Application-Based Network Operations (ABNO):
EC Research Projects and Future Direction

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What is ABNO?

- Applications-Based Network Operations
  - A PCE-based Architecture for Application-based Network Operations
    <u>draft-farrkingel-pce-abno-architecture</u>

- Network Controller Framework
  - Avoiding single technology domain "controller" architecture
  - Reuse well-defined components
    - Discovery of network resources and topology management.
    - Routing and path computation
    - Multi-layer coordination and interworking
    - Policy Control
    - OAM and performance monitoring
  - Support a variety of southbound protocols
    - Leveraging existing technologies, support new ones

- Integrate with defined and developing standards, across SDOs

ABNO
Functional Components

- "Standardized" components

- Policy Management

- Network Topology
  - LSP-DB
  - TED
  - Inventory Management

- Path Computation and Traffic Engineering
  - PCE, PCC
  - Stateful & Stateless
  - Online & Offline
  - P2P, P2MP, MP2MP

- Multi-layer Coordination
  - Virtual Network Topology Manager

- Network Signaling & Programming
  - RSVP-TE
  - ForCES
  - OpenFlow
  - Interface to the Routing System
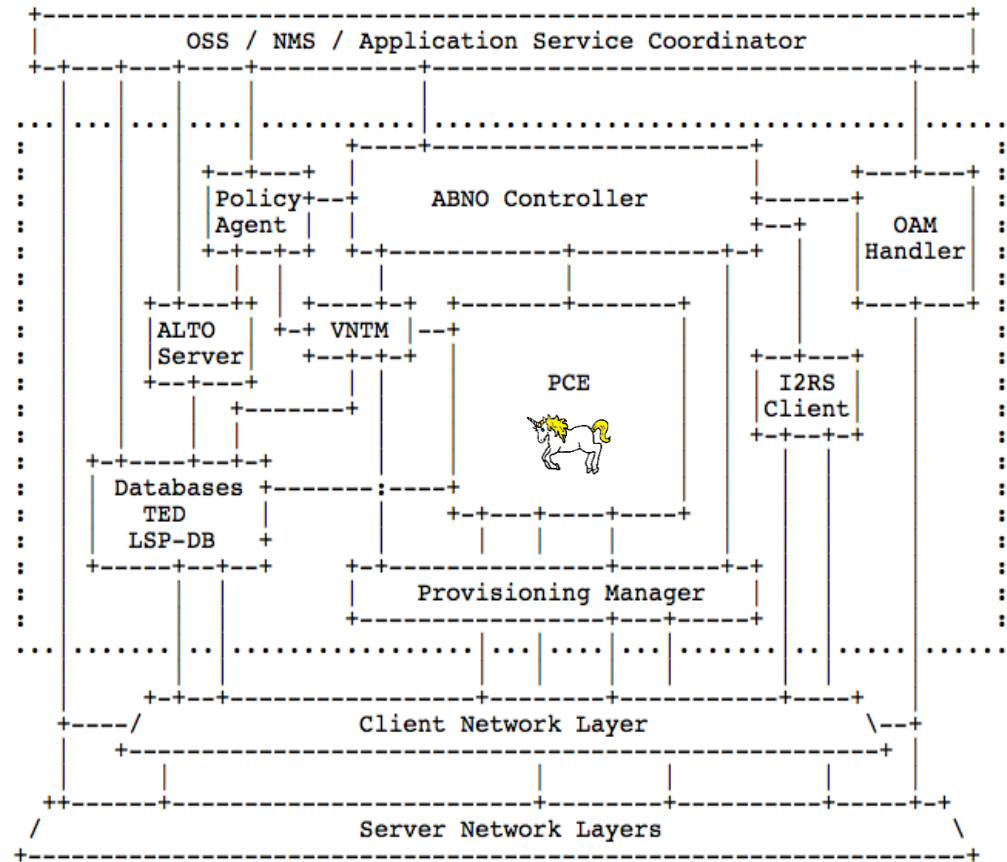 - Future technologies: Segment Routing & Service Function Chaining

Figure 1: Generic ABNO Architecture

ABNO Applied
Elastic Optical Networks

- Elastic Optical Networks
  - Photonic Integrated Circuit (PIC) technology
    - Paving the path towards cost effective transmission schemes beyond 100Gbps.
  - Digital Coherent and SuperChannel technology solutions
    - Variable >100Gbps client signals and cost effective >100Gbps transponders
    - Capable of long reach up to 400Gbps without regeneration
  - Cost effective and flexible transponders
    - The Sliceable-Bandwidth Variable Transponder (SBVT).
      - Reduce bandwidth to extend reach
      - More spectrum to extend reach
      - More bandwidth over short reach

- Flexi-grid
  - A variable-sized optical frequency range.
 - ITU-T Study Group 15 (www.itu.int/rec/T-REC-G.694.1)

EC Framework Programme
FP7 "IDEALIST" Project

- Industry-Driven Elastic and Adaptive Lambda Infrastructure for Service and Transport (IDEALIST) Networks
    - The work is partially funded by the European Community's Seventh Framework Programme FP7/2007-2013 through the Integrated Project (IP) IDEALIST under grant agreement nº 317999.
    - www.ict-idealist.eu

- The network architecture proposed by IDEALIST is based on four technical cornerstones:
    - An optical transport system enabling flexible transmission and switching beyond 400Gbps per channel.
    - Control plane architecture for multi-layer and multi-domain optical transport network, extended for flexi-grid labels and variable bandwidth.
    - Dynamic network resources allocation at both IP packet and optical transport network layer.
    - Multilayer network optimization tools enabling both off-line planning, on-line network reoptimization in across the IP and optical transport network.

FP7 IDEALIST Adaptive Network Manager
Based on an ABNO architecture
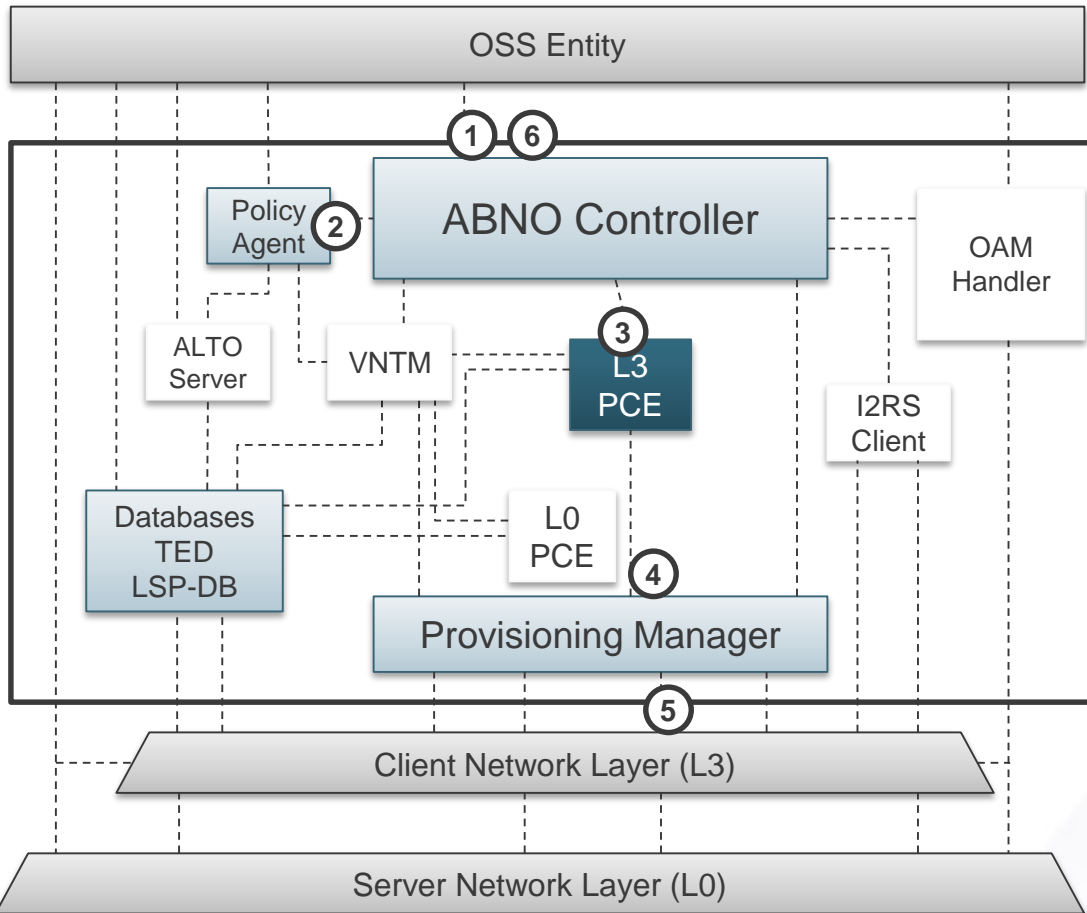
ABNO Operation

1. **OSS Entity** requests for a path between two L3 nodes.

2. **ABNO Controller** verifies **OSS Entity** user rights using the **Policy Manager**.

3. **ABNO Controller** requests to **L3-PCE** (active) for a path between both locations.

4. As **L3-PCE** finds a path, it configures L3 nodes via the **Provisioning Manager**.

5. **Provisioning Manager** configures L3 nodes using the required interface (RSVP-TE)

6. Response of successful path setup sent to **ABNO Controller**

7. **ABNO Controller** notifies the **OSS Entity** that the connection has been set-up.

6

FP7 IDEALIST Findings
## ABNO Related Articles & Developments

- Publications (just a few)
  - In-Operation Network Planning
    IEEE Communications Magazine
  - Experimental Demonstration of an Active Stateful PCE performing Elastic Operations and Hitless Defragmentation
    ECOC European Conference on Optical Communications
  - Planning Fixed to Flexgrid Gradual Migration: Drivers and Open Issues
    IEEE Communications Magazine
  - Dynamic Restoration in Multi-layer IP/MPLS-over-Flexgrid Networks
    IEEE Design of Reliable Communication Networks (DRCN)
  - A Traffic Intensity Model for Flexgrid Optical Network Planning under Dynamic Traffic Operation
    OSA Optical Fiber Communication (OFC)
  - Full list of IDEALIST publications: www.ict-idealist.eu/index.php/publications-standards

- Standards Input
  - Unanswered Questions in the Path Computation Element Architecture
    tools.ietf.org/html/draft-ietf-pce-questions

Additional EC Projects
ABNO Actively being investigated and developed

- **FI-PPP XIFI** (wiki.fi-xifi.eu) Creating a multi-DC community cloud across Europe.
    - **Flexible User Interface**
    - **Federated Cloud and Service Management**
    - **Dynamic Network Management**
    - **Resource Monitoring**
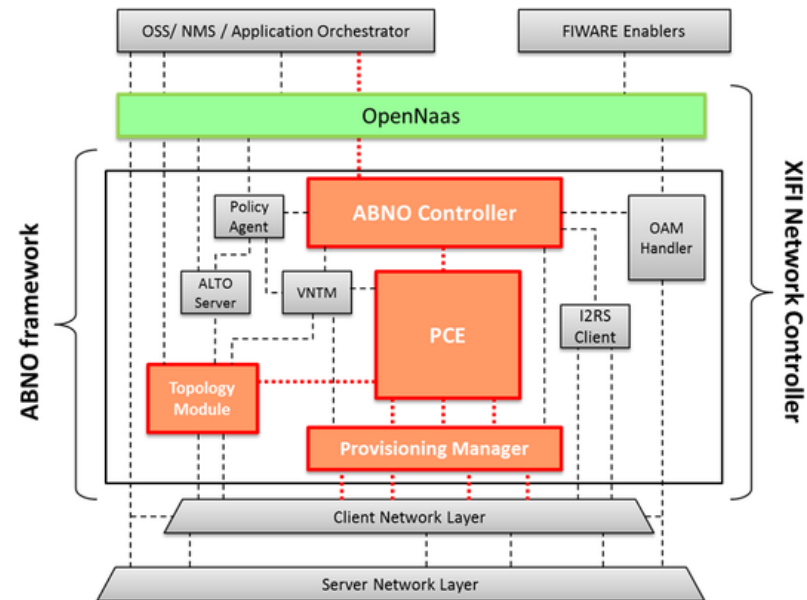
- **FP7 OFERTIE** (www.ofertie.org) Enhances the OFELIA testbed facility to allow researchers to request, control and extend network resources dynamically.

- **FP7 DISCUS** (discus-fp7.eu) Distributed Core for unlimited bandwidth supply for all Users and Services

- **FP7 CONTENT** (content-fp7.eu) Convergence of Wireless Optical Network and IT Resources in Support of Cloud Services

- **FP7 PACE** (ict-pace.net) - Next Steps for the Path Computation Element

Unanswered Questions
## For Path Computation Element Architectures

- Three PCE Architectures
    - **RFC 4655** defines the PCE Architecture
    - **RFC 5623** extended PCE for multi-layer networking with Virtual Network Topology Manager (VNTM)
    - **RFC 6805** defines Hierarchical PCE (H-PCE)

- These three architectural views of PCE are applicable within the ABNO framework

- Some key questions unanswered especially with respect to the interactions between architectural components

o **What Is Topology Information and How Is It Gathered?**

o **How Do I Find My PCE, And How Do I Select Between PCEs?**

o **How Do Redundant PCEs Synchronize TEDs?**

o **Where Is the Destination?**

o **Who Runs Or Owns a Parent PCE?**

o **Does H-PCE Solve The Internet?**

o **What are Sticky Resources?**

o **What Is A Stateful PCE For?**

o **How Is the LSP-DB Built?**

o **How Do Redundant Stateful PCEs Synchronize State?**

o **What Is An Active PCE? What is a Passive PCE?**

o **What is LSP Delegation?**

o **Is An Active PCE with LSP Delegation Just a Fancy NMS?**

o **Comparison of Stateless and Stateful PCE**

o **How Does a PCE Work With A Virtual Network Topology?**

o **How Does PCE Communicate With VNTM?**

o **How Does Service Scheduling and Calendering Work?**

o **Where Does Policy Fit In?**

o **What Is A Path Computation Elephant?**

UK EPSRC-funded Project
TOUCAN

- Towards Ultimate Convergence of All Networks (TOUCAN)
  - Define technology agnostic architecture for convergence based on SDN principles
  - Facilitate optimal interconnection of any network technology domains, networked devices and data sets with high flexibility, resource and energy efficiency

- A UK funded project
  - £6M from the UK Research Council
  - £6M from industry partners
  - Duration 5 years from August 2014
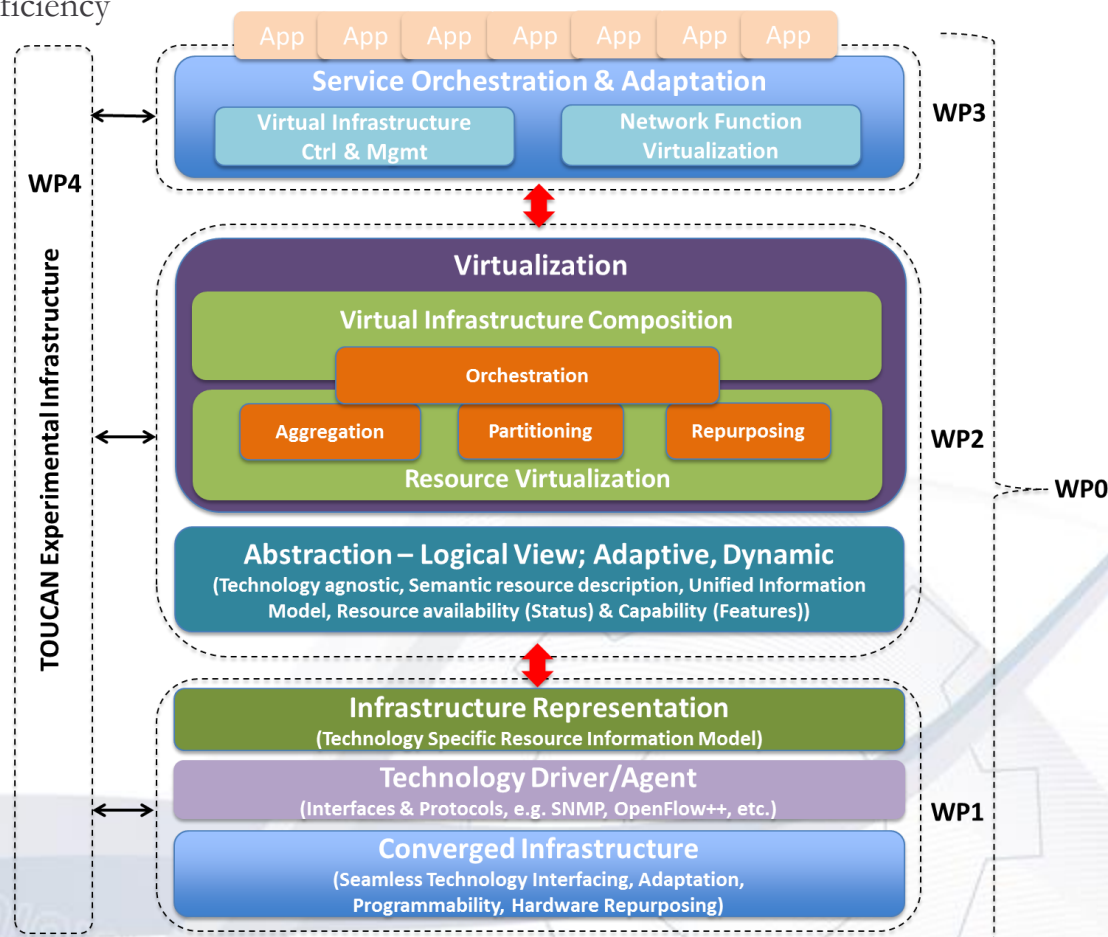
IETF BoF Proposal
Abstraction and Control of Transport Networks (ACTN)

- The aim of ACTN is to facilitate virtual network operation, creation of a virtualized environment allowing operators to view, control, and partition, multi-subnet multi-technology networks

- ACTN Use Cases
  - Multi Tenant VNO
    draft-kumaki-actn-multitenant-vno
  - Data Center Interconnects
    draft-fang-actn-multidomain-dci
  - Transport Network Operators
    draft-klee-actn-connectivity-multi-vendor-domains
    draft-lopez-actn-vno-multidomains
  - Mobile Network Operators
    draft-shin-actn-mvno-multi-domain

- ACTN BoF Meeting
  - Thursday, July 24, 2014 – 13:00 to 15:00
  - Agenda for ACTN

Thank You!

Any comments or questions are welcome.

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