

Network Description Language (NDL) developments

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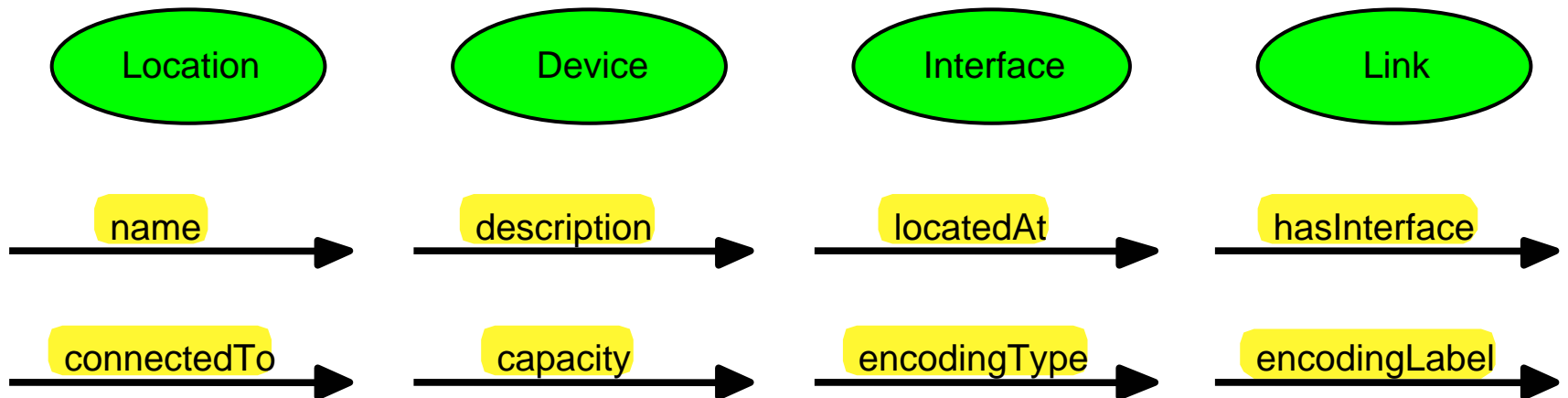
Outline

- Recap: NDL tools
- Supercomputing 2006 demo:
multi domain path finding in the GLIF
- Standardization effort:
NML workgroup in the OGF
- Multi-layer extensions to NDL

Recap: NDL tools

NDL schema

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



Do-it-yourself tools (1/3)

NDL Generator form

An NDL file is automatically generated based on user input:

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

- Location
- Devices
- Interfaces

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

NDL Validator Results

Do-it-yourself tools (2/3)

Your file is valid NDL!

The NDL Validator found the following *warnings*

- Warning: The graph is not completely connected.
- Warning: Device 'http://noc.netherlight.net/netherlight.rdf#tdm3.amsterdam1.netherlight.net' does not have a location.
- Warning: Device 'http://sw1.amsterdam1.netherlight.net#6509' does not have a location.
- Warning: Device 'xnEdtoPI11' does not have a location.
- Warning: Device 'xnEdtoPI14' does not have a location.
- Warning: Device 'xnEdtoPI9' does not have a location.
- Warning: Device 'http://noc.netherlight.net/netherlight.rdf#tdm1.amsterdam1.netherlight.net' does not have a location.
- Warning: Device 'http://rembrandt8.uva.netherlight.nl#Rembrandt8' does not have a name.
- Warning: Device 'http://qc.netherlight.net/netherlight.rdf#tdm3.amsterdam1.netherlight.net' does not have a name.
- Warning: Device 'http://lala.uva.netherlight.nl#Lala' does not have a name.
- Warning: Device 'http://sw1.amsterdam1.netherlight.net#6509' does not have a name.
- Warning: Device 'xnEdtoPI6' does not have a name.
- Warning: Device 'http://npu.uva.netherlight.nl#IDXP2810' does not have a name.
- Warning: Device 'http://vangogh7.uva.netherlight.nl#VanGogh7' does not have a name.
- Warning: Device 'xnEdtoPI1' does not have a name.
- Warning: Device 'http://rembrandt3.uva.netherlight.nl#Rembrandt3' does not have a name.
- Warning: Device 'xnEdtoPI14' does not have a name.
- Warning: Device 'xnEdtoPI9' does not have a name.
- Warning: Device 'http://rembrandt5.uva.netherlight.nl#Rembrandt5' does not have a name.
- Warning: Device 'http://vangogh7.uva.netherlight.nl#VanGogh7' does not have a name.
- Warning: Device 'http://vangogh6.uva.netherlight.nl#VanGogh6' does not have a name.
- Warning: Device 'http://speculaas.uva.netherlight.nl#Speculaas' does not have a name.
- Warning: Device 'http://beautydes.uva.netherlight.nl#BeautyDes' does not have a name.
- Warning: Device 'http://vangogh0.uva.netherlight.nl#VanGogh0' does not have a name.
- Warning: Device 'http://noc.netherlight.net/netherlight.rdf#tdm1.amsterdam1.netherlight.net' does not have a name.
- Warning: Device 'http://rembrandt4.uva.netherlight.nl#Rembrandt4' does not have a name.

