Virtual Networks Session

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AGENDA

- Network Virtualisation
- Cloud Computing impact
- The GEYSERS EC FP7 project

What is Network Virtualisation ?

...but, Standards Body

Network virtualisation definition I

Standards Body IRTF/NVRG ITU-T

- ITU-T Focus Group on Future Networks
  - "Framework of network virtualization",
  - http://www.itu.int/oth/T3A05000017/en
- IETF/IRTF NVRG (Network Virtualisation Research Group)
  - First NVRG meeting at the IETF-77 in Anaheim, USA
  - http://www.ietf.org/id/draft-shin-virtualization-meta-arch-01.txt

Network virtualization is the technology that enables the creation of logically isolated network partitions over shared physical network infrastructures so that multiple heterogeneous virtual networks can simultaneously coexist over the shared infrastructures. Also, network virtualization allows the aggregation of multiple resources and makes the aggregated resources appear as a single resource……Also, network virtualization can reduce the total cost by increasing the utilization of resources

Network virtualisation definition II

GN3 JR1-T4

- Virtualisation is creation of a virtual version of a physical resource (e.g. network, router, switch, optical device or computing server), based on an abstract model of that which is often achieved by partitioning (slicing) and/or aggregation. A virtual infrastructure is a set of virtual resources interconnected together and managed by a single administrative entity.

FEDERICA

- Is the capability to create a virtual version of a physical resource, both in computing and network environments. The virtual resources (e.g. a virtual network circuit, a disk partition, a virtual computer) are typically created by segmenting a physical resource. Virtualization creates unconfigured (clean) virtual resources. Those resources can be then tailored and configured to users needs and by users and even moved from a virtualization-aware platform to another.

4WARD

- Is ideally suited to allow the coexistence of different network architectures. Virtualisation is thus not only an enabler for the coexistence of multiple, possibly revolutionary, architectures, but also provides a smooth path for the migration towards more evolutionary approaches. ……. Virtualisation further provides a general approach for network service providers to share a common physical infrastructure.

IEEE papers

- Is a promising approach to cover individual and dynamic resources provision while keeping strong individual QoS requirements and optimizing the overall resource usage
- Is a collection of virtual nodes connected together by a set of virtual links to form a virtual topology, which is a subset of the underlying technology. It is defined by decoupling the roles of the traditional Internet Service Providers unto two independent entities. Infrastructrue provider and service providers.

Network virtualisation definition III

Cisco

- Network Virtualization is the efficient utilization of network resources through logical segmentation of a single physical network. An example of multiple logical networks over a common infrastructure could be different organizational units or departments on a single companywide network. Alternatively, it could be an enterprise customer wanting to differentiate between an employee and vendor and to which resources each has access in the network

Juniper

- Virtualization is about partitioning a router in such a way that each partition have same capabilities and functionality as a physical router. Each router partition has separate control plane, separate administration plane, can run different software versions, supports Inter-partition forwarding without physical interfaces, and can share physical interfaces and also opens up a range of new business models and partnership opportunities, such as the ability to deliver "Open Garden" services, virtual network operator, network as a service (NaaS) and network sharing.

Wikipedia

- Network Virtualization is the process of combining hardware and software network resources and network functionality into a single, software-based administrative entity, a virtual network. Network virtualization involves platform virtualization, often combined with resource virtualization.

Network virtualisation definition IV

Googling we can find…

- **(TechTarget)** Network virtualization is a method of combining the available resources in a network by splitting up the available bandwidth into channels, each of which is independent from the others, and each of which can be assigned (or reassigned) to a particular server or device in real time. Each channel is independently secured. Every subscriber has shared access to all the resources on the network from a single computer.
- **(Internet.com)** Network virtualization is using network resources through a logical segmentation of a single physical network. Network virtualization is achieved by installing software and services to manage the sharing of storage, computing cycles and applications. Network virtualization treats all servers and services in the network as a single pool of resources that can be accessed without regard for its physical components.
- **(PC Magazine)** Network virtualization is the monitoring and managing an entire network from a single network administrator's console. Network virtualization begins with monitoring the network and often encompasses storage virtualization, which manages all of storage as a single resource. In its ultimate manifestation, network virtualization treats all servers and services in the network as a single pool of resources that can be rearranged and redeployed in real time to meet changing user and transaction requirements.

