OnVector 2009:
Topology handling in GLIF

Cees de Laat
GLIF.is founding member

SURFnet
EU
BSIK
NWO
University of Amsterdam
# Service Matrix

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Single λ, any bitstream</th>
<th>SONET/SDH</th>
<th>1 Gb/s Ethernet</th>
<th>LAN PHY Ethernet</th>
<th>WAN PHY Ethernet</th>
<th>VLAN tagged Ethernet</th>
<th>IP over Ethernet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WDM (multiple λ)</strong></td>
<td>cross-connect multicast, regenerate, multicast</td>
<td>WDM demux</td>
<td>WDM demux</td>
<td>WDM demux</td>
<td>WDM demux</td>
<td>WDM demux</td>
<td>WDM demux</td>
<td>WDM demux</td>
</tr>
<tr>
<td><strong>Single λ, any bitstream</strong></td>
<td>WDM mux</td>
<td>cross-connect multicast, regenerate, multicast</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>SONET/SDH</strong></td>
<td>WDM mux</td>
<td>N/A</td>
<td>SONET switch, +</td>
<td>TDM demux</td>
<td>TDM demux</td>
<td>SONET switch</td>
<td>TDM demux</td>
<td>TDM demux</td>
</tr>
<tr>
<td><strong>1 Gb/s Ethernet</strong></td>
<td>WDM mux</td>
<td>N/A</td>
<td>TDM mux</td>
<td>aggregate, Ethernet conversion</td>
<td>aggregate, Ethernet conversion</td>
<td>aggregate, VLAN encap</td>
<td>L3 entry</td>
<td></td>
</tr>
<tr>
<td><strong>LAN PHY Ethernet</strong></td>
<td>WDM mux</td>
<td>N/A</td>
<td>TDM mux</td>
<td>aggregate, Ethernet conversion</td>
<td>aggregate, Ethernet conversion</td>
<td>Ethernet conversion</td>
<td>aggregate, VLAN encap</td>
<td>L3 entry</td>
</tr>
<tr>
<td><strong>WAN PHY Ethernet</strong></td>
<td>WDM mux</td>
<td>N/A</td>
<td>SONET switch, +</td>
<td>aggregate, Ethernet conversion</td>
<td>aggregate, Ethernet conversion</td>
<td>aggregate, VLAN encap</td>
<td>L3 entry</td>
<td></td>
</tr>
<tr>
<td><strong>VLAN tagged Ethernet</strong></td>
<td>WDM mux</td>
<td>N/A</td>
<td>TDM mux</td>
<td>aggregate, VLAN decap</td>
<td>aggregate, VLAN decap</td>
<td>Aggregate, VLAN decap &amp; encap +</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td><strong>IP over Ethernet</strong></td>
<td>WDM mux</td>
<td>N/A</td>
<td>TDM mux</td>
<td>L3 exit</td>
<td>L3 exit</td>
<td>L3 exit</td>
<td>N/A</td>
<td>Store &amp; forward, L3 entry/exit+</td>
</tr>
</tbody>
</table>
Network Description Language

• From semantic Web / Resource Description Framework.
• The RDF uses XML as an interchange syntax.
• Data is described by triplets:

```
<table>
<thead>
<tr>
<th>Subject</th>
<th>Predicate</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>Device</td>
<td>Interface</td>
</tr>
<tr>
<td>name</td>
<td>description</td>
<td>locatedAt</td>
</tr>
<tr>
<td>connectedTo</td>
<td>capacity</td>
<td>encodingType</td>
</tr>
</tbody>
</table>
```
Choice of RDF instead of XML syntax
Grounded modeling based on G0805 description:

A weird example

Université du Quebec

StarLight Chicago
can adapt GE in STS-24c or STS-3c-7v

CA★Net Canada
can adapt GE in STS-24c

MAN LAN New York

Universiteit van Amsterdam

can adapt GE in STS-3c-7v

Gigabit Ethernet

OC-192 (22 free)

OC-192 (38 free)

2x OC-192 (87 free)

2x OC-192 (63 free)
The result :-)
A device switches data based on:
- The source interface
- One or more labels

Example label types:
- Ethernet VLAN
- SONET STS Channel
- Wavelength ($\lambda$)

For example, all data from channel 31 of interface 2 is forwarded to channel 28 of interface 4.
Multi-layer extensions to NDL
From network to applications

From the physical architecture

To the semantic model for the architecture
RDF describing Infrastructure

“I want”

Application: find video containing x, then trans-code to it view on Tiled Display

RDF/CG

RDF/CG

RDF/ST

RDF/NDL

RDF/NDL

RDF/CPU

RDF/VIZ

content

content

COCE
Semantic Reasoning
The Problem

I want HC and AB

Success depends on the order

Wouldn’t it be nice if I could request [HC, AB, ...]?
NDL + PROLOG

Research Questions:
• order of requests
• complex requests
• Usable leftovers

• Reason about graphs
• Find sub-graphs that comply with rules
Mathematica enables advanced graph queries, visualizations and real-time network manipulations on UPVNs

Topology matters can be dealt with algorithmically
Results can be persisted using a transaction service built in UPVN

Initialization and BFS discovery of NEs

Network flows using real-time bandwidth measurements

ref: Robert J. Meijer, Rudolf J. Strijkers, Leon Gommans, Cees de Laat, User Programmable Virtualized Networks, accepted for publication to the IEEE e-Science 2006 conference Amsterdam.
TouchTable Demonstration @ SC08
Interactive programmable networks
OGF NML-WG
Open Grid Forum - Network Markup Language workgroup

Chairs:
Paola Grosso – Universiteit van Amsterdam
Martin Swany – University of Delaware

Purpose:
To describe network topologies, so that the outcome is a standardized network description ontology and schema, facilitating interoperability between different projects.

https://forge.gridforum.org/sf/projects/nml-wg
Questions?

Accepted ONDM paper: A Declarative Approach to Multi-Layer Path Finding Based on Semantic Network Descriptions.

http://delaat.net/~delaat/papers/declarative_path_finding.pdf

Thanks: Paola Grosso & Jeroen vd Ham & Freek Dijkstra & team for several of the slides.