Network Interoperability - the Role of Optical Technologies

e-Photon/ONe+/IST Phosphorous meeting

Held in Internationales Congress Centrum, Berlin on 16 September 2007

Objective

The purpose of the meeting was to gather information and views for the e-Photon/ONe+/IST Phosphorous Road Map report: "Network Interoperability - the Role of Optical Technologies". Twelve experts from Europe, USA and Asia attended the meeting and each was invited to give their view according to the brief below. Each expert contributed a written view and a selection of these was discussed during the meeting. Their views, which are personal and not necessarily that of their organisations, are recorded in this report.

Brief

Delivery of services over today's telecom networks is complicated by the many network types needed to provide an end to end service. In this environment networks are evolving towards a new architecture that provides a more flexible relationship among the various entities and which separates services operations from transport networks operations. The architecture relies on an intervening convergent packet layer to ensure that any service can be carried over any suitable infrastructure. However, as the evolution progresses services will become more diverse in their demands on the network, and better controls will be needed.

This Road Map recognises that optical fibre technology will be a critical part of the new infrastructure and it will highlight how the technology will impact on future networks interoperability.

The Road Map will be approached from two directions:

1. Projections following the trends and evolution that are associated with the industry developments

2. More radical approaches that are perceived as breaking the conventional network design rules

As guidance, we seek views on how optical network technology, in a broad sense, impacts on each part of the end to end service delivery and on the interoperability of public and service provider networks of all kinds: access to metro/collector network, metro/collector network to core network, access to core, core to service provider network and content provider networks.

We would like you to contribute your views in the format given.

1. The concept, including what new optical technology features are needed to improve interoperability and end to end network service delivery
2. The nature of the research in the particular area
3. The critical factors and dependencies
4. The possible impacts that would accrue from successful research

We ask that you complete a pro-forma describing at least two network interoperability situations according to the template overleaf.

Contributions from Participants

The summaries of the experts are recorded on the following pages.

Name   S J Ben Yoo   Organisation   UCDavis

Optical label switching

1. *State the concept, including what new optical technology features are needed to improve interoperability*

Network interfaces using optical labels

2. *Comment on the nature of the research in the particular area*

Systems, components, test bed studies. OLS router development. OLS router, components, networking testbed, tunable lasers and filters

3. *What are the critical factors and dependencies?*

GMPLS extension standardisation is critical

4. *Describe the possible impacts that would accrue from successful research*

High performance, intelligent, agile networking

Intelligent programmable network elements

5. *State the concept*

Universal router interfacing any network to any network (wireless, optical, wireline etc.). "Impedance matching" of different networks with different characteristics.

6. *Say what new optical technology features are needed to improve interoperability*

Intelligent, adaptive and programmable linecards

7. *Comment on the nature of the research in the particular area*

Edge routers (without significant adaptability) have been developed but no universal and adaptive routers developed. For wireless – wireline – optical this development is critical.

8. *What are the critical factors and dependencies?*

Machine learning and embedded systems are necessary.

9. *Describe the possible impacts that would accrue from successful research*

High performance (high throughput, low latency/jitter etc.) end to end through impedance matching.

Name   Anna Tzanakakis   Organisation   AIT, Greece

Topic 1:

State the concept, including what new optical technology features are needed to improve interoperability

Mostly control and management plane features need to be proposed and developed to ensure interoperability and communications across different domains.

Comment on the nature of the research in the particular area

The related research needs to take into consideration the specific features & characteristics of the underlying data plane technology & how it can be directly exploited to satisfy requirements in the most efficient way.

What are the critical factors and dependencies?

Virtualisation of network resources will be critical

Describe the possible impacts that would accrue from successful research

Management & allocation of network resources

New network node architectures & technologies. Multi granularity switching nodes to support various granularities.

Name   Franco Calleghi   Organisation   ?

Topic 1:

State the concept, including what new optical technology features are needed to improve interoperability

Optical user interfaces for terminals

Comment on the nature of the research in the particular area

Interaction between terminal hardware architectures and optical interface. New architectures for terminals and applications.

What are the critical factors and dependencies?

Currently terminals cannot carry data close to the capacity of the bit pipe.

Describe the possible impacts that would accrue from successful research

More interest to have access to optical networks directly at the desk

Topic 2:

State the concept, including what new optical technology features are needed to improve interoperability

Define descriptors for optical networks to be used by service 'constructors'.

No specific technology, but methods to describe the technology in a standard way.

Comment on the nature of the research in the particular area

Match the service requirements with optical network characteristics.

What are the critical factors and dependencies?

Consensus.

Describe the possible impacts that would accrue from successful research

Great impact on easy service provisioning.

Name   Artur Binocewski   Organisation   PSNC

Topic 1:

State the concept, including what new optical technology features are needed to improve interoperability

Control plane supporting Ethernet

Comment on the nature of the research in the particular area

Concentrate on the interface and interoperability

What are the critical factors and dependencies?

Standards bodies

Describe the possible impacts that would accrue from successful research

Allows to create global optical network

Topic 2:

State the concept, including what new optical technology features are needed to improve interoperability

Introducing tera scale of optical network.

Signal format, interfaces, ROADM, tunable lasers and filters

Comment on the nature of the research in the particular area

New coding systems

What are the critical factors and dependencies?

Availability of optical hardware technologies & co-operation with vendors.

Describe the possible impacts that would accrue from successful research

New generation of optical systems

Name   Ioannis Tomkos   Organisation   AIT, Greece

Optical technologies supporting users/networks in motion

State the concept, including what new optical technology features are needed to improve interoperability

Novel optical technologies to ensure proper integration among fixed and mobile networks with the goal to offer broadband services to mobile users. The new optical technologies should support such applications by ensuring easy adaptation with wireless networks.

Comment on the nature of the research in the particular area

Should be multidisciplinary covering issues related to physical layer (e.g. radio over fibre) but also with new MAC layer that considers the unique features of the hybrid fixed/wireless network.

What are the critical factors and dependencies?

Wireless access networks are also evolving rapidly and can potentially offer very good capabilities. The involvement in relevant standards activities and multi-vendor support is required.

Describe the possible impacts that would accrue from successful research

This research topic should allow the delivery/availability of services that are not currently supported by any technology to end users (e.g. Gb/s capacity to users in offices/hotels) & fast moving users in trains etc.

Network/IT Resources availability

State the concept, including what new optical technology features are needed to improve interoperability

IT resources should be shared through the intelligent use of the underlying infrastructure in the same way that network resources become available through the use of new control planes. Resource reservation for IT services may be based on new optical transport solutions like OBS or OFS.

Comment on the nature of the research in the particular area

Research should focus on the network protocols and cross-layer optimisation issues with the supported services.

What are the critical factors and dependencies?

Support of the research developments from both NREN and telecom service provider on a global scale.

Describe the possible impacts that would accrue from successful research

Availability of new services, service virtualisation and sharing of expensive resources from multiple users, greatly reducing the costs.

Name Dominique Verchere Organisation Alcatel-Lucent, France

Topic 1:

State the concept, including what new optical technology features are needed to improve interoperability

Features to enable different network switching capability to interoperate. With high transmission capacity network, optical network can enable open dedicated networks in order to provide services.

Comment on the nature of the research in the particular area

To provide interface at the physical layer but also at the control to enable networks to exchange traffic.

What are the critical factors and dependencies?

Standardisation of the solutions. Agreement between manufacturers to deliver unified interface to enable interoperability.

Describe the possible impacts that would accrue from successful research

To trigger the interest of interoperability, the solution should be single and provide advantage to network operators such as to enhance their existing network infrastructure by providing new services. Leads to return on investment.

Topic 2:

State the concept, including what new optical technology features are needed to improve interoperability

Interoperability between multiple network operator domains. To define reference points that enable controlled exchanges of configuration information. Flexibility of configuring wavelengths in the network (e.g. WSS, AWG etc.)

Comment on the nature of the research in the particular area

To understand if services can trigger network configuration over the network.

What are the critical factors and dependencies?

Interactions between S… Distributed Applications requiring specific network services (QoS, performance and security)

Describe the possible impacts that would accrue from successful research

Security of distributed service to be used by enterprises.

Name   Weisheng Hu   Organisation   Shanghai Jiao Tong University, China

Topic 1:

State the concept, including what new optical technology features are needed to improve interoperability

Define standard interfaces of both control and transport planes such as GMPLS, OTN and Ethernet. Also to develop unified building blocks.

Comment on the nature of the research in the particular area

Packet transport network (e.g. T-MPLS), OTN (G.709) to contain 2.5 Gb/s to 100 Gb/s payloads

What are the critical factors and dependencies?

Bandwidth demand is the determining factor. HD or SHD video will be one of the forces.

Describe the possible impacts that would accrue from successful research

Data intensive (image file, such as PPT)

Bandwidth consuming (HD/SHD TV)

Topic 2:

State the concept, including what new optical technology features are needed to improve interoperability

PTN oriented technology. Integration and massive produced devices … or fundamental one

Comment on the nature of the research in the particular area

Integration

What are the critical factors and dependencies?

Integration & yields of cost effective building blocks.

Describe the possible impacts that would accrue from successful research

Not clear.

Name   Wei Guo   Organisation   Shanghai Jiao Tong University, China

Topic 1:

State the concept, including what new optical technology features are needed to improve interoperability

Resource notification, task scheduling, integrated management.

Comment on the nature of the research in the particular area

Joint resources allocation for workflow applications.

What are the critical factors and dependencies?

Resource management in integrated model and optimal scheduling algorithms.

Describe the possible impacts that would accrue from successful research

Resources are used by application drivers

Topic 2:

State the concept, including what new optical technology features are needed to improve interoperability

For some applications the source and destination nodes for optical core networks don't know initially. How to set up a connection according to the requirements and use the network resource efficiently is a problem. We need an interface to get the network resources and allocate network and IT resources jointly.

