

# Inter-domain Integration and Interoperation

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# What is missing in e-Infrastructure from the e-Science viewpoint?

- Useful ubiquitous access to photonic networks
  - first mile problems
- Grid programming models which go beyond treating the communication as Virtual Private Networks
- Scalable optical/photonic network resources preventing cost explosions





GLIF Q3 2005

Visualization courtesy of Bob Patterson, NCSA  
Data collection by Maxine Brown.

# MULTI-DOMAIN TESTBED



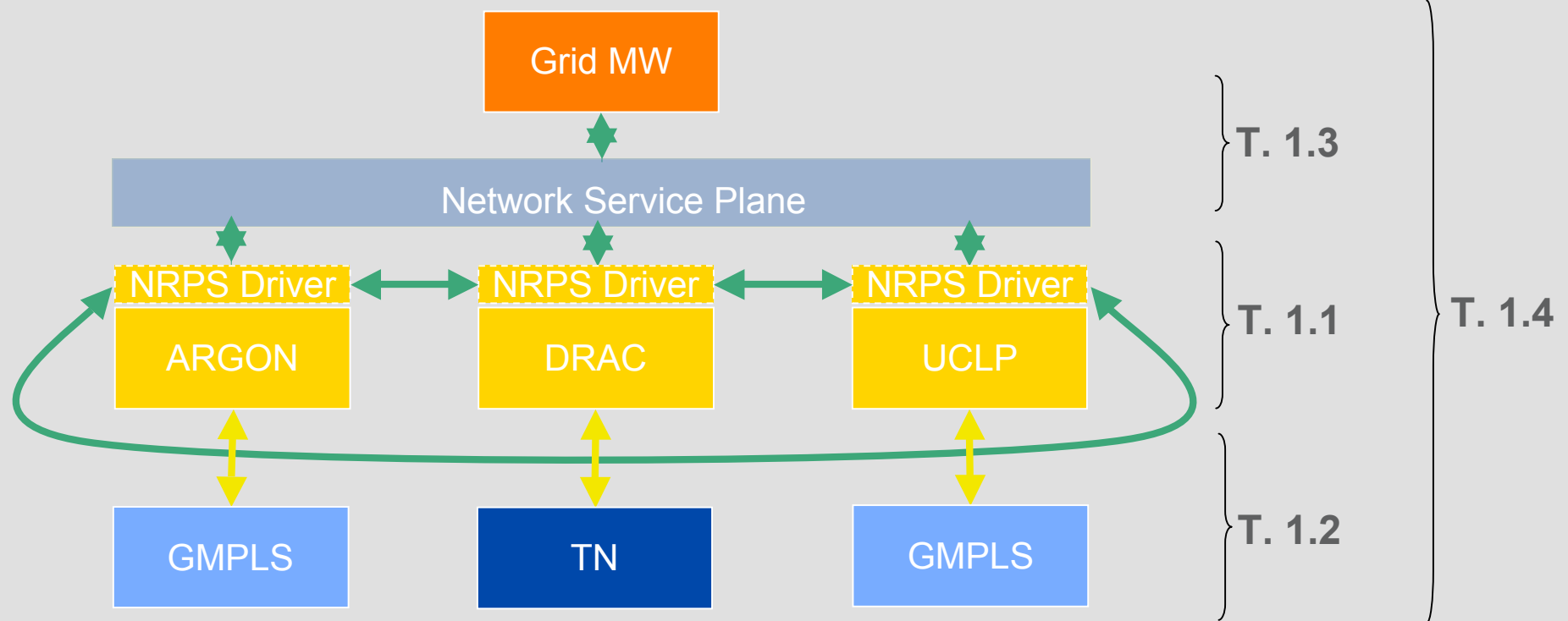


# PROJECT KEY FEATURES 1/3



- **Demonstrate on demand service delivery across multi-domain/multi-vendor research network test-beds on a European and Worldwide scale. The test-bed will include:**
  - EU NRENs: SURFnet, CESNET, PIONIER as well national test-beds (VIOLA, OptiCAT, UKLight)
  - GN2, GLIF and Cross Border Dark Fibre connectivity infrastructure
  - GMPLS, UCLP, DRAC and ARGON control and management planes
  - Multi-vendor equipment environment (ADVA, HITACHI, NORTEL, Vendor's equipment in the participating NREN infrastructure)

