Network Virtualization within the 4WARD Project

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Current Status

- Created an architectural framework for network virtualization in a commercial setting
- Project ends in mid of this year (2010)
- Implementation and evaluation of several feasibility tests for parts of the architecture (ongoing)
(non-exhaustive) List of research topics

- Architectural framework for network virtualisation
  - Definition of a basic architecture model

- Virtualisation of resources
  - Link virtualisation (wired, wireless)
  - Node virtualisation

- Provisioning, management and control
  - Signaling and management protocols
  - Description of virtual networks and resources
  - Embedding of virtual resources; resource optimization
  - Management of resources and isolation of virtual networks

- Interoperability
  - Interoperability between stakeholders
  - Interoperability between virtual networks (folding points)
4WARD Network Virtualization business model

Virtual Network Operator (VNO)

Virtual Network Provider (VNP)

Infrastructure Provider A

Infrastructure Provider B

Infrastructure Provider C

Virtual Network Provider
**Architecture interfaces**

1. **VNO/VNP** - Virtual network description and request
2. **VNP/InP** - Request and negotiation of virtual resources
3. **InP/Network elements** - Setup of virtual nodes and virtual links
4. **InP/InP (+VNP)** - Setup of inter-domain virtual links and virtual networks
5. **VNO/InP** - “Out of band” virtual node access for bootstrapping/rebooting/configuration
6. **End user/VNO** - End user attachment

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**Legend:**
- **Virtual Network**
- **InP**
- **VNO**
- **VNP**
- **Physical Networks**
- **Virtual Nodes**
- **Links**
Virtual Link Setup

- Two variants: intra-domain and inter-domain
  - Intra-domain:
    - Basically an extension of Constraint-Based Routing for Traffic Engineering?
  - Inter-domain:
    - Standardization is required to enable interoperability between different InP domains
    - Currently, a prototype uses an additional object for QoS NSLP
      - path-coupled signaling for QoS reservation combined with virtual link setup
Topics for discussion/standardization (1)

- **Common network virtualization framework**
  - Terminology, definition of reference points, interfaces

- **Namespaces**
  - Globally unique VNet IDs (e.g. for end user attachment to VNFs) represent a global namespace that needs to be standardized

- **Resource Description Language**
  - Describing networks and network resources is essential for provisioning and management of virtual networks (VNPs to specify resources to be requested from InPs; InPs to describe resources provided to VNPs).

- **VNet Resource Request Protocol**
  - required for VNP to InP interaction
  - InP doesn’t want to publish too much of its internals
Topics for discussion/standardization (2)

- **Virtual Node Setup Protocol**
  - To setup the virtual nodes that make up virtual networks running inside a single infrastructure domain; required for vendor interoperability.

- **Virtual Link Setup/Management**
  - Inter-domain virtual links setup required
    - Inter-AS MPLS-VPNs are considered in RFC4364, Section 10
    - But this is limited to the MPLS-VPN model
  - a new approach for the control plane (virtual link setup) is required
  - monitoring capabilities/debugging support

- **Cross InP Virtual Network Management**
  - need to locate virtual resources (VNO)
  - probably distributed management architecture

- **End-user attachment**
  - users must find their Virtual Access Node
  - users/apps must attach to the correct VNet (in case of multiple VNets)