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PHOSPHORUS

Lambda User Controlled Infrastructure for European Research

Integrated Project

Strategic objective:
Research Networking Testbeds

Deliverable reference number <D.7.1.2>

Plans for using and disseminating the knowledge

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UESSEX

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Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission	
RE	Restricted to a group specified by the consortium (including the Commission	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Abstract

The Phosphorus project is expected to provide an improvement of the partners' know-how in the areas of design and integration of multi-service and multi-technologies optical networks with a particular focus on Grid application and related middleware. Therefore, accurate tracking and registration of the knowledge produced, as well as appropriate dissemination and identification of the exploitable results will be needed during the project execution. This deliverable will report the plans and efforts to disseminate and exploit the knowledge produced throughout the project's duration.

This is the first release of an evolving deliverable document. Subsequent releases are planned at M12, M24 and M30.

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Section 1 - Exploitable knowledge and its Use

Taking into account the fact that the consortium consists of major research players in the fields of optical networking and Grid technologies, it is obvious that the exploitation of the results obtained in this research project through each partner organisation is the most desirable way to benefit from the work done. Each Party will enforce necessary measures to exploit project results at its level. In addition to the partners' level the TB is looking for the possible co-operation with external bodies for results which are not handled by the Parties on their own.

An initial list of exploitable knowledge is presented in the table below:

Exploitation overview table

Exploitable Knowledge (description)	**Exploitable product(s) or measure(s)**	**Sector(s)** of application	Timetable for commercial use	Patents or other IPR protection	**Owner** & Other Partner(s) involved
1. Grid and GMPLS architectures	Consulting, training courses and seminars for network operators, manufacturers and service providers	1. ICT 2. Telecommunications	2007-2010	None planned	NXW
2. Simulation environment	Simulation environment	1.Network operators 2. Network consultants	2008	None	IBBT (owner) Extra functionality supplied by CTI, UniBonn and AIT
3. Resource management and job routing algorithms	Advanced control plane	Network operators	2008	None	IBBT, CTI, AIT and UniBonn (owners)
4. Scheduling and Resource management in Grid and SOA environments	MetaScheduling Service MSS supporting resource allocation for annotated applications	Grid and SOA Applications	Open Source	None so far	FHG
5. Resource management in Grid middleware	UNICORE supporting resource co-allocation via MSS	Grid middleware	Open Source	None so far	FZJ

Exploitable Knowledge (description)	**Exploitable product(s) or measure(s)**	**Sector(s)** of application	Timetable for commercial use	Patents or other IPR protection	**Owner** & Other Partner(s) involved
6. Authorization and Accounting Architecture for Optical networks	Addition to GMPLS or NPRS based optical networks	1. Optical network service providers	2009-2010	Public domain	Phosporus partners
7.. GMPLS Gateway Router	Addition to an IETF FORCES architecture based router	1. Campus networks conneting to a GMPLS network	2009	Public domain	UvA, Hitatchi, University of Padras

1. Grid and GMPLS architectures

Result Description

The result of the PHOSPHORUS project which NXW plans to exploit is the Grid-GMPLS Control Plane. This Control Plane result is instantiated in various forms: (a) architectural specification and study, (b) software design, (c) open source implementation, and (d) experimental activity.
Each of these forms will present a substantial degree of innovation, all inherited from the Grid-GMPLS concept: first implementation of the Grid Network Services by a network control plane.
In addition to that, each of these forms will be suitable for exploitation by NXW, as explained in the following text.

Partner(s) involved in the exploitation, role and activities

NXW is the leading partner in the architectural specification, design and development of the Grid-GMPLS (G^2MPLS) network control plane (technical leader of WP2)
In particular, NXW will carry out the following activities concerning the Grid-GMPLS in the PHOSPHORUS project:

- Coordinate the definition of the Grid-GMPLS architecture and its design, development and system integration (WP2).
- Support partners hosting a PHOSPHORUS test-bed in the test-bed integration activities concerning Grid-GMPLS controllers, and the related experimental activities (WP6).
- Contribute to standardization and dissemination activities, by extracting and elaborating relevant material standardization and dissemination from the WP2 outcomes (WP7).

