OnVector 2009:
Topology handling in GLIF

Cees de Laat

GLIF.is founding member

SURFnet

EU

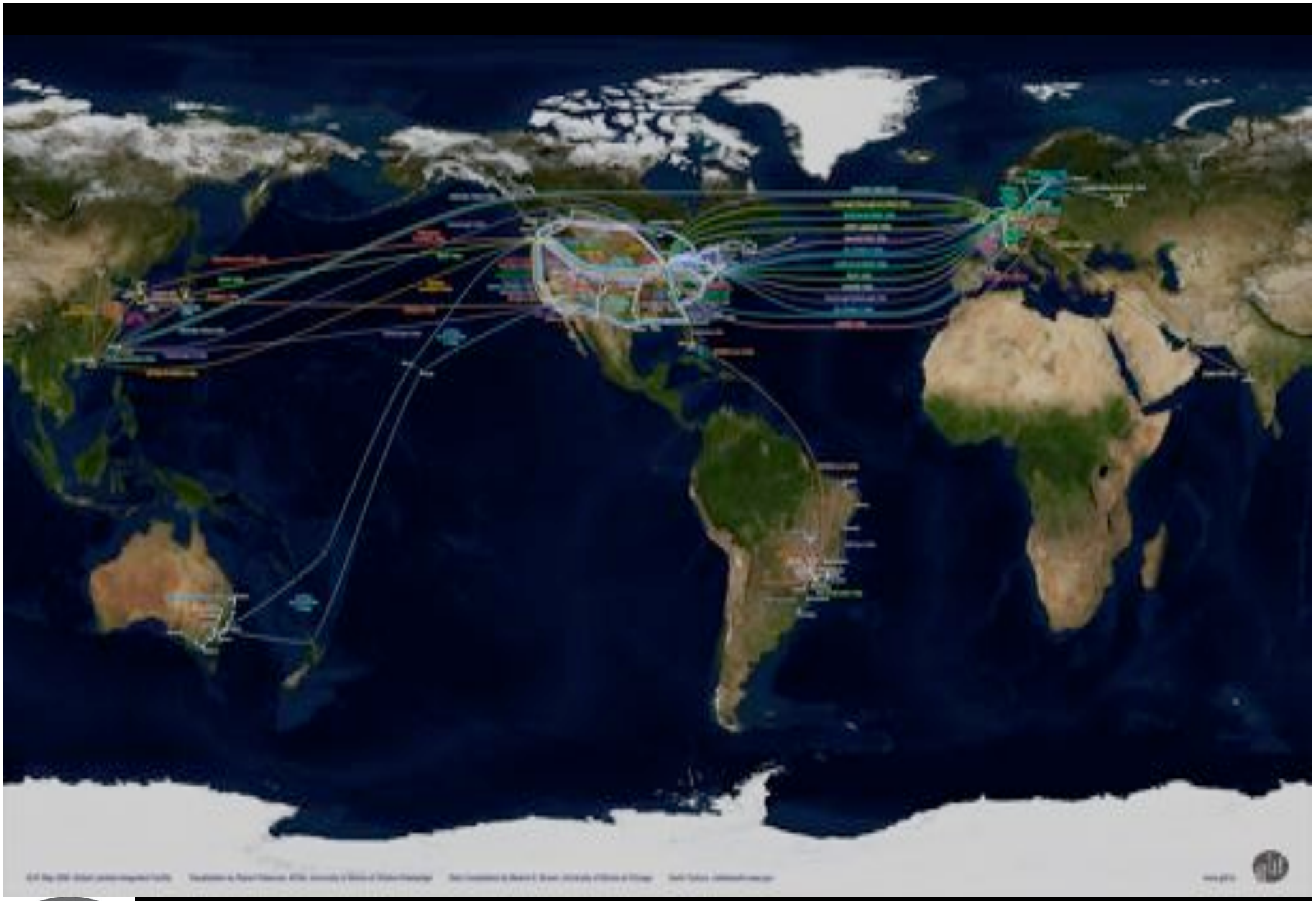