NDL Validator

- Syntax MUST be valid

- E.g. has interface 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)

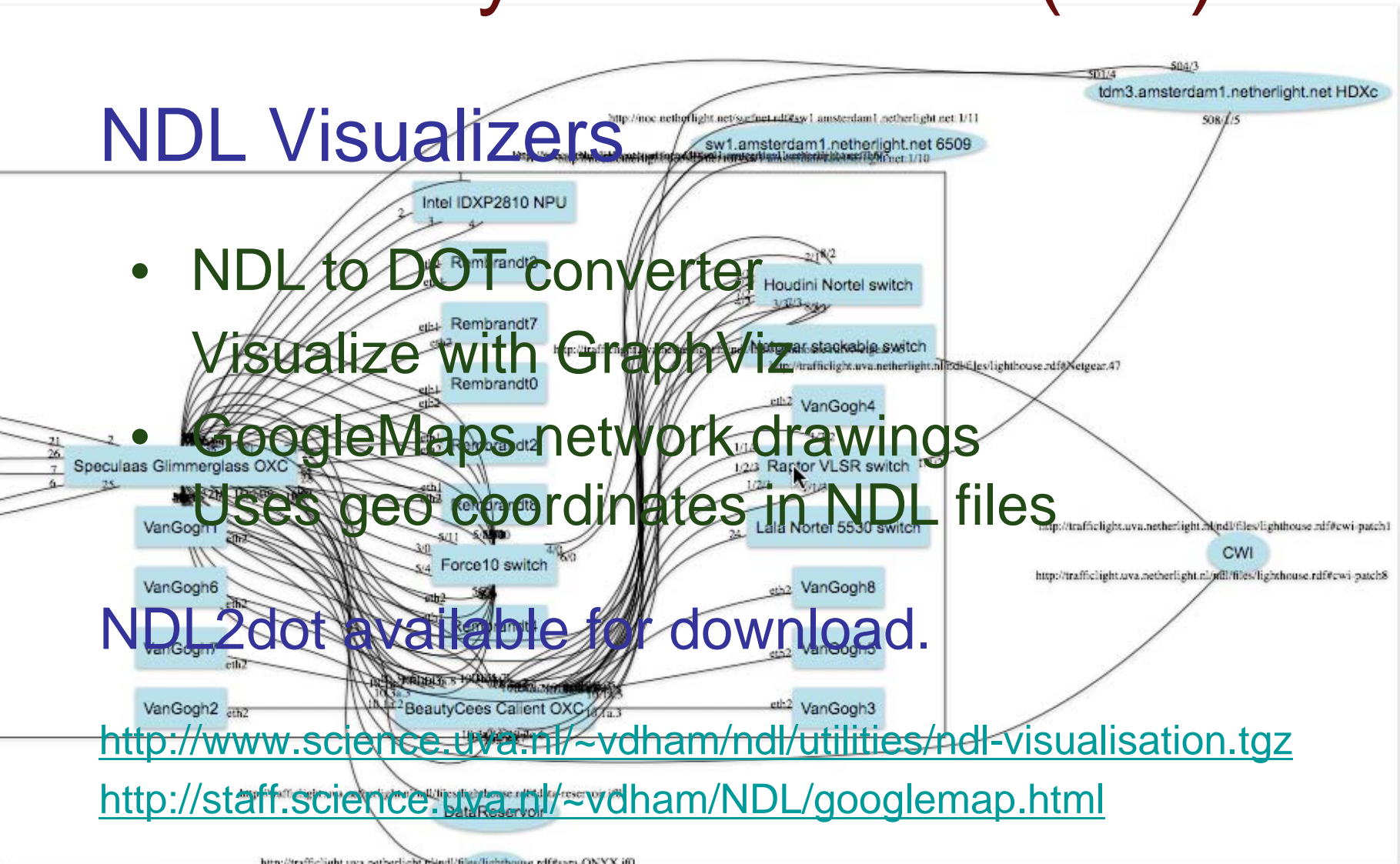
NDL Visualizers

- 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*

GOLEs in NDL

GOLE descriptions:

- either produced by GOLE themselves (presumably using the online form)
- or derived from our interpretation of the available GOLE networks' maps.

GOLE name	Contributed?
NetherLight (RDF)	√
T-Lex (RDF)	√
KR-Light (RDF)	√
HOPI (RDF)	√
Internet2 (RDF)	√
StarLight (RDF)	-
PacificNorthwestern GP (RDF)	-
Canarie (RDF)	-
ManLan (RDF)	-
CERN (RDF)	-
HK-Light (RDF)	-
NorthernLight (RDF)	-
UK Light (RDF)	-

Distributed NDL files

Each GOLE maintains their own NDL file.

For example: <http://www.t-lex.net/t-lex.ndl>

Crawlers can collect this distributed information.

```
<rdf:RDF>
<!-- Description of T-LEX-->
<ndl:Location rdf:about="#T-LEX">
  <ndl:name>T-LEX</ndl:name>
  <geo:lat>35.684788</geo:lat>
  <geo:long>139.770896</geo:long>
</ndl:Location>
<!--ONS-15454-->
<ndl:Device rdf:about="#ONS-15454">
  <ndl:name>ONS-15454</ndl:name>
  <ndl:locatedAt rdf:resource="#T-LEX"/>
  <ndl:hasInterface rdf:resource="#ONS-
15454:12/1"/>
```

SC|06 demonstration

A path finding application that used the distributed NDL files from the GOLEs.



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A web interface to choose:

Starting location/device/interface

Destination location/device/interface

A web services interface (WSDL file)

A path finding algorithm based on the Dijkstra algorithm.

The graphical representation of the found path

Multi-Domain Pathfinding in GLIF

SC|06 Form

Multi-Domain

Several exchange points in GLIF have published NDL descriptions of their networks. We crawl these descriptions and create an overview of the global network.

Path-Finding

Using the global overview, we have created a web-service that can calculate paths across this network.

The form below is generated from the output of the web-service, so you can select devices and their interfaces from the whole GLIF network and request for paths between them.