Why Network Virtualisation?

- It helps on de-ossifying the current network architectures.
- It allows multiple virtual networks to coexist over a shared physical infrastructure.
- It provides paths to the Future Internet approaches.
- Allows the deployment of new business roles and players.
- Reduced/shared cost of ownership.
- It optimizes the resource (network infrastructure) usage.
- It extends the concept of IaaS to the network sector.
- It enables the creation of marketplaces of virtual resources

" The **benefits of virtualization apply equally to carrier networks and enterprise data centers**, both of which are undergoing complex consolidation efforts. The most salient benefits include **simplification** of architecture, **consolidation** of devices, **reduction of operational complexity,** and **improvement** in scale driven by **efficient** and **dynamic partitioning** of resources. These advantages play a central role in reducing TCO in both networking and IT environments." Ref (2008. Yankee Group Research, Inc., P. Marshall, M. Bieberich)

Network Virtualisation – ARCHITECTURE

- **Architectural Principles**
  - Coexistance
  - Recursion
  - Inheritance
  - Revisitation
  - Federation
- **Design Goals**
  - Flexibility
  - Manegability
  - Scalability
  - Isolation/segmentation
  - Stability and Convergence
  - Programmability
  - Heterogeneity
  - Legacy Support

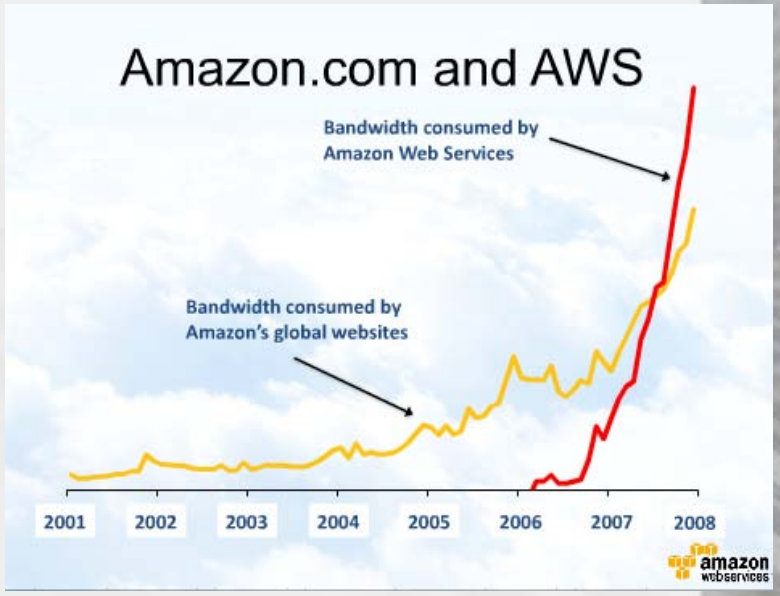
Ref. M. Kabir, R. Boutaba, University of Waterloo “Network Virtualization: State of the Art and Research Challenges.“ IEEE Com Mag. N.M.

Cloud Computing...

- Today, Cloud Computing is referred to as an IT service available to an end user out of a "cloud," whereby the cloud is an abstract thing that has no specific physical location. Generally speaking, the cloud is a conglomerate of interconnected, redundant data centers that were built to provide certain services ("Ref: A LOOK BEHIND THE CLOUD – AN INTRODUCTION TO GRID/CLOUD COMPUTINGA. ADVA White paper")

Concerns on Cloud Computing (CC):

- CC do not take the network infrastructure necessarily for flawless service interaction, sufficiently into consideration.
- Network is a key for CC to mission-critical IT processes.
- CC always includes the concept of sharing, and enterprises don't want to use shared infrastructures
- Describing networks and IT resources is essential for provisioning and management of virtual infrastructures (ongoing work in NDL, VxDL,…)
- The Open Grid Forum Open CC Interface (OCCI-WG) will deliver an API specification for remote management of CC infrastructure.
- New research group at OGF (ISOD-RG)



And so… GEYSERS

- GEYSERS: Generalized Architecture for Dynamic Infrastructures Services
- Instrument: **Collab. Project - Large Scale Integr. Project (IP)**
- Activity: **ICT-2009.1.1 The Network of the Future, FP7 Call 4**
- Project duration: **36 months**
- Project start date: **January 2010**
- Project budget: **10.433.205€** (*7.035.000€ EC contribution*)
- Project resources: **947 person months**

Talk introduction:

It will also cover the impact that virtualization may have to telecom operators, and the advantages it will bring by opening the door to new players while reducing the gap between network and IT providers

What is GEYSERS about?