# WP1: ARCHITECTURE & TASKS (First phase)



**Task 1.1** Heterogeneous NRPSs interoperability.

**Task 1.2** Interoperability of NRPS and GMPLS control plane.

**Task 1.3** Integration of the Network Service Plane.

**Task 1.4** Interoperability between NRPS, GMPLS and the Service Layer.

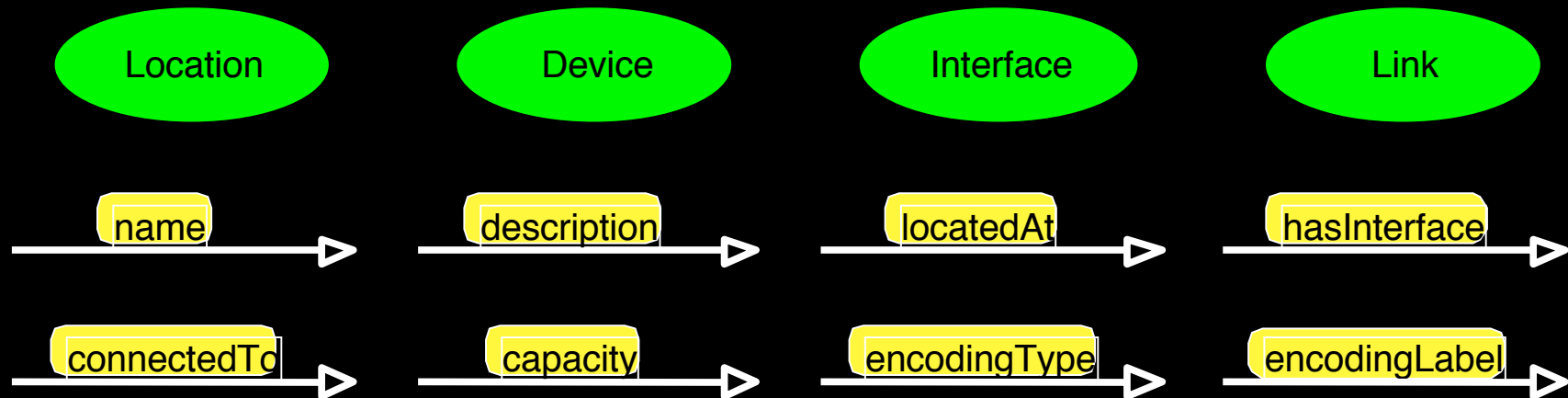
# Status UvA research

- NDL
- TBN
- TwT
- wvttk



# NDL schema

The NDL schema allows for description of network connections among GOLEs.



Standardization effort: *NML workgroup in the OGF*



# Do-it-yourself tools (1/3)

## NDL Generator form

An NDL file is automatically generated based on user input:

- Location
- Devices
- Interfaces

<http://trafficlight.uva.netherlight.nl/NDL-demo/NDL-Generator.html>

The screenshot shows a web browser window with the URL <http://trafficlight.uva.netherlight.nl/NDL-demo/NDL-Generator.html>. The page title is "NDL for the GLIF - NDL Generator". The main heading is "NDL for the GLIF - NDL Generator". Below the heading, there is a brief introduction to NDL (Network Description Language) and its use in the GLIF collaboration. The page is divided into three steps: "Step 1 - Location", "Step 2 - Devices", and "Step 3 - Interfaces".

**Step 1 - Location**

Indicate the location of the network. Provide a human-readable name of the network, and its latitude and longitude.