Select a starting-point: HOPI Los Angeles | hopi-losa-force10 | t1/0

Select an end-point: Netherlight | tdm3.amsterdam1.ne | 501/1

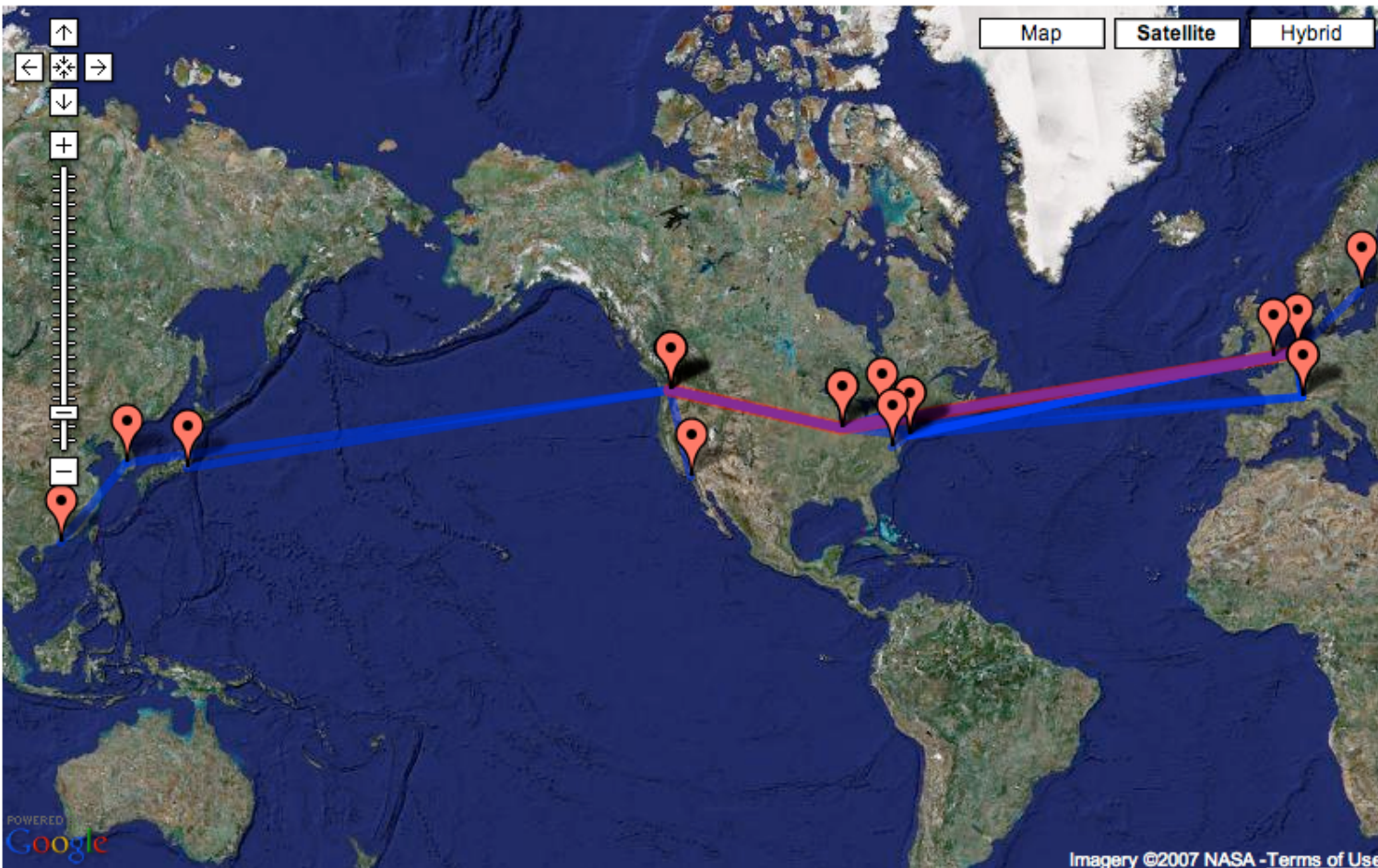
NDL GOLE and Network Descriptions

Below is an overview with links to the used GOLE and Network Descriptions. The table also shows whether they were provided by the GOLE or provider themselves, or whether these descriptions are our own interpretations.

GOLE name	Contributed?
NetherLight (RDF)	✓
T-Lex (RDF)	✓
KR-Light (RDF)	✓
HOPI (RDF)	✓
Internet2 (RDF)	✓
StarLight (RDF)	-
PacificNorthwestern_GP (RDF)	-
Canarie (RDF)	-

<http://traffilight.science.uva.nl/NDL-demo/sc-demo-test/pathfind-new.htm>

SC|06 result



In blue the
GLIF
network;

in red the
found path
between
PNWGP
and
Netherlight.

Looking back

- GOLE descriptions in NDL
- Beyond the GLIF. NDL descriptions of:
 - Internet2 network
 - OptIPuter / UCSD campus network
- Demonstration at SC|06
Multi-domain path finding in the GLIF

<http://trafficlight.uva.netherlight.nl/NDL-demo/sc-demo-test/pathfind-new.htm>

Standardization effort:
NML workgroup in the OGF

Looking ahead

- As a community we need to consolidate our network descriptions and standardize the schema used.
- NDL can allow to find 'simple' paths.
- For more realistic path finding and provisioning we need multi-layer description of the devices.
This is the focus of our current work.

Future of NDL: research or stable tool?

NDL works best if many people use it.

The community at large benefits from a stable version of NDL.

However, we do research, and want to be able to change the schema to test new ideas.

The solution: standardize a network description language in the OGF, while keeping a separate version which may be prone to quick changes.

OGF NML-WG

Open Grid Forum - Network Markup Language workgroup

Chairs:

Paola Grosso – Universiteit van Amsterdam (UvA)

Martin Swany – University of Delaware (PerfSONAR)

Purpose:

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

NML-WG: Scope

Scope/goal: one or more schemas to describe:

- a layer independent network topology
- properties that are common across multiple network technologies,
- a mechanism so that other working groups or other projects may combine technology specific schemas with the schemas created by the NML working group.

Such a schema can be used to create inter-domain network graphs at various abstraction levels, to provide an information model for service discovery, and to facilitate lightpath provisioning.

