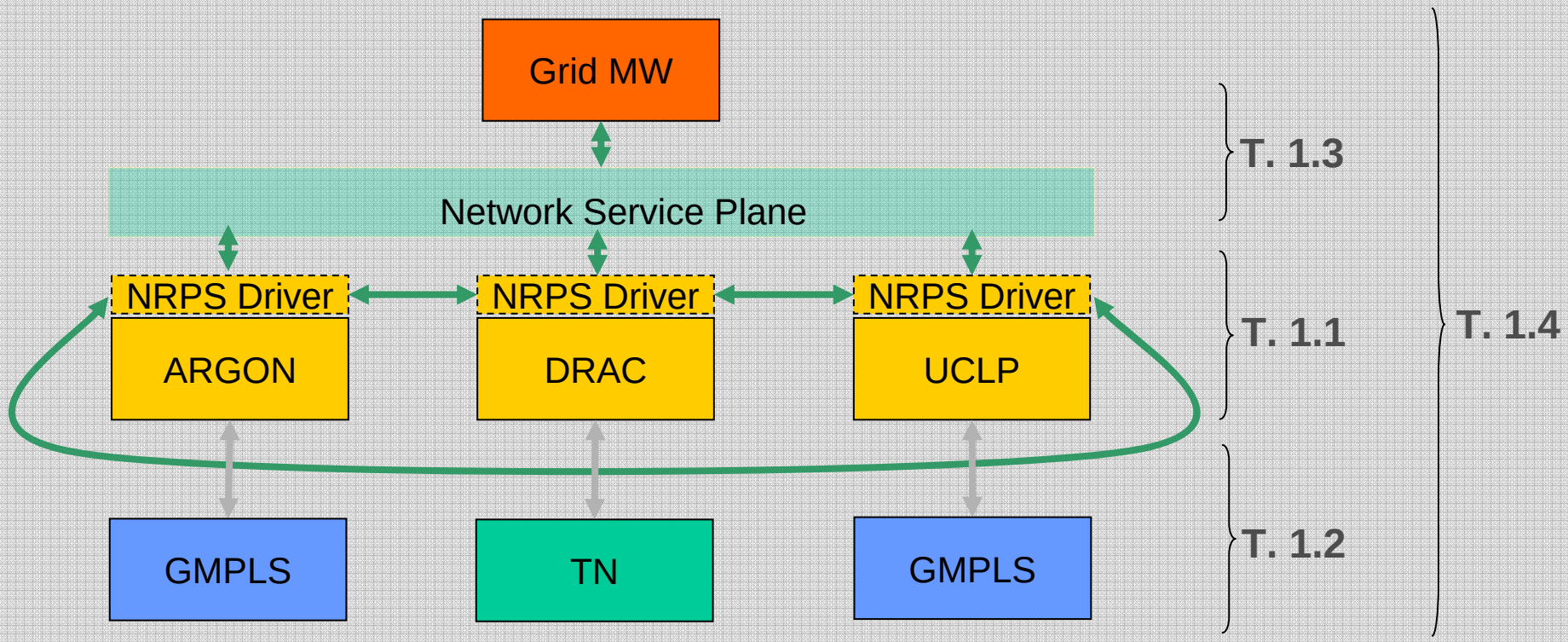
2. Development of interfaces:
   - For NRPS interoperability.
   - Between different NRPS's and the standard GMPLS control plane.
   - Between different NRPS's and the Grid enabled GMPLS (G^{2}MPLS) control plane. (Preliminar prototype by the end of First Phase)

3. Implementation of the Network Service Plane.



- Demonstrate interoperability between NRPS, G^{2}MPLS and Grid middleware.

WP1: ARCHITECTURE & TASKS (First phase)



Task 1.1 Heterogeneous NRPSs interoperability.

Task 1.2 Interoperability of NRPS and GMPLS control plane.

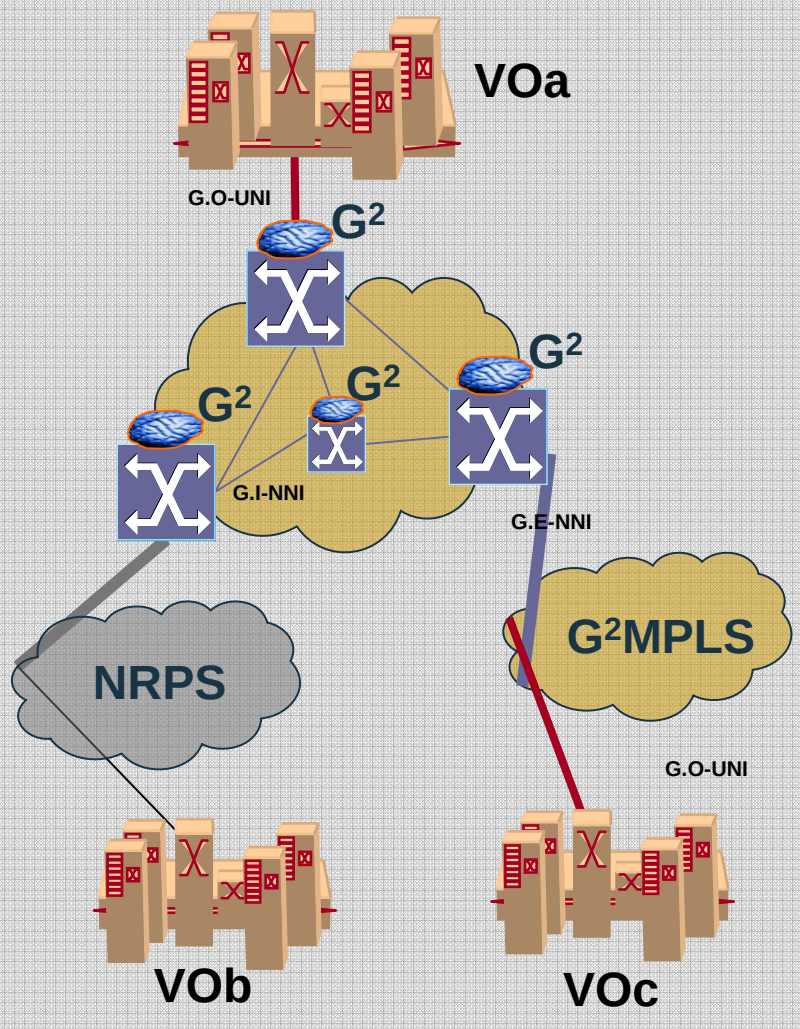
Task 1.3 Integration of the Network Service Plane.

Task 1.4 Interoperability between NRPS, GMPLS and the Service Layer.

WP2: ENHANCEMENTS TO THE GMPLS CONTROL PLANE FOR GRID NETWORK SERVICES (GNS)

Extensions to the GMPLS CP for automatic and single-step setup of Grid & network resources

- Grid-GMPLS (G^2MPLS) main tracks:
  - seamless coexistence with NRPS & Grid MW
  - Grid-aware network reference points (G.O-UNI, G.E-NNI, G.I-NNI)
  - CBR algorithms for recovery and TE
  - Integration with AAA system
- Planned delivery of G^2MPLS CP prototypes
  - R1.0 by M12: G.I-NNI + G.O-UNI
  - R2.0 by M24: full-fledged G^2MPLS
- Technical validation
  - supporting studies (WP5), demos (WP6) and disseminations (WP7)
  - cooperation with US initiatives (i.e. EnLIGHTened) and synergies with GN2-JRA3

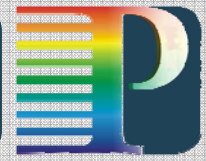


WP3: MIDDLEWARE AND APPLICATIONS

- Integration of network reservation services into existing Grid middleware
  - services for user-driven or application-driven set-up of execution environments with dedicated capabilities & performance
    - Compute nodes, storage systems, visualization devices
    - Network resources with defined QoS
- Integration of applications
  - WISDOM: Wide in silicio docking on Malaria
  - KoDaVis: collaborative, distributed visualization of huge data sets
  - TOPS: Streaming of ultra high resolution data sets over lambda networks
  - DDSS: Distributed Data Storage System