Identify (Human-readable) Name:  Latitude:  Longitude:

**Step 2 - Devices**

Indicate the name of the device in the network. If you need to describe more devices just press "Add a Device"

Device	Device's location id
<input type="text" value="Nortel Houdini"/>	<input type="text" value="houdini"/>
<input type="text" value="Gigaset"/>	<input type="text" value="speculaas"/>
<input type="text"/>	<input type="text"/>

**Step 3 - Interfaces**

Click on the button "Generate interfaces for devices" to create the table of the interfaces for the above devices. For each interface, please give the name of the interface, where it is connected to and (if possible) the capacity for each of the interfaces on a device.

Done

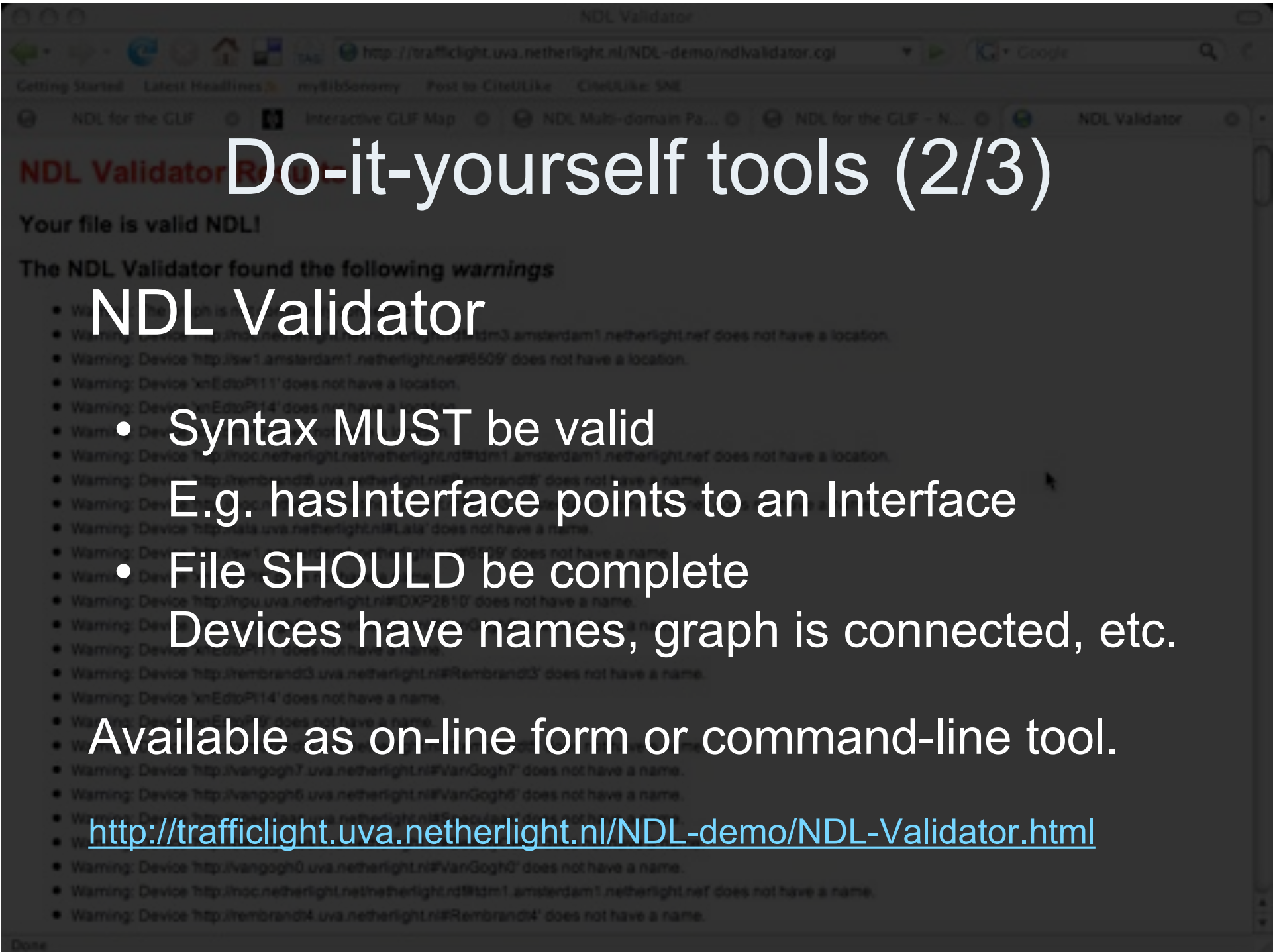
# Do-it-yourself tools (2/3)

## NDL Validator

- Syntax MUST be valid  
E.g. hasInterface points to an Interface
- File SHOULD be complete  
Devices have names, graph is connected, etc.