NML-WG: Starting Points

- NDL: an RDF Schema
(including multi-layer extensions)
- XML Schema used for PerfSONAR
(as defined by the Network Measurement
workgroup in the OGF)

First meeting at OGF 20 (Jan 2007)

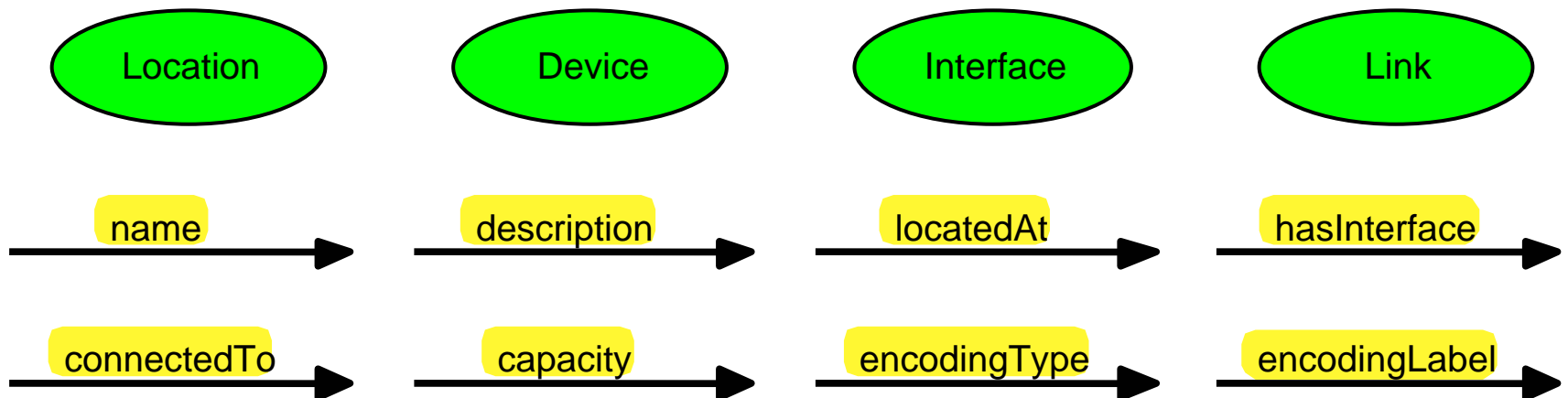
<https://forge.gridforum.org/sf/projects/nml-wg>

Off-line discussions in January between Martin Swany,
people from University of Amsterdam, from Max
Gigapop and from Internet2.

Multi-layer extensions to NDL

NDL v1 schema

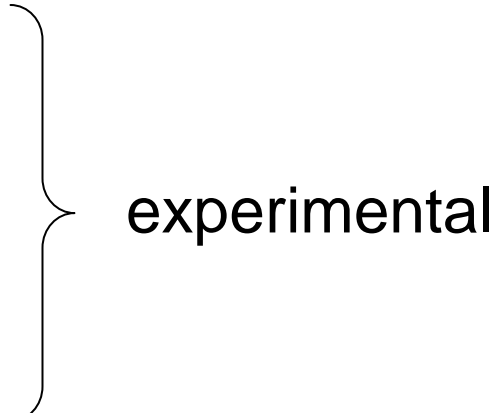
This NDL schema allows for description of networks at a single layer.



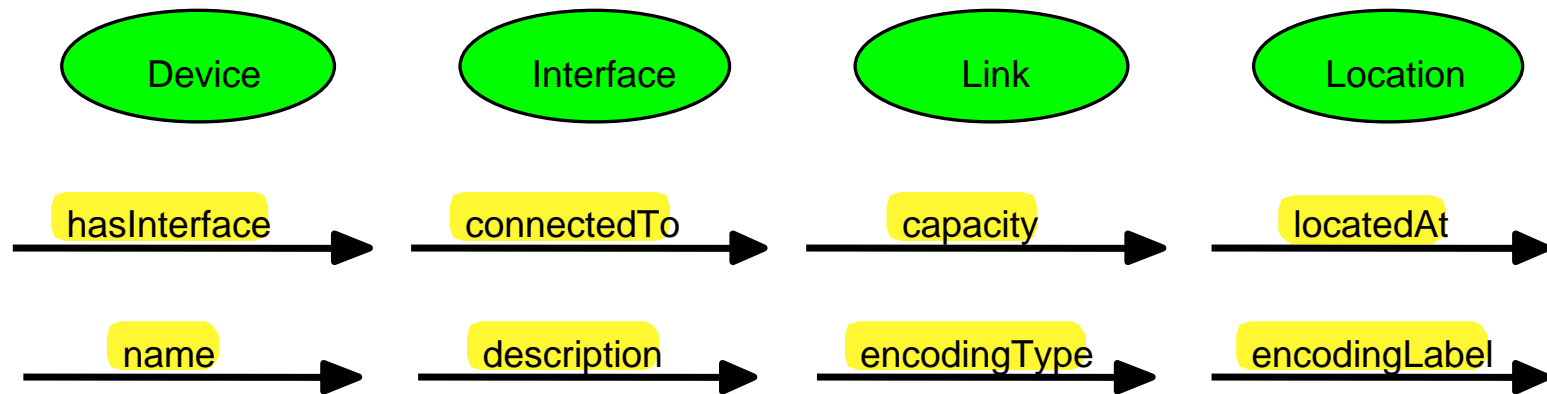
We wanted more...

- Describe a **topology** (current NDL)
- Describe a device **configuration**
- Describe a **specific technology**
(Layer, Label Type, Adaptation)
- Describe **device capabilities**
- Describe **domain** abstractions
- Describe **path request**
(application specific topology)