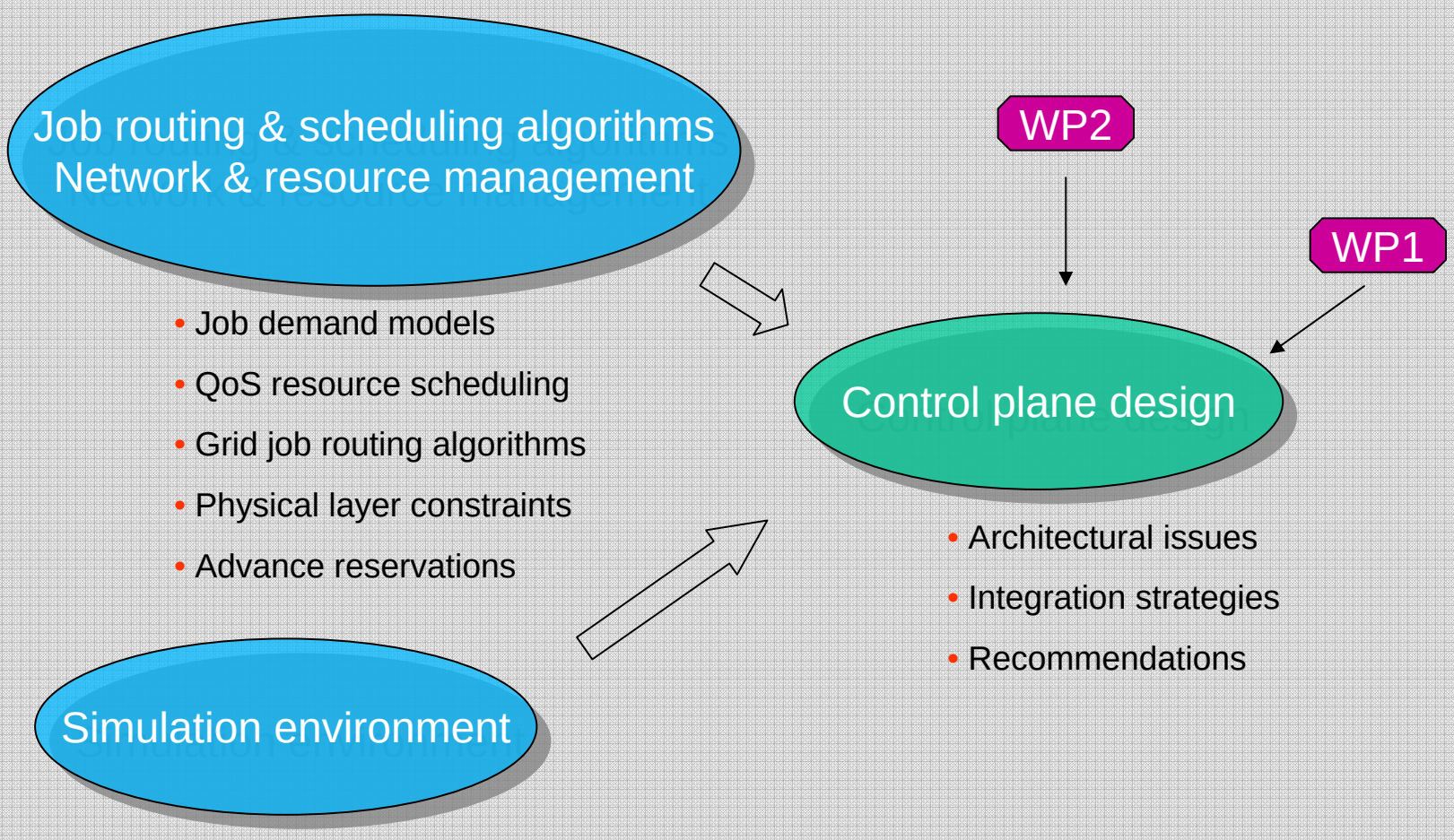
Provide application access to PHOSPHORUS services and showcase their benefit via applications

WP4: AUTHENTICATION, AUTHORIZATION & ACCOUNTING



- WP4 (Service Plane - AAA) will focus on implementing and integrating Authentication, Authorization and Accounting solutions for the Phosphorus test-bed. The objectives of WP4 in the first 18 month are:
  - To study the applicability of current and emerging AAA related technologies in order to select a suitable set with enough flexibility to create and test the interoperability of optical network domains. Collaborations with GEANT2 (JRA5), DRAGON and EGEE will be established which and will be used as a base.
  - Collaborate with WP1, 2 and 3 to establish their specific needs towards AAA and describe their needs in a uniform way that allowing a more generalized implementation
  - To create prototypes, running in a test-bed which demonstrates authorization sequences applied in multiple functional layers of the network. The AAI work within GEANT2 and VOMS work within EGEE will be used as starting point and expanded.
- Consequently the work is organized into
  - Task 4.1 AAA architecture selection
  - Task 4.2 AAA scenario development
  - Task 4.3 Integration and testing

WP5: SUPPORTING STUDIES



WP6: TESTBED & DEMONSTRATION ACTIVITIES

- Objectives:
  - Requirements analysis and design of the test-bed
  - Construction of the test-bed and configuration of all related software components, middleware and applications
  - Tests of project's developments
  - Demonstration of project's results
  - Recognizing, description, deployment and testing of new types of Layer 0 and Layer 1 resources
- Current status:
  - Work package is in the phase of test-bed design. The members are gathering information about their local network requirements and possible connections with other partners, and the coordinator is collecting data from other work packages, regarding e.g. applications' requirements.

WP7: DISSEMINATION, CONTRIBUTION TO STANDARDS, LIAISONS

- Disseminate information concerning the technical developments to
  - NRENs
  - Related projects:
    - MUPBED, GN2, NOBEL, EGEE, DEISA, OpenNet, RING, ONELAB, PANLAB, UCLP, DRAGON, Enlightened Computing, G-Lambda…
- Coordinate direct contributions to standards
- Build a collaborative framework for participation to test-bed activities from within and external to EU

PHOSPHORUS

Thank you