How the result might be exploited

The various forms of instantiation of the Grid-GMPLS Control Plane will lead to different exploitation channels.
Overall, the whole WP2 activity will allow NXW to consolidate its know-how and past industrial developments activities in the technical topic of GMPLS and related Control Plane concepts. In particular, NXW is seeking to keep its GMPLS knowledge updated concerning the following facets:

- keeping the pace of the most recent GMPLS standardization activities (mainly CCAMP and OIF), and
- application of GMPLS to full optical transport networks, and

- application of GMPLS to specialized and challenging end-users, such as Grids.

This will strengthen its position of niche consulting company in those fields and adjacent ones (e.g. MPLS, T-MPLS).
More precisely, NXW is aiming to reinforce and feed the following types of commercial activities:

1. Consulting in the field of GMPLS for equipment manufacturers (mainly) and network operators, in the following phases:
    - Architectural evaluation of GMPLS protocol suites
    - Design of system integration of a third-party controller into the customer's equipment (including the design of "glue" components – e.g. modules for control plane management of transport plane resources).
    - System proving: definition of test cases for control plane protocol debugging or check of standard compliance, and support in their execution.
2. Software development of a complete GMPLS protocol stack (or parts of it) for customers (mainly equipment manufacturers), supporting the following phases:
    - Architectural specification of the protocol suite and choice of the (real-time) OS where the stack is going to run
    - Design and development of any OS-specific glue module in support of the protocol stack
    - Functional decomposition, design and development of every module in the architecture (protocols, auxiliary components, etc.)
    - Execution of first-run tests, and support in the system proving activities
3. Teaching about GMPLS
    - The target audience is made of: equipment manufacturers, network operators, service providers
    - The content of the courses is tuned according to the audience and its level of involvement: initial evaluation of the technology, early stages in the development/deployment of the technology, middle or late stages in the development (i.e. teaching about GMPLS proving). Thus, the course might range from an early tutorial about GMPLS to a practical discussion on specific areas of the technology:
        - Beginners's tutorial on GMPLS
        - Advanced tutorial on GMPLS
        - Course on specific parts of the GMPLS protocol suite (e.g. organized according to the targeted network reference points – UNI, E-NNI or just I-NNI – or according to protocols): critical review of the applicable standards, design and implementation issues.

Each type of activity on the Grid-GMPLS will play a positive influence on the different commercial activities.
The architectural specification and studies, carried out in the early stages of WP2, will provide a good starting platform and material to improve NXW's offer in terms of beginners/advanced tutorial courses on GMPLS (and novel extensions) to equipment manufacturers and network operators.
The software design activities can provide a substantial improvement in the preparation and execution of advanced and specific courses to equipment manufacturers, in the execution of consulting activities and in the customized software development.
Finally, the WP2 software developments would greatly contribute to the activities of third-party developments for equipment vendors.

In addition to the legacy activities presented above, NXW could have a great opportunity to launch a range of consulting services related to the Grid-GMPLS OSS project, which will be a by-product of WP2. The produced Grid-GMPLS protocol stack could not be used 'as is' in a GMPLS controller, but it (or parts of it) could be used as a starting point for a commercial protocol stack development with the proper assistance of one of the technology providers in the project. This kind of activity could integrate some of the commercial initiatives listed in 1 or 2 above.

Further additional research and development work
None planned as yet.

Intellectual Property Rights protection measures
None planned as yet.

Any commercial contacts already taken, demonstrations given to potential licensees and/or investors and any comments received (market requirements, potential etc.).
Expected as an outcome of the PHOSPHORUS public demonstrations.