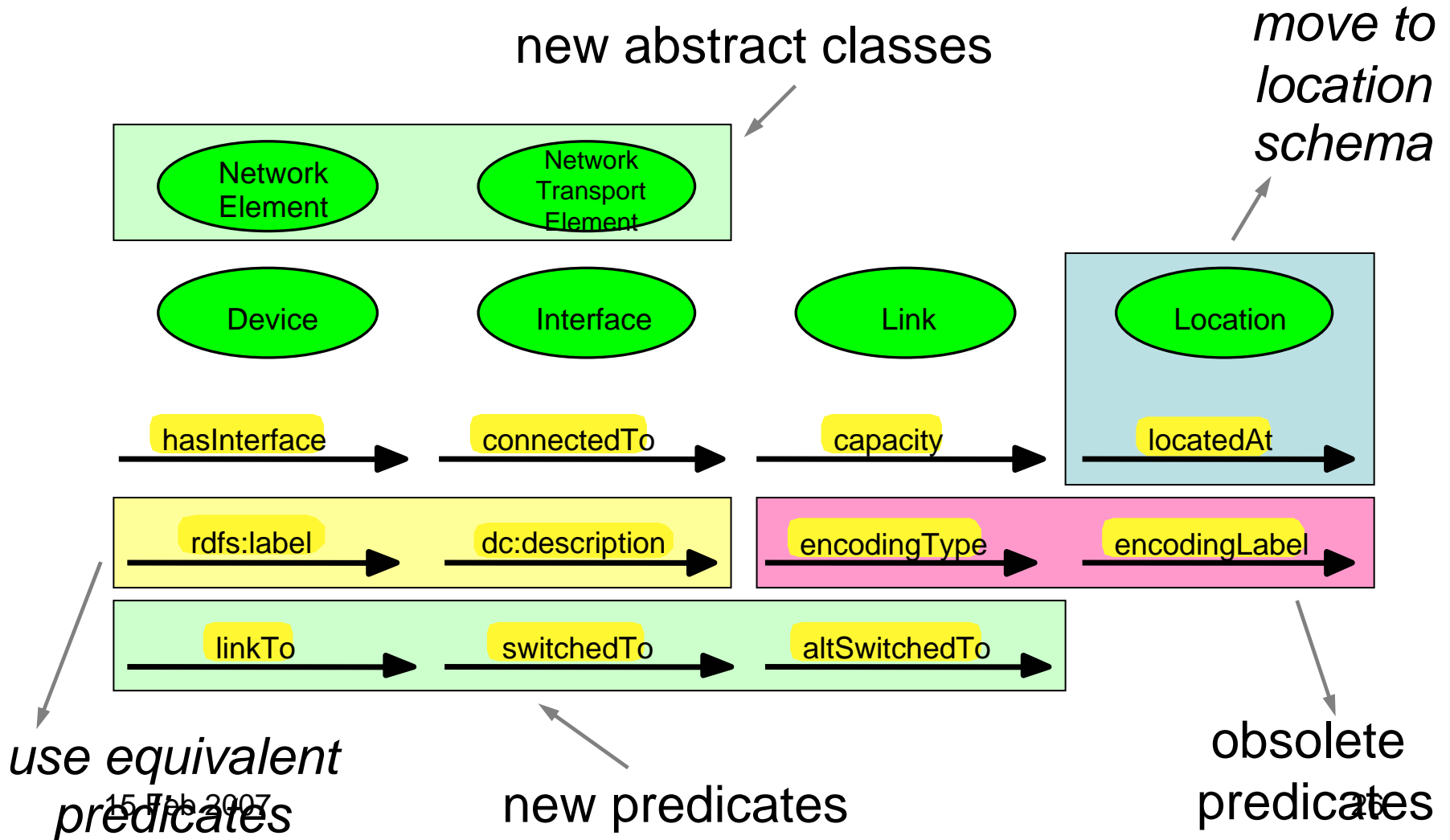
NDL v2 Schemas

- Topology schema
existing NDL schema + internal connections within a device
 - Layer schema
based on G.805 functional elements
 - Capability schema
 - Domain schema
including service pointers
 - Location schema
including CIM physical properties
- 
- experimental

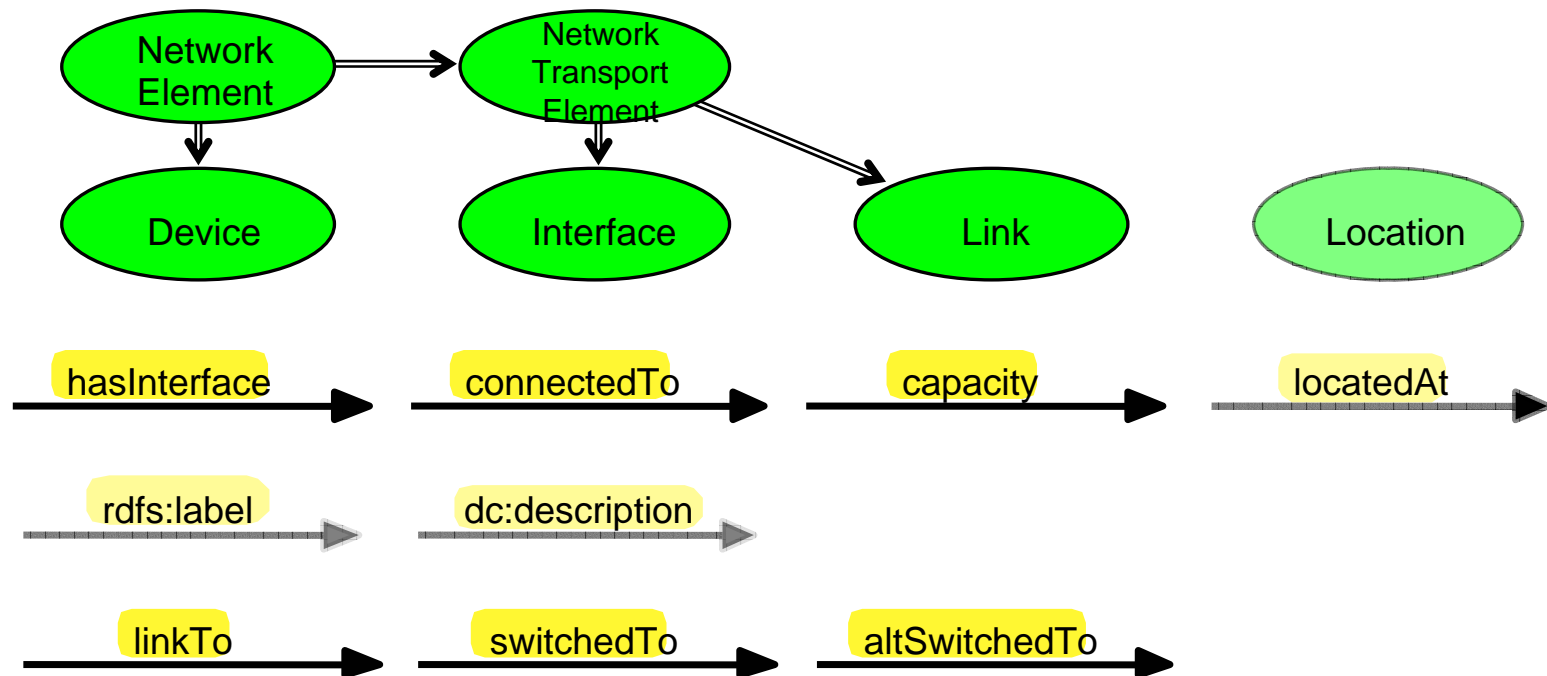
NDL v1 Schema



Schema Changes



NDL Topology v2 Schema

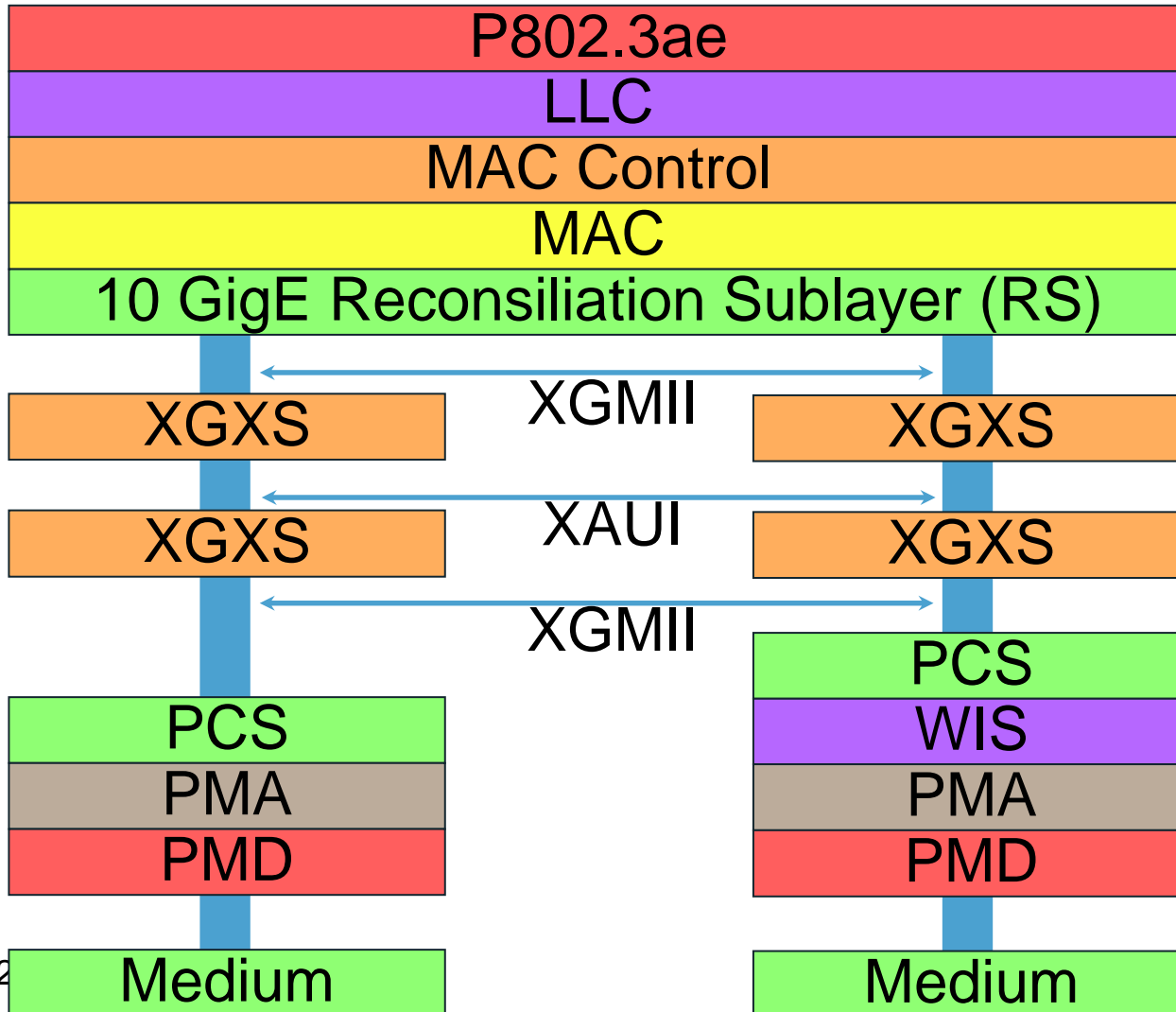


Why Multi-layer NDL?