Available as on-line form or command-line tool.

<http://trafficlight.uva.netherlight.nl/NDL-demo/NDL-Validator.html>



# Do-it-yourself tools (3/3)

## NDL Visualizers

- NDL to DOT converter  
Visualize with GraphViz
- GoogleMaps network drawings  
Uses geo coordinates in NDL files

NDL2dot available for download.

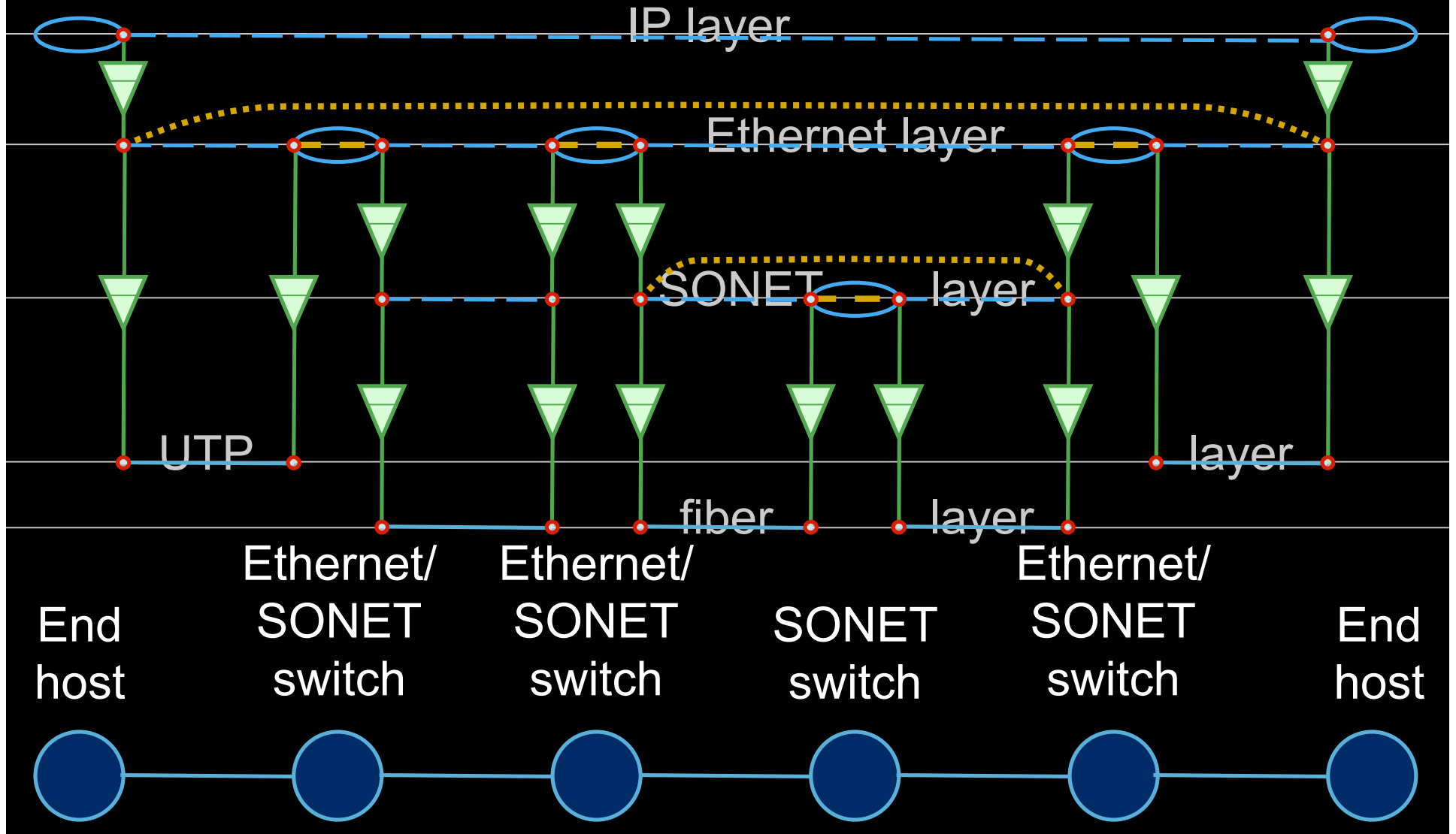
<http://www.science.uva.nl/~vdham/ndl/utilities/ndl-visualisation.tgz>