Socio-economic impact
The Grid-GMPLS architecture will have a strong impact on the way research users access and use the transport networks, and will improve and optimize the network usage by advanced applications. The expected range of availability of operational services based on this paradigm is 3-5 years, and will influence the "classical" environments of remote and collaborative research, but especially the "newer" demanding services such as Grid applications, Collaborative Caves, Shared Virtual Reality spaces and TV broadcasting, news distribution.

2. Simulation Environment

The exploitable *result* is a set of software tools which allow optimization of multi-domain, optical Grid networks in terms of routing/scheduling algorithms, network technologies, topologies and characteristics by network dimensioning/planning and performance analysis.
The *partners* involved are IBBT (lead developer), CTI (QoS resource scheduling), AIT (responsible for constrained based routing) and UniBonn (responsible for advance reservations).

3. Resource management and job routing algorithms

The exploitable result is a set of algorithms which perform advanced resource management and job routing functions. These include:

- Grid job routing algorithms: support for network, resource and service related constraints, multiple domains and multiple costs
- QoS-aware resource scheduling: anycast routing, scheduling, joint network and resource assignment
- Support for advance reservations in scheduling: malleable reservations, centralized vs distributed control

The partners involved are IBBT (lead developer), CTI (QoS resource scheduling), AIT (responsible for constraint based routing) and UniBonn (responsible for advance reservations).
These algorithms can be implemented and deployed in novel control/service plane solutions.

4. Scheduling and Resource management in Grid and SOA environments

The MetaScheduling Service (MSS) will offer possibility to automatically do resource allocation and scheduling for applications or services that are annotated with their resource requirements.
The MSS is currently an open source development, thus no commercial exploitation is planned.
Research is increasingly done trough a specialised, domain specific interoperating services instead of stand-alone applications. The MSS is a leading development to be used for orchestration of services in Grid based research and in follow-up research projects.

5. Resource management in Grid middleware

The new Web-Service based version of the UNICORE Grid middleware will be enhanced to provide coordinated reservation and allocation of network and compute resources by integration of the MSS.
UNICORE is an open source development, thus no commercial exploitation is planned.
UNICORE is a major European Grid middleware that is used in various e-Science projects and production environments worldwide. Adding co-allocation capabilities to the already available workflow support will enable new areas of application in Grid based research and in follow-up projects.

6. Authorization and Accounting Architecture of Optical networks

Planned exploitable results.

The result should allow individual optical network providers to recognize that a particular IP datastream has been authorized by an organization that has negotiated the usage of such link prior to requesting its usage. The architecture does not define how such authorization is granted. Various (web services based) methods can be used here. The architecture describes how such authorization can be enforced by means of recognizing a secure token that has been signed by the authorizing party. The tokens are included inside the stream of control packets (RSVP-TE messages) that are send along the optical path via a separate control plane as defined in the IETF GMPLS architecture. The secure token will be included in an attribute field that has been defined for including Policy Data objects. The authenticity and integrity of a token is verified using a cryptographic method using a shared key. Such a key must be issued per IP flow and distributed to the generation process of a token and the verification process of the token. The token may include additional attributes, which are also signed by the key, such as a reference number which points at the agreed handling of the flow. The architecture will define how the keys, attributes and resulting tokens should be defined, created, handled and verified at places at the ingress and egress of a network. By allowing the GMPLS signalling messages, containing tokens, to cross domain boundaries, each individual domain can verify the validity of the token, and pass on the signalling if they do. Depending on the fact if each domain wants to use the same or a different key, the token needs to be regenerated at each domain's egress switch. If a domain does not natively support GMPLS (e.g. domains using a NRPS or OSS), a GMPLS agent inside such domain may be used to detect the usage of a particular path. This usage may be flagged to the NRPS, which may setup or tear down a path accordingly. Tokens may be "counted" to support an accounting process.

Involved Partner(s) involved in the exploitation.

Partners, such as SURFnet, and interested parties (Internet2) who provide optical network resources and are looking at way to interoperate with other domains.