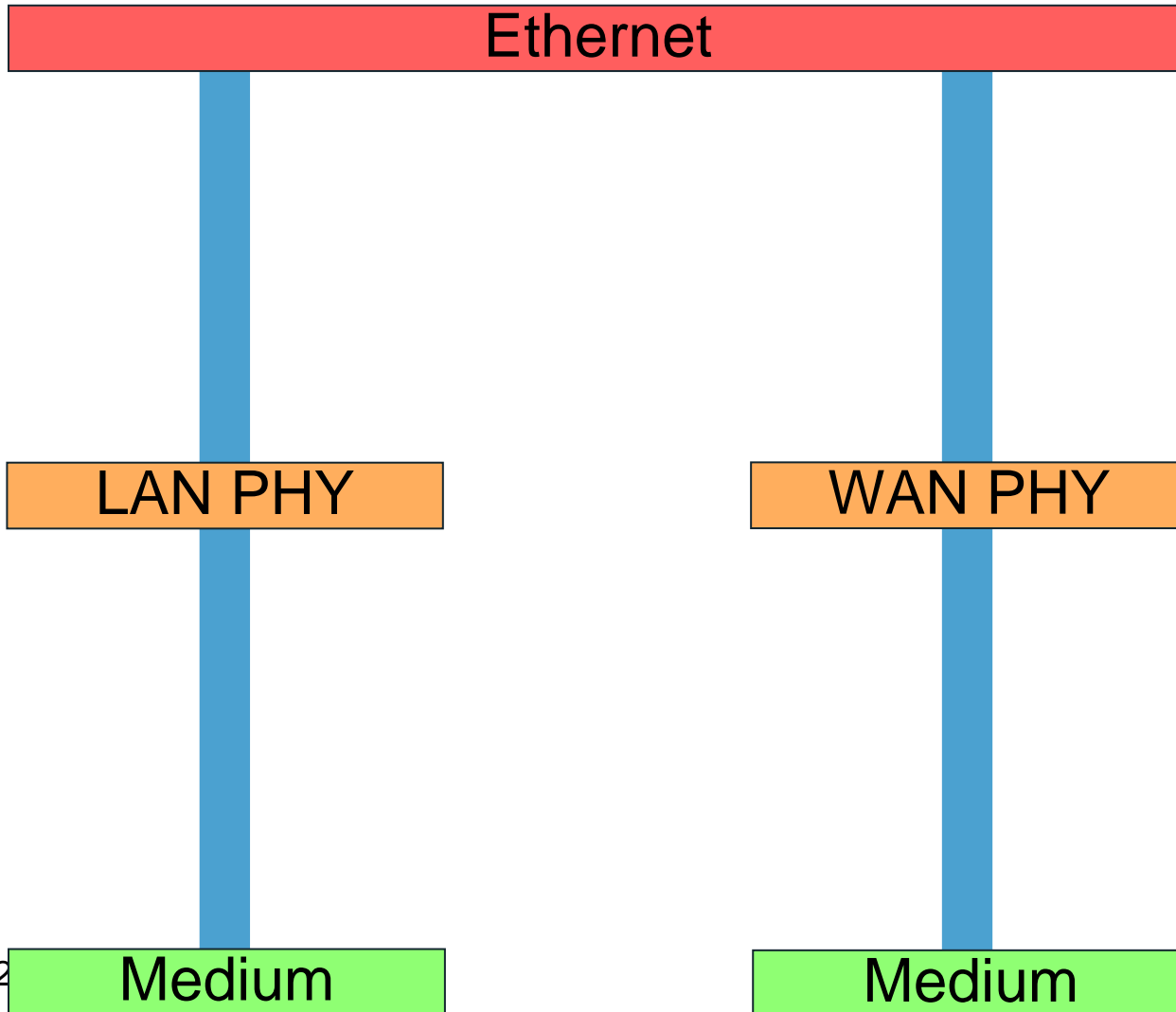
- Target applications:
 - Visualization
 - Path finding
(find incompatibilities. E.g. conflicting wavelengths, different adaptation, incompatible MTU sizes)
 - Fault isolation
(required network connection description)

The last two items require multi-layer network descriptions.

Describe All Layers?



Or Only Possible Incompatibilities?



Multi-Layer NDL

- Layer schema is used to describe technologies
(thus does not describe technologies itself)
- Flexible
(can describe technologies in multiple ways)

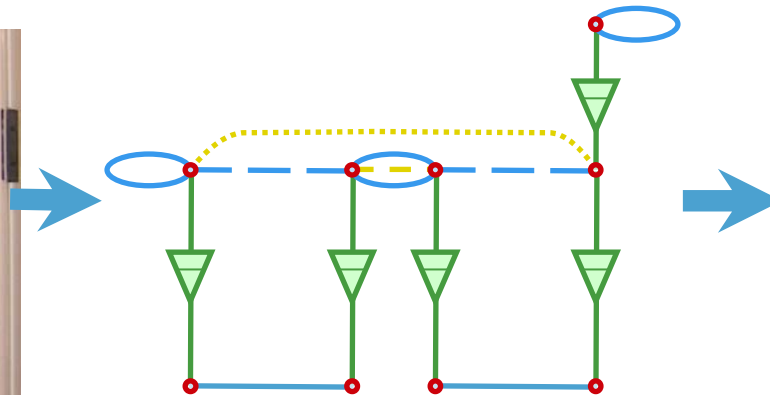
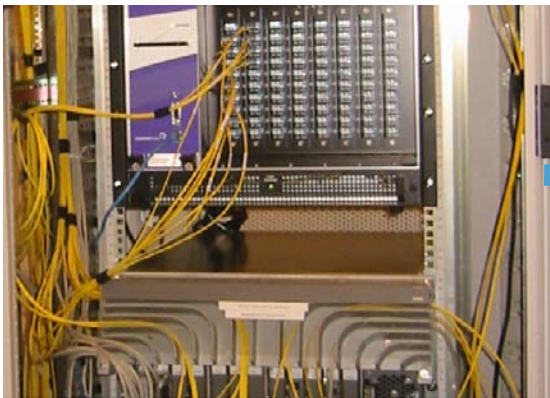
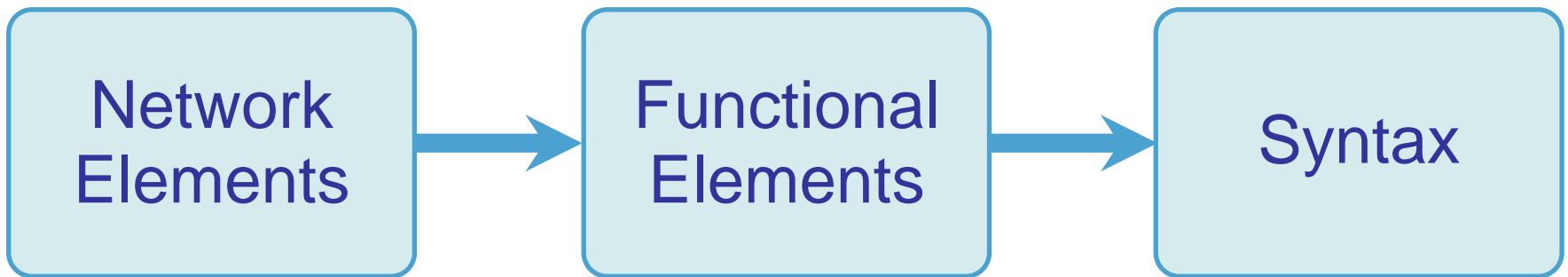
Non-goals:

- Packet networks (MAC, IP): describes those as large broadcast networks (not true for IP)
- Physical properties: very limited concept of regeneration
- But: can be included with other schemas (that's the strength of RDF)

Existing Models

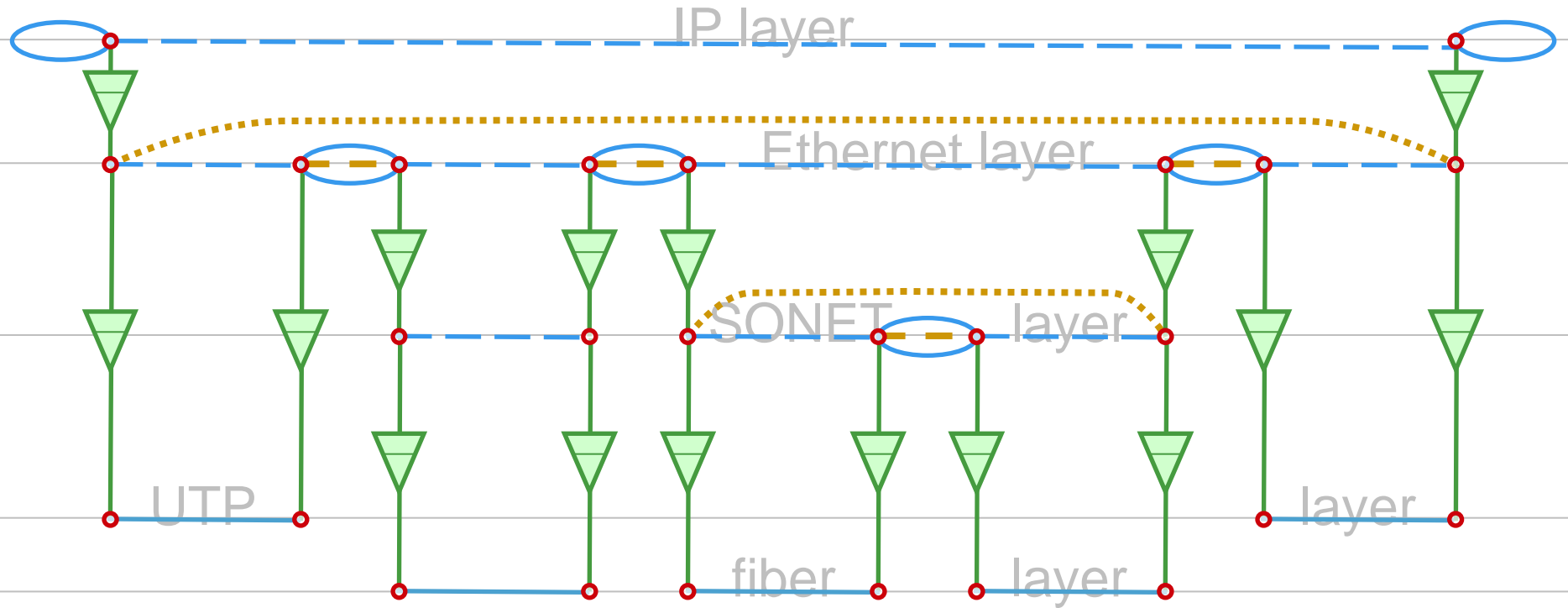
- Graph Theory
- GMPLS: switching based on labels
- ITU-T G.805 (functional elements)
Originally for network connections, but extended to describe networks

Model versus Syntax



```
<ndl:Device rdf:about="#Force10">
  <ndl:hasInterface rdf:resource=
    "#Force10:te6/0"/>
</ndl:Device>
<ndl:Interface rdf:about="#Force10:te6/0">
  <rdfs:label>te6/0</rdfs:label>
  <ndl:capacity>te6/0</ndl:capacity>
  <ndlconf:multiplex>
    <ndicap:adaptation rdf:resource=
      "#Tagged-Ethernet-in-Ethernet"/>
    <ndlconf:serverPropertyValue
      rdf:resource="#MTU-1500byte"/>
  </ndlconf:multiplex>
  <ndlconf:hasChannel>
    <ndlconf:Channel rdf:about=
      "#Force10:te6/0:vlan4">
      <ndleth:hasVlan>4</ndleth:hasVlan>
      <ndlconf:switchedTo rdf:resource=
        "#Force10:gi5/1:vlan7"/>
    </ndlconf:Channel>
  </ndlconf:hasChannel>
</ndl:Interface>
```

Layer schema based on G.805



End host Ethernet/SONET switch Ethernet/SONET switch SONET switch Ethernet/SONET switch End host



Technologies

Test cases for the layer schema:

- IP layer
- Ethernet (MAC + LAN/VLAN layers)
- ATM (AAL5/VCI + VPI (NNI/UNI) + cell layers)
- SONET/SDH (15 (!) layers as RFC 4606)
- WDM (Lambda + Fiber layers)
- Copper (UTP) layer
- Bundle layer (multiple fibers in a single duct)

And even: PPP, MPLS, L2TP, 802 Wireless

Applications in Development

- Configuration of devices
- Path Walk (given an end-point, find the destination)
- Fault Isolation
- Path Finding (must be a combination of topology, technology constraints, policy and scheduling/reservation)

<http://ndl.uva.netherlight.nl/>

Questions?