<http://staff.science.uva.nl/~vdham/NDL/googlemap.html>

Supercomputing 2006 demo:  
*multi domain path finding  
in the GLIF*

# Multi-layer extensions to NDL

Layer schema based on G.805



# OGF NML-WG

## *Open Grid Forum - Network Markup Language workgroup*

### Chairs:

Paola Grosso – Universiteit van Amsterdam

Martin Swany – University of Delaware

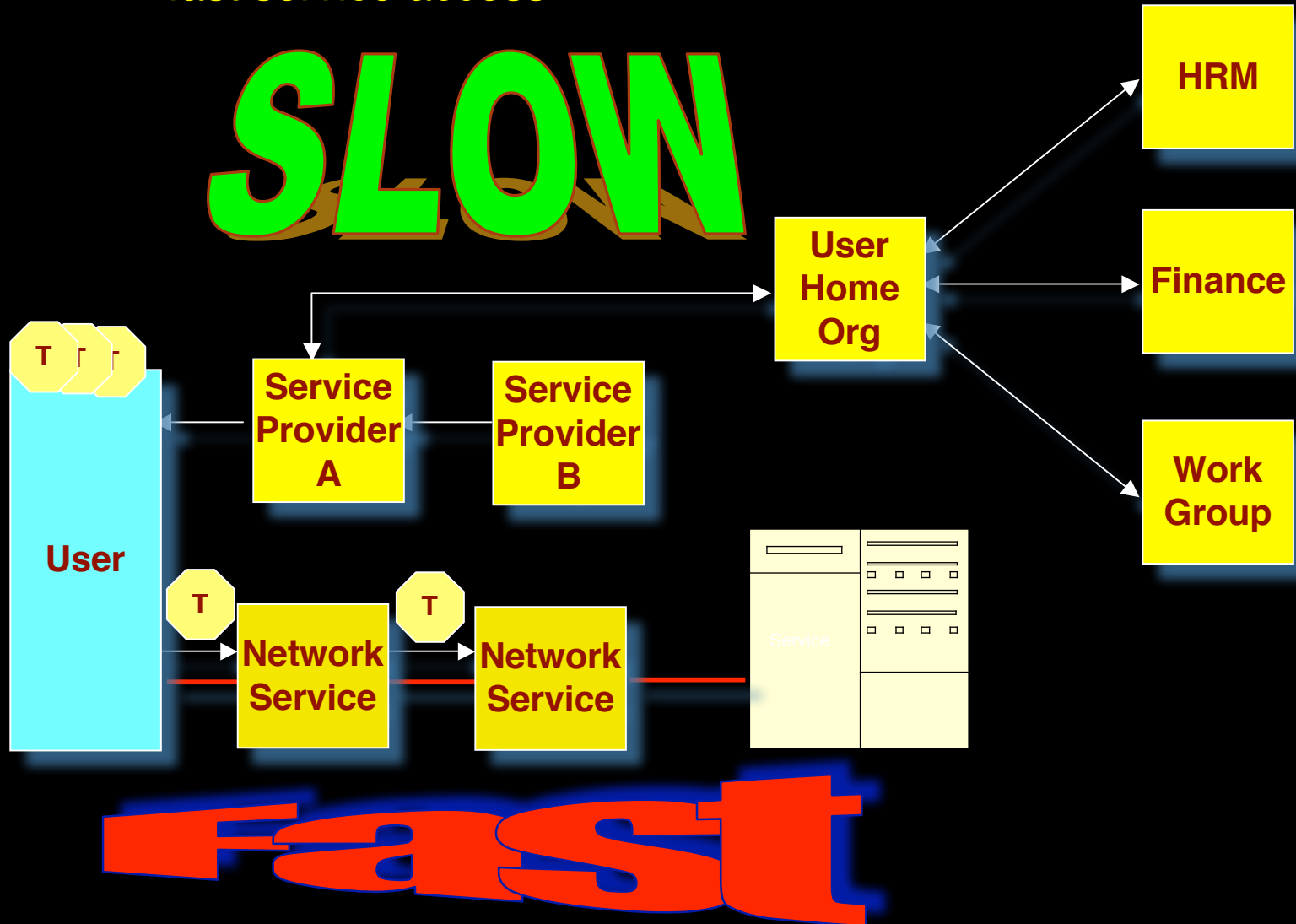
### Purpose:

*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>

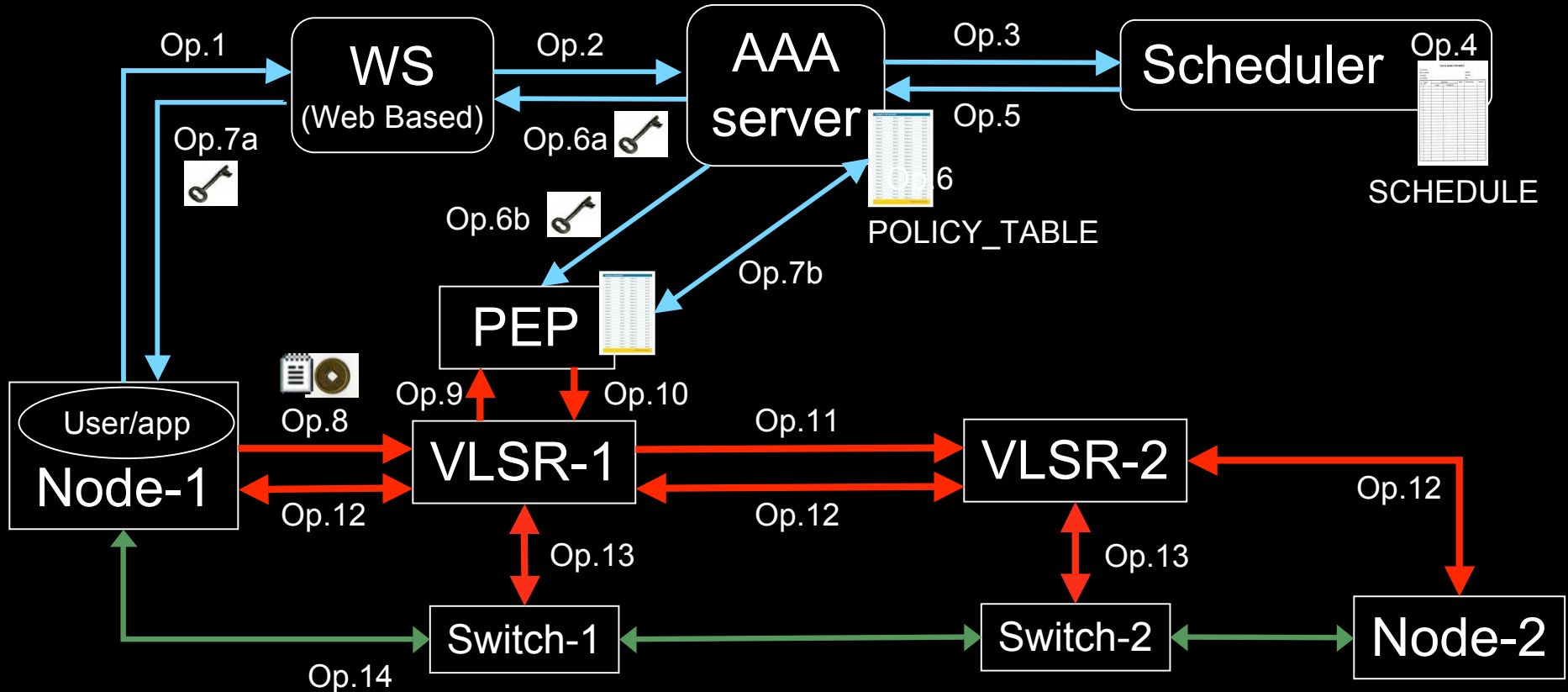


TBN: split (time consuming) service authorization process from service access using secure tokens in order to allow fast service access.





# Workflow for TBN in GMPLS with DRAGON



1. User (on Node1) requests a path via web to the WS.
2. WS sends the XML requests to the AAA server.
3. AAA server calculates a hashed index number and submits a request to the Scheduler.
4. Scheduler checks the SCHEDULE and add new entry.
5. Scheduler confirms the reservation to the AAA.
6. AAA server updates the POLICY\_TABLE.
- 6a. AAA server issues an encrypted key to the WS.
- 6b. AAA server passes the same key to the PEP.
- 7a. WS passes the key to the user.
- 7b. AAA server interacts with PEP to update the local POLICY\_TABLE on the PEP.

8. User constructs the RSVP message with extra Token data by using the key and sends to VLSR-1.
9. VLSR-1 queries PEP whether the Token in the RSVP message is valid.
10. PEP checks in the local POLICY\_TABLE and return YES.
11. When VLSR-1 receives YES from PEP, it forwards the RSVP message.
12. All nodes process RSVP message(forwarding/response)
13. The Ethernet switches are configured
14. LSP is set up and traffic can flow



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## Token based GMPLS Demo at SC '06



NSF

DRAGON Project



# Leading principles

(in random order)

- Invent solutions that scale
- No single point of failure (no hostmapfile)
- Keep information at the source/owner
  - so that it can be up to date at all times
- Allow every kingdom to implement its own policy, implementation, not invented here...
- Interfaces, protocols, api's count
  - not implementations per-se



# What are the hot topics in engineering e-Infrastructures?

- Middleware is the key to unlock the tremendous capacity in dark fiber networks
  - RDF, policy, addressing & routing
  - make these networks functions in WFM systems
  - make infrastructure part of the programming model of Applications
- Utilize the capacity
  - few Tbit/sec/fiber => few 100 times 10 Gbit/s
- reduce cost and complexity of grooming and switching
- power per bit, power per multiplication, etc.
  - 250 W/10 Gbit -> few times 25 kW/fiber/side for > L0
  - costs ~ 1 kEuro (= ~ k\$) per kW per year



# Revisiting the truck of tapes

## Consider one fiber

- Current technology may allow 320  $\lambda$  in the frequency bands
- Each  $\lambda$  has a bandwidth of 40 Gbit/s
- Transport:  $320 * 40 * 10^9 / 8 = 1600$  GByte/sec (160 kW)
- Take a 10 metric ton truck
  - One tape contains 50 Gbyte, weights 100 gr
  - Truck contains  $( 10000 / 0.1 ) * 50$  Gbyte = 5 PByte
- Truck / fiber =  $5 \text{ PByte} / 1600 \text{ GByte/sec} = 3125 \text{ s} \approx \text{one hour}$
- For distances further away than a truck drives in one hour (50 km) minus loading and handling 100000 tapes **the fiber wins!!!**
- Note: a 220 hp truck uphill also uses 160 kW!



# Questions?

This work is supported by  
SURFnet / GigaPort  
EU - Phosphorus  
EU - NextGrid  
EU - EGEE2  
SARA  
TNO  
NCF