BSIK

NWO

University of Amsterdam

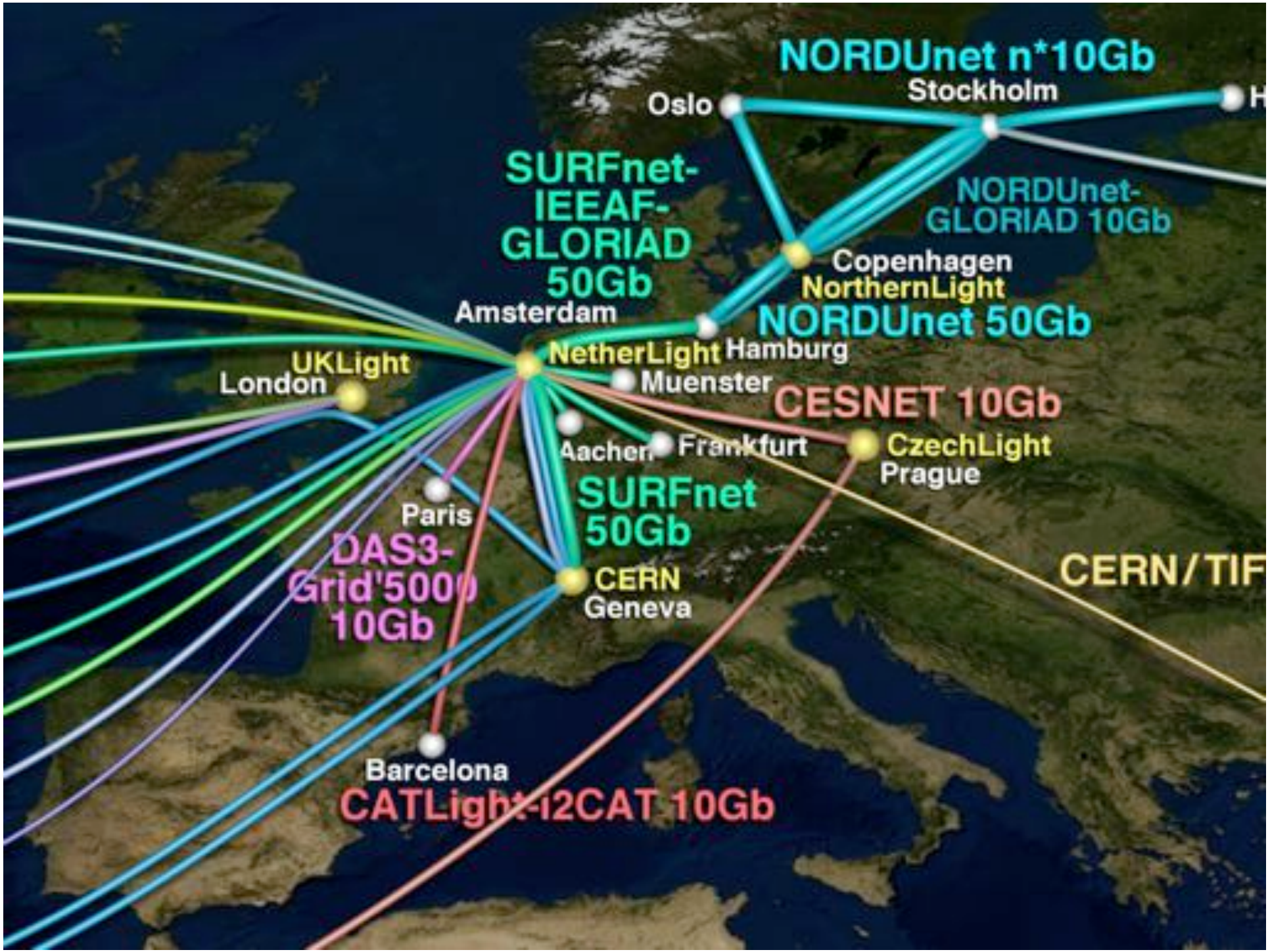
TNO

NCF

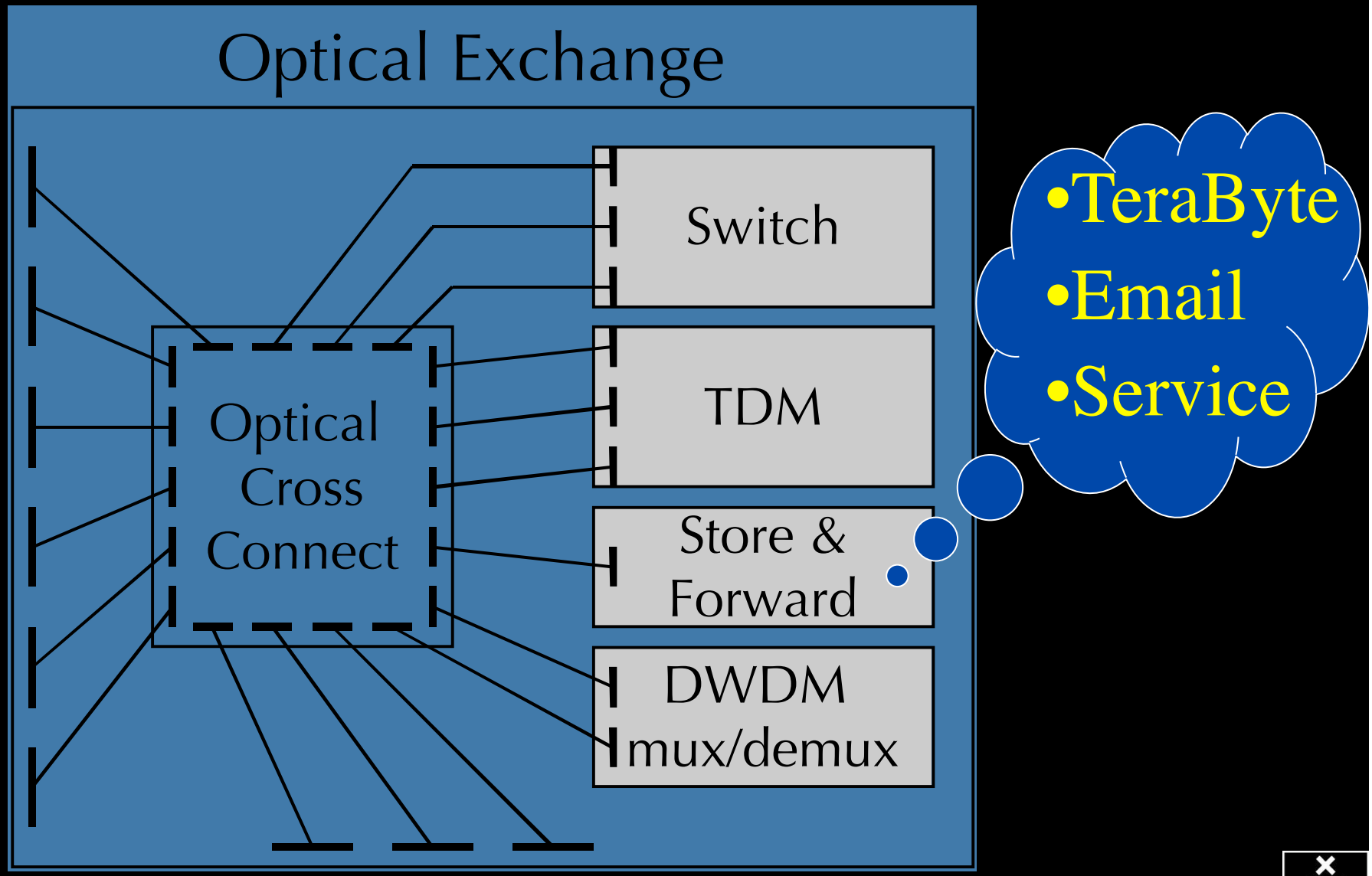


GLIF 2008

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


NORDUnet n*10Gb
Stockholm
Oslo
SURFnet-
IEEAF-
GLORIAD
50Gