Service Oriented Sub-wavelength Optical Networks

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Need for the sub-lambda optical networks (SLON)

- Evolving broad range of emerging applications:
  - Need infrastructures that make IT resources (e.g. CPU, storage, information content) potentially available to a large number of users.
  - Need dynamic network services for users/applications with widely varied traffic and BW demands.

- SLON is able to provide:
  - Bandwidth granularity from packet level to circuit (wavelength) level
  - Separation of control and data plane
    - Electronic processing of the burst-control packet at each node
    - All-optical data transmission
  - High speed and “short lived” sessions

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SIP (Session Initiation Protocol) is an IETF standard application layer protocol

- Service provisioning to large variety of users & large number of users
- Flexible, Scalable (e.g. Support of mobile Grids)
- Easy to extend for non native operations
- Establish sessions described by applications (Grid/Cloud jobs by JSDL, Resources by RDF)

SOON (Service Oriented Optical Network) is a functional middleware that supports

- Application-to-network interaction
- Service-aware dynamic network optimization.
- Service abstraction and resource virtualization based on Service Mapping Logic and Edge Node Coordination
Programmable or Application Aware SLON (Sub-Lambda Optical Network)
- Directly offer resources (network and data) as service
  - To migrate service layer functionality close to the optical layer
- Network elements are able to recognise and process application demands/request
  - To facilitate intelligent discovery, reservation and co-allocation of distributed resources
  - To cope with random changes user patterns, demands for resources (storage/processing) as well as availability of resources

Service oriented SLON integration delivers
- Dynamic interaction between session and connection
  - Session-aware connection establishment and QoS provisioning.
- Single step for session and connection establishment
  - Fast provisioning and recovery.

Implementation consists of:
- A framework able to map Application requests to sub-lambda network parameters
- A specific control interface to communicate dynamically with sub-lambda edge node
- A signalling to coordinate the different edge nodes
Sub-Wavelength Network Test-bed

- Test-bed consists of two Multi-Granular edge nodes and 3 core nodes.
- Tested is able to map application requests to sub-wavelength network parameters
  - Burst size
  - Latency
  - Wavelength
  - Path
  - Resource reservation method
- A specific sub-wavelength control interface to communicate dynamically among different layers
  - Service Plane
  - Control Plane
  - Data Plane
Publications

- **4 Journals**

- **8 Conference papers and Postdeadline paper**

- **4 Invited conference papers**

- **List and details on:**

  - [http://privatewww.essex.ac.uk/~gzerva/publications.htm](http://privatewww.essex.ac.uk/~gzerva/publications.htm)
MAINS
(Metro Architectures enablINg Subwavelegths)

http://www.ist-mains.eu/
MAINS consortium

- MAINS is a project FP7 project with a consortium of 2 operators, 2 equipment vendors and 2 Universities

- Each critical area is covered by at least two partners:
  - Specifications, business analysis and field trial: Telefonica I+D (co-ordinator) and Primetel
  - Software design and development: Nextworks and UAM
  - Design and development of metro architectures exploiting optical packet/flow switching: Intune and UESSEX

- Length: 30 months (started January 2010)
- Budget: ~ 2 M€
An innovative and cost-effective metro network architecture based on optical packet/flow switching technologies

What is MAINS proposing?

Short Term 2009-2011

Medium Term: 2015-2020

Shared infrastructure: Network centric + other services

Agile network: dynamic configuration (restoration)

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Why do we need new metro architectures?

- The network costs of current metro architectures strongly depend on traffic growth; the higher the traffic the higher the network costs.

- New architectural solutions able to face with the expected traffic increase in a more cost-effective way will be needed in order to assure a low cost broadband Internet access in Europe.

MAINSMains architectural solution aims to minimize the total metro network costs (CAPEX and OPEX) by means of two complementary networking solutions:

- New control plane functionalities allowing network and IT resources interworking
- All optical metro domain solutions supporting enhanced network dynamics and sub-wavelength granularity.
MAINS architectural concept is based on two pillars:
- Sub-wavelength optical switching technologies in the Data Plane (i.e. optical bursts and packets)
- An enhanced GMPLS architecture in the Control Plane to extend network control to the sub-lambdas, and ease the interworking of network and IT resources
MAINS proposes new metro network architectures based on the introduction of subwavelength granular all-optical switching technologies so that IP routers are exclusively used in those nodes where IP header processing is mandatory.

- **Minimizing CAPEX**: by optimizing the number of expensive high capacity optoelectronic IP ports. A single optical tuneable transmitter per node can connect with the other local access routers in the same metro area.

- **Minimizing OPEX**: space and power consumption could be significantly reduced by using optical switching instead of electronic switching matrices. Furthermore, operational costs could be considerably reduced by minimizing the number of electronic switching nodes.

- **Fulfilling the granularity requirements** of metro regional networks
MAINs fulfills the granularity requirements of metro regional networks.

Expected traffic evolution of internal metro flows in Madrid metropolitan area (source: Telefonica I+D)
Currently IP access routers are interconnected by means of L2 or L3 electronic switches.

Traffic between access IP routers is electronically switched by intermediate switches.

Network costs vs Traffic:
- IP transit
- L2 transit
MAINS proposes direct optical connections between access routers.

Traffic between access IP routers is optically switched.

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IT servers distribution improves network scalability and reduces latency

Centralized approach: Few servers located in core nodes

- High bandwidth consumption
- Single failure point
- Expensive server

Distributed cloud approach: Multiple servers located in metro and core nodes

- Low latency: minimum delay
- Just required bandwidth
- Low cost servers

Rationale behind network and IT resources interworking
MAINS architecture allows to access optical layer resources from the service layer, on-demand and with sub-wavelength granularity.

Distributed approach

COST OPTIMIZATION: Computing and storage resources are shared by using cloud computing.
Optical layer resources are accessed from the service layer, on-demand and with sub-wavelength granularity. Consequently, servers can be distributed in the metro network to provide a very cost-efficient solution in terms of bandwidth and server commodities.

- The bandwidth consumption is reduced due to the distribution of service flows around the network. Also service flows do not follow the same path to a central server which may cause bottleneck problems.

- ISPs can maximize the performance of distributed IT servers by dynamically managing their computing and storage resources. Therefore, the quantity and processing power of the distributed ISP's IT servers can be minimized.

- A distributed server approach is more reliable, can lead to a more energy-efficient service provisioning, and noticeably reduce latency due to the local proximity of content and application servers to consumers.
Control Plane extensions:

Two major contributions of MAINS are the development of the GMPLS extension for sub-wavelength granularity, together with the XML interface for flexible transport resource configurations.

Network-Service Interface:

The service to network interface which will be developed by MAINS provides direct access to sub-wavelength granularity services from the application layer.
**OPST Nodes:** Intune Networks will provide a pre-commercial beta version of OPST to the project

**OBST Nodes:** The extensions to OBST nodes are proposed to make the OBST mesh network GMPLS-enabled, interoperable with OPST rings by use of XML API and in turn introduce new sub-wavelength services.
✓ It will be used to evaluate and provide detailed analysis of the end-to-end network performance on different applications (e.g. PC virtualisation, high-end multimedia) and traffic scenarios.
The field trial features real users and it will serve to assess the project results in practice.

It also contributes to achieve a higher impact, as it will demonstrate the project results in a real world scenario.
The distributed server approach allows the introduction of innovative services such as the virtual PC, which consists of a virtual terminal which is executed on a remote host, and is accessed through the “remote desktop” capabilities of a standard Windows or MacOS terminal at home.
Questions?

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