Spin-off

This result may spin off into commercial use by interested commercial Phosphorus partners.

Additional research
Additional research is needed in the process that authorizes and issues / provisions / distributes the keys and possible attributes in for optical network resources. Requesting parties could ask for "bulk time" which they then subsequently subdivide for a set of applications. The negotiation process between individual domains needs to be further defined.

2. GMPLS gateway router

Planned exploitation
Phosphorus plans to add components to a modular router, which can be used as a gateway between a regular connectionless IP (Campus) network and a connection-oriented GMPLS network of an Optical Network Service provider. This item will re-use an existing FORCES based router provided by HEL, to which the project will add modules that can recognize tokens inside IP packets and use these tokens subsequently to include them into the RSVP signalling message that opens an authorized optical path in the way described in the previous subject. The token may be generated by an application, residing in the campus network and included into IP packets by using the IP options field. The solution can be used to connect authorized applications, running on general campus network resources to a pre-authorized GMPLS connection, assuming that the performance of the campus network is high enough to not pose any bottleneck. The applications can negotiate with the GMPLS network to obtain the proper key material. The GMPLS network provider will provision the GMPLS gateway router to both recognize the tokens inside the IP packets from the campus side and subsequently setup and maintain the GMPLS connection a the other side.

Involved Partners
UvA, Hitatchi and University of Patras will further develop this idea. The idea will be demonstrated and tested and exploitation may thereafter be possible by network equipment vendors supporting the FORCES architecture.

Additional Research.
Needs to be done in area's such as performance. Initial trials using the IP token based approach showed these types of operations can be performed at multi-gigabit speeds using an Intel IXP2850 network processor.

Section 2 – Dissemination of knowledge

The dissemination activities listed in the table below include past and future foreseen activities. This table will be maintained and continously updated by University of Essex which is charged with controlling the dissemination activities**.**

Dissemination overview table

Planned/ actual Dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible /involved
Oct.'06	Project web-site	General	Any	Very large	PSNC
Nov.'06	Project poster	Research and Industry	Any	Large	PSNC and UESSEX
Feb.'07	Project Flyer	Research and Industry	Any	Large	PSNC
Dec.'07	Project Presentation	Research and Industry	Any	Large	PSNC and UESSEX
Dec'07	Establishing an open discussion forum in the website	Research and industry	Any	Potentially large	PSNC
EVENTS					
Oct'06	AGNM 2006	Research and industry	Any	20-30	NXW
Nov.'06	SC'06 Supercomputing 2006	Research and industry	Any	100s	UESSEX and SARA
Feb.'07	TERENA EFNIW workshop	Research networking community	EU	<100	I2CAT
March'07	OFC'07	Research and industry	Any	100s	UESSEX
June'07	IEEE ICC'07	Research and industry	Any	100s	UESSEX
Sept.'07	ECOC 2007 workshop	Research and industry	Any	50-100	UESSEX
Nov.'07	APOC 2007	Research and industry	Any	100s	I2CAT

Project website: http://www.ist-phosphorus.org/

Project Poster: The PHOSPHORUS poster has been prepared and first presnted at the 3rd Concentation meeting on e-Infrastructure, 20th of November 2006, Helsinki, Finland. The poster, prepared by PSNC, describes the Phosphorus' objectives, architecture, testbeds with applications and all the partners' logos. The poster can be seen at: http://www.ist-phosphorus.org/files/photos/ist-helsinki.jpg 3rd

Project Presentation: This is a general project presentation outlining the project's structure goal and technical objectives. The presentation will evolve with the project. The current status of the presentation can be seen at: http://www.ist-phosphorus.org/files/press/Phosphorus-general_presentation.pdf

Website forum: This forum provides a facility for comments and discussion with the relevant research and technical community outside PHOSPHORUS (http://www.ist-phosphorus.org/forum/)

EVENTS

2nd IEEE/IFIP International Workshop on Autonomic Grid Networking and Management (AGNM 2006), http://www.manweek2006.org/agnm/agnm.php

NXW presented the Phosphorus project in Dublin on Oct. 26th and 27th, 2006, in the Panel session 1 "Making Sense of Grid on IP Control Plane."
(http://www.manweek2006.org/agnm/program.php#AGNMP1)

Supercomputing 2006, SC'06 in Tampa, Florida (Nov 11-17, 2006):

1. SARA demonstrated TOPS (the application that is used in the Phosphorus testbed under WP3) at SC'06. Joint sessions were organized from the Dutch Research Consortium booth and with international partners at the exhibition floor, using lambda networks. Phosphorus goals were explained to visitors of the Dutch booth, using the new Phosphorus poster.
2. UESSEX organised and chaired a BOF session in SC'06:
   GHPN/GLIF: Delivery of Network Services across Heterogeneous Optical Domains, 14 Nov, Tampa, US http://sc06.supercomputing.org/schedule/event_detail.php?evid=5184

   The BOF discussed solutions provided by three research projects: PHOSPHORUS (EU), ENLIGHTENED (US), G-Lambda (JPN). All 3 projects are concerned with interoperability issues between heterogeneous network domains. The BOF targeted wider community awareness and participation in the main common technical challenges concerning these projects.

TERENA's European Future Networking Initiatives Workshop: (22 February 2007, Amsterdam). The objective of the workshop is to exchange information and raise awareness about the many discussions and initiatives world-wide to develop a new, 'clean slate' architecture for the Internet, and to discuss how the European research networking community will want to participate in these developments (http://www.terena.org/activities/efniw/).

OFC'07： http://www.ofcnfoec.org/
PHOSPORUS will be presented in the "The 2nd International OFC/NFOEC Workshop on the Future of Optical Networking (FON)", http://www.cse.buffalo.edu/~qiao/workshop/FON2/

IEEE ICC 2007, 24-28 June, Glasgow, UK
Workshop on "Findings and Experiences from European Research Projects on Optical Networking"
In this workshop PHOSPHORUS will be presented among other high profile EU projects in the field of optical networks.

The workshop description and programme can be found at http://www.icc007.org/ under workshops.

ECOC 2007 Workshop: 16 September 2007, Berlin, Germany
A workshop is planned, jointly sponsored by PHOSPHORUS and the IST Network of Excellence ePhoton/ONE+ (http://www.vde.com/Conferences_en/ECOC+2007/Workshops/)

Workshop title: Networks for IT: A new opportunity for optical network technologies

Chair: Dimitra Simeonidou, University of Essex; dsimeo@essex.ac.uk
Co-chairs: Mario Pickavet, Ghent University – IBBT mario.pickavet@intec.ugent.be
Anna Tzanakiki, Athens Information Technology atza@ait.edu.gr

Abstract: Networks increasingly deal with managing and adapting distributed computing and associated data management resources (PCs, servers, supercomputers, clusters) and storage systems. Due to potentially very high aggregated demands for networked IT, a paradigm shift in the optical network architecture may be needed to enable dynamic and distributed IT services at large scale. This workshop offers a unique opportunity for optical network researchers and practitioners to exchange ideas and experiences on problems, challenges, solutions and future research and development issues concerning the deployment of optical networks for providing IT services. In addition to invited paper presentations, the workshop provides an intimate setting for discussion and debate.

APOC 2007:
I2CAT expects to participate in the Asia-Pacific Optical Communications (1-5 November 2007, Wuhan Optics Valley of China), where the WP1 leader Sergi Figuerola has been proposed as invited speaker to give a presentation (pending of confirmation) about Phosphorus on the scope of 'Network Architecture, Management and Applications'. APOC is SPIE's primary conference on optical communications in Asia, and the world's third largest conference in the field of Optical communications (http://wnlo.hust.edu.cn/APOC-2007.htm).

Section 3 - Publishable results

No publishable exploitable result have been generated by the PHOSPHORUS consortium at present..