- An **architecture and tools** for the **composition of logical infrastructures** from physical optical **networks** and **IT** resources
- An **enhanced Network Control Plane** (ASON/GMPLS + PCE) architecture and protocols to use these logical infrastructures to provide advanced transport services coupled with cloud services
- **Business cases** where these two approaches can bring new value to infrastructure providers, network operators and app providers
- Our methodology: architecture **definition, design** and **prototyping, validation** on a real pan-EU testbed

Our problem statement

- New emerging applications with highly demanding network & IT resource requirements, but still **unable to exploit** the potentialities of the current **optical network technologies**
  - Network layer unaware of applications' dynamic requirements
  - Network and IT resources controlled separately **without any integration between NCP and application layer**
- Optical infrastructure **providers** and network **operators** unable to provide enhanced and customized network services
  - Today just simple connection services over generic optical network infrastructures
- Opportunities for **new business models** from the latest advances in network virtualization, physical resource partitioning and network control plane architectures:
  - Multiple virtual networks integrated with IT resource offered as a service to network operators
  - Virtual networks customized with enhanced NCP instances to support dynamic Network+IT provisioning services

GEYSERS and Cloud Computing I

Why Cloud Computing is relevant for GEYSERS requirements and use cases :

- The way in which Cloud computing services (application or infrastructure) are accessed and used increases the criticality of network QoS.
- Network infrastructure services should be offered and managed using similar ownership models and enabling similar virtualization and elasticity capabilities.
- The convergence of IT and Telco service management is an important outcome for Cloud computing to reach a new level of critical mass.
- As cloud computing increases in popularity and scale, massive utilisation of network infrastructure will be observed, where single fibres potentially serving 1000's of cloud customers and service providers simultaneously