Comment on the nature of the research in the particular area

In workflow based applications the tasks are dependent on each other. The users don't know where the resources are and we need middleware to allocate resources and direct the application to run in … resources.

What are the critical factors and dependencies?

How to get the network resources and schedule the application.

Describe the possible impacts that would accrue from successful research

Define new interface and develop a new management plane.

Name   Chunming Qiao   Organisation Stanford University, USA

Topic 1:

State the concept, including what new optical technology features are needed to improve interoperability

Different applications require different services, and thus it is important for the underlying optical networks to be able to support both optical circuit switching and optical packet/burst switching.

Comment on the nature of the research in the particular area

Research is needed to come up with a truly universal and yet integrated control & signalling framework for both OCS and OBS/OPS

What are the critical factors and dependencies?

Since fast (nsec/microsec)switching is needed for OBS/OPS thus the ability of advantage of the integrated framework depends on the availability /low cost implementation of the fast switching technology. (Otherwise have two separate networks).

Describe the possible impacts that would accrue from successful research

The optical networks will become truly ubiquitous and capable of supporting various applications effectively.

Topic 2:

State the concept, including what new optical technology features are needed to improve interoperability

A related concept is to support applications directly over optical networks, bypassing unnecessary and often inefficient overlays as well as TCP/IP layers. The optical networks have to be very agile and controllable by standard interfaces. In particular they have be able to reconfigure and support any granularity (large or small).

Comment on the nature of the research in the particular area

Address the scalability of the approaches as many applications may be running at the same time.

What are the critical factors and dependencies?

In addition to hardware technologies such as switches, design & development of efficient middleware for resource management is also crucial.

Describe the possible impacts that would accrue from successful research

The inefficiencies associated with the current TCP/IP layers in supporting high end applications go away with this paradigm.

Name   Peter Van Daele   Organisation   IBBT, Belgium

Topic 1:

State the concept, including what new optical technology features are needed to improve interoperability

Starting point is applications run on all networks, independent of the technology and invisible to user. Optics provides the core network and access to wireless access points. Optics are used for high speed and high capacity.

Comment on the nature of the research in the particular area

Improve speed at all points: switching and transmission. Also inside racks (short distance optical connections).

What are the critical factors and dependencies?

Critical factors on physical layer are the cost of higher speed and shorter distances where optics is introduced.

Describe the possible impacts that would accrue from successful research

Further introduction of optics deeper into the systems and racks, for higher capacities and lower power.

Topic 2:

State the concept, including what new optical technology features are needed to improve interoperability

Optical switching only makes sense if this is combined with in-systems optical interconnections. Short distance optical interconnections at low cost.

Comment on the nature of the research in the particular area

What are the critical factors and dependencies?

Describe the possible impacts that would accrue from successful research

Name   Piero Castoldi   Organisation Scuole Superiore Sant'Anna

Topic 1: Transparent Network Domain Extensions

State the concept, including what new optical technology features are needed to improve interoperability

Strength of optical technologies is in line speed and span length. Transparent domain may span access, metro, core segments in terms of optical bypassing.

Comment on the nature of the research in the particular area

Mainly the interfaces among PON - metro ring - mesh core segments are equipped with o-e-o and no optical bypassing is deployed.

What are the critical factors and dependencies?

Setting up lightpaths across different segments. Respect physical impairment limitations. Allow end to end transparency as far as possible.

Describe the possible impacts that would accrue from successful research

Reduction of network cost (CAPEX). Improved transparency to formats (scalability). Less need for network planning.

Topic 2: Invocation of optical services in view of OBS/OPS

State the concept, including what new optical technology features are needed to improve interoperability

Bandwidth management at the optical level can flexibly bring large benefits for privileged users and third party operators.   (LX VPN). Flexible, adaptive access to optical transport objects based on optical transmission.

Comment on the nature of the research in the particular area

Service oriented architectures for optical nodes are receiving great attention. Lack of standardised approach to the problem.

What are the critical factors and dependencies?

Service interface to be standardised. Virtualisation approaches. Overlay model.

Describe the possible impacts that would accrue from successful research

Time to market of optical services is accelerated. Larger deployment of optical networks. Future proof technology for bandwidth demand increase.

Discussion Topics

High bandwidth services to mobile users
- Redesign fibre-wireless interface to offer high bandwidth service to mobile users at both physical + MAC layers.
- Standards needed. 3 to 4 years for a prototype solution.

Interface between any networks
- Develop new protocols for impedance matching, so that any network can be interfaced to any network.

Flexible and agile optical networks
- What are the limits of optical transparency.
- Limit is ultimately set by practical considerations and costs.

Services at Layers 1 and 2
- User interfaces need a lot of tuning and experimentation

100GbE transmission
- Technology was not considered to be an issue, only its cost.

Programmability of the end to end network for high speed services
- GMPLS to the user for business 'on demand' services
- How to deliver over multi domains