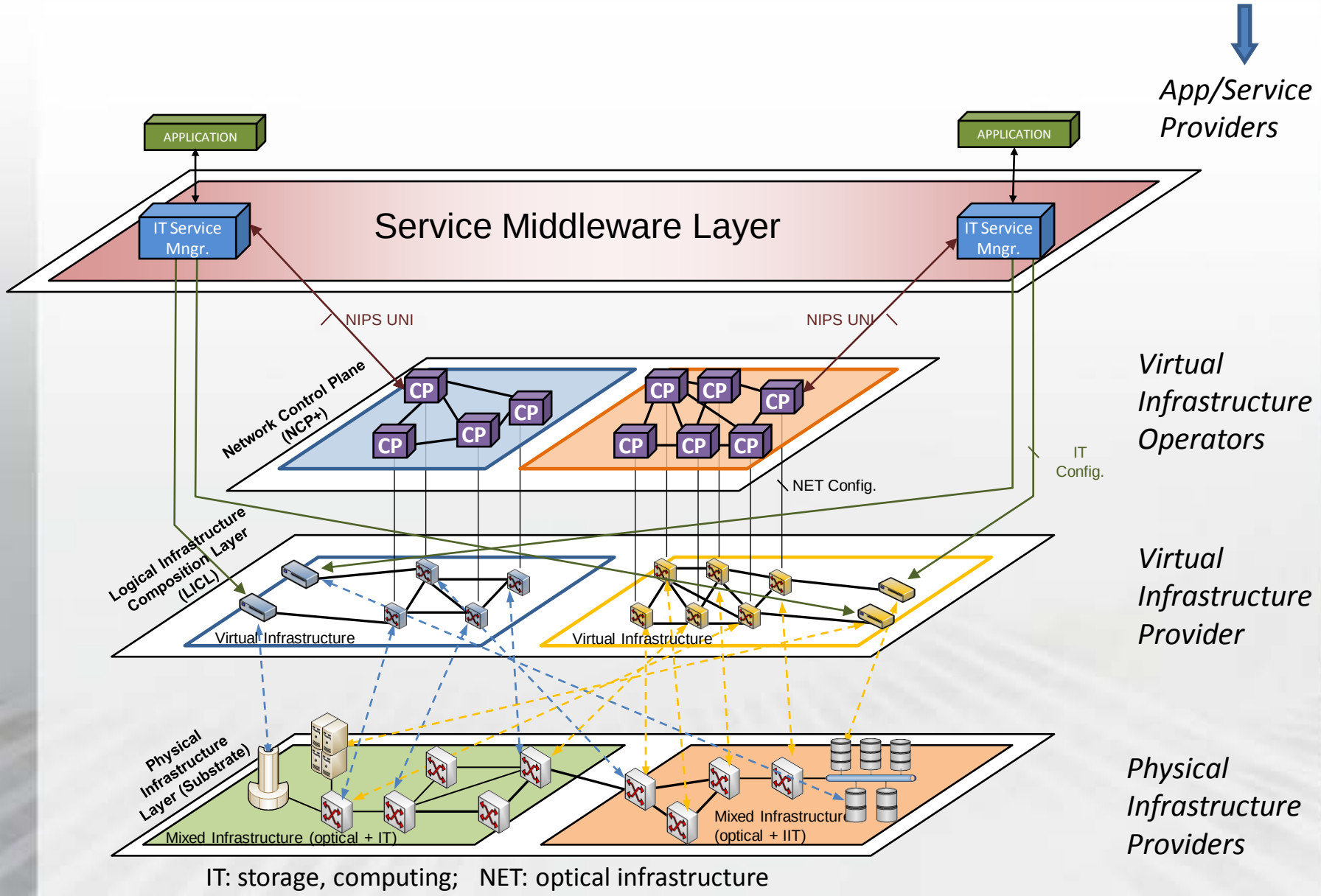
GEYSERS and Cloud Computing II

Properties of cloud computing that need to be considered when planning and provisioning network and IT infrastructure for these applications:

- **Users**: variations in the privileges, location, number, connection frequency and response time constraints of users alter the QoS expectations from the network.
- **Transactions:** the number, frequency and size of transactions change the determination of optimisation
- **Cost:** both providers and users of the network aim to minimise the usage and operational costs of the network. The effort to do this will lead to changes in routing, switching and provisioning of network resources.
- **System distribution:** the distribution of a system may change over time. The physical, geographical separation of application from storage, for example, changes the network utilisation.
- **Connectivity:** the best connectivity at any location is limited by the providers and medium (fibre, copper, satellite) available at the point of connection. This provides constraints when provisioning.
- **SLAs and QoS**: different users and customers will have different agreements with cloud resource providers and network providers concerning the level and quality of service. The cloud and network providers need to be capable of providing differentiated services taking these into consideration.
- **Operations:** especially in the case of distributed data centres, the management operations such as replication, migration and archival trigger large peaks in network utilisation. If not properly planned for, these can be disruptive to other applications and users.

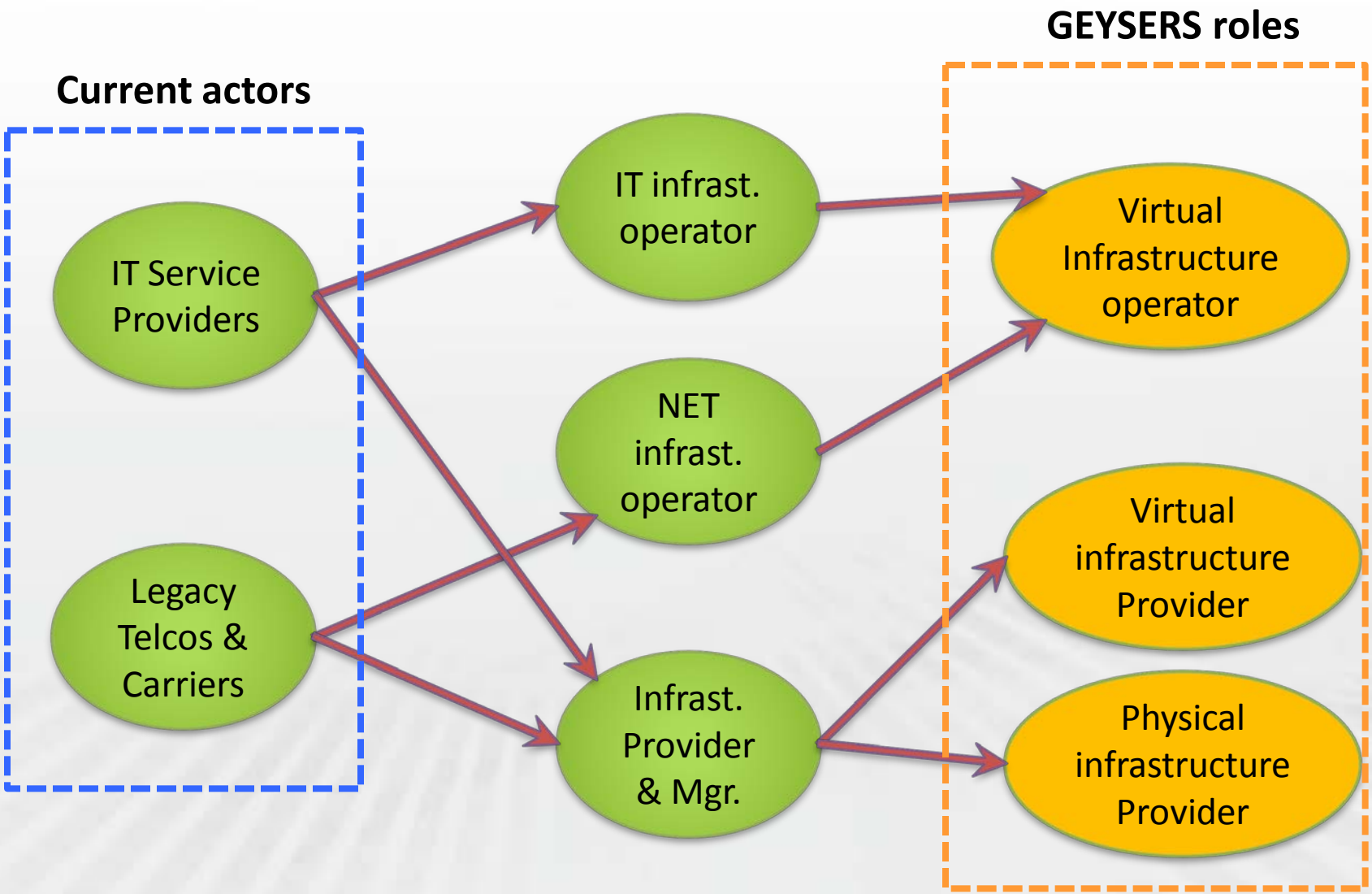
GEYSERS Reference Model

Roles



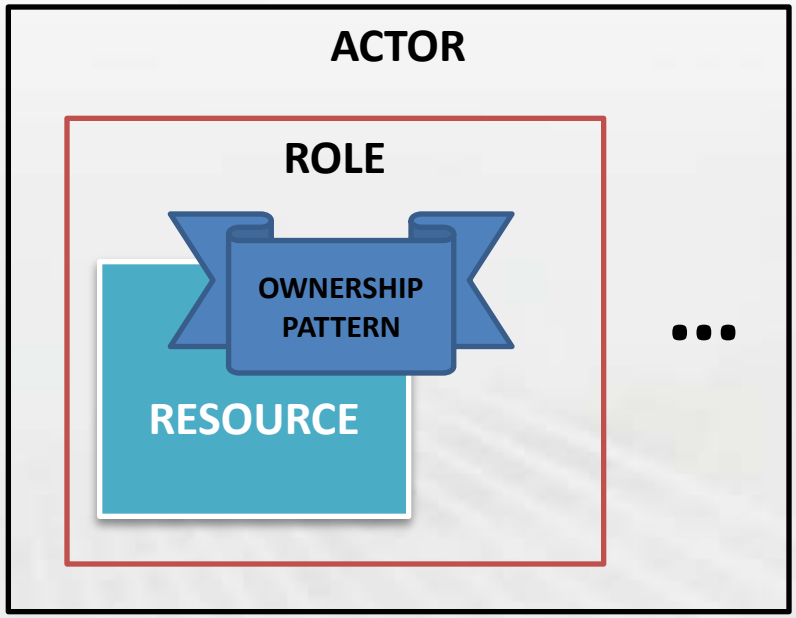
IT: storage, computing; NET: optical infrastructure

From Legacy Actors to GEYSERS Roles



Rationale

- Four pillars for contextualising GEYSERS use cases (RORA):
  - **R**esources (net + IT)
  - **O**wnership (models)
  - **R**oles
  - **A**ctors



ONGOING WORK

RORA Model Basics

- Role and Actor:
  - **Role**: Names a **behaviour of an entity** participating in a particular context and generally is used for identifying it.
  - **Actor**: An **entity taking part in a use case** that may or may not interact with other entities that take one or several roles.
- Provider vs. Operator:
  - **Provider**: A role for offering a resource or a service.
  - **Operator**: A role for controlling a resource, commodity or service.
  - **Requester**: A role for requiring the usage of a resource.
- Ownership (simplified)
  - **Economical**: rights for physically controlling the access to the resource.
  - **Administrative**: rights to configure or operate a resource.
  - **Usage**: utilisation rights of the resources for executing a workflow.

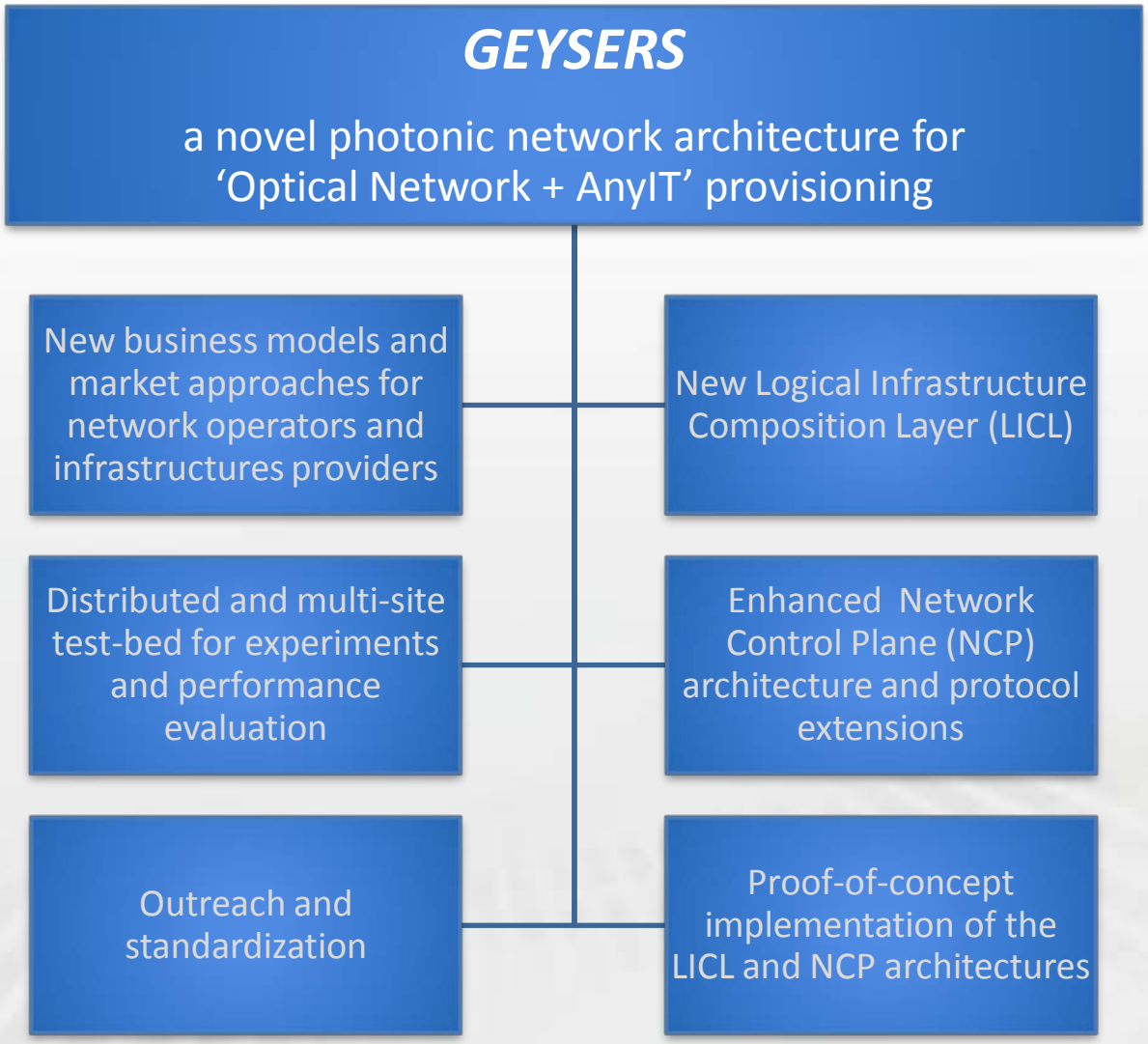
ONGOING WORK ⚠

Roles and Capabilities

- Physical infrastructure provider (**PIP**)
  - Owns economical rights over PHY resources
    - Is able to abstract, partition and lease the infrastructure
    - Monitors hardware
    - Solves PHY resource problems (hardware maintenance)
- Virtual infrastructure provider (**VIP**)
  - Owns administrative rights for planning virtual infrastructures
    - Is able to compose virtual infrastructures
    - Offers VIs to operators (VIO)
- Virtual infrastructure operator (**VIO**)
  - Owns administrative rights over virtual infrastructures
    - Configures and monitors virtual resources
    - Solves virtual resource problems
    - Call for re-planning virtual infrastructures
- User/application/Service provider
  - Consumes Net+IT unified services (NIPS UNI) as resources

ONGOING WORK ⚠

Main goals


GEYSERS
a novel photonic network architecture for 'Optical Network + AnyIT' provisioning
New business models and market approaches for network operators and infrastructures providers
New Logical Infrastructure Composition Layer (LICL)
Distributed and multi-site test-bed for experiments and performance evaluation
Enhanced Network Control Plane (NCP) architecture and protocol extensions
Outreach and standardization
Proof-of-concept implementation of the LICL and NCP architectures

Logical Infrastructure Composition Layer (LICL)

Tech objectives:

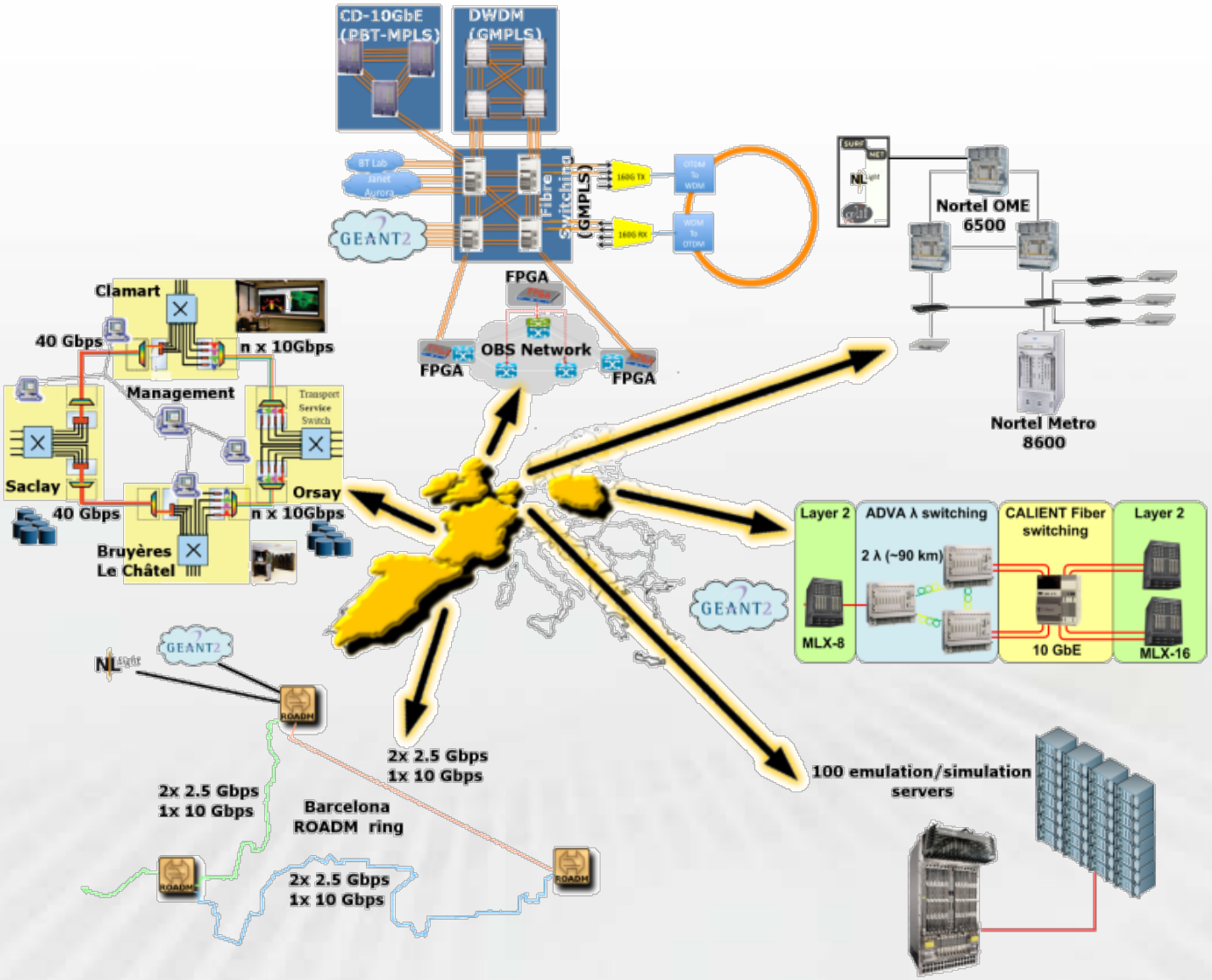
- Partitioning of the physical optical network and IT infrastructures resources through **resource virtualization**
- **Composition** of network and IT resources **from multiple providers** in a logical abstraction of the underlying infrastructures
- Dynamic creation of **multiple isolated virtual infrastructures** sharing the same physical resources
- Management of static and **dynamic** resource sharing between infrastructure providers and network operators

Enhanced Network Control Plane

Tech objectives:

- Advanced network support for cloud services:
  - seamless one-step provisioning of network+IT resources (**NIPS**: Network+IT Provisioning Service)
  - **new network connection paradigms** for the application layers (*assisted unicast, restricted anycast, full anycast*)
- Logical infrastructure dynamic **replanning**
  - **Enhanced TE** in GMPLS/PCE "think of" and trigger underlying virtual infrastructure replanning
- Dynamic provisioning, monitoring and **recovery** functions
  - Coordinated recovery escalation among LICL/NCP/[appl. layer]
- **Backward** compatibility & **interoperability**
  - ASON/GMPLS and PCE
  - UNI and E-NNI interfaces
- Interworking with std PCE/NMS for connection service provisioning

GEYSERS Pan-EU testbed



Expected business impact

- GEYSERS concepts will allow the development of **new actors** in the ICT environment
  - existing and emerging network operators, virtual infrastructure providers
- GEYSERS approach will enable **telcos to access new markets** with **new models**
  - moving their business towards higher value application layers
- IaaS in GEYSERS will strongly impact **new business models**
  - E.g. allowing to **compose network + IT resources**
- Application and market expectations will drive the development of new business models based on GEYSERS concepts and outcomes
  - E.g. **targeting CAPEX and OPEX optimization**

Consortium

Pan-EU Carriers	• Interoute (coordinator)
Telecom Operators	• Telefonica I+D • Telekom Polska
NRENs	• Poznan Supercomputing and Networking Center (PSNC)
Service Providers	• SAP AG
Telco manufacturers	• ADVA Optical Networking • Alcatel-Lucent Italia
SMEs	• Nextworks, Martel
Universities and Research Centres	• Fundació i2CAT • University of Essex • Institut National de Recherche en Informatique (INRIA) • University van Amsterdam (UvA) • Athens Information Technology (AIT) • Technical University of Braunschweig (TUB) • Interdisciplinair instituut voor BreedBand Technologie (IBBT) • Indian Institut of Technology (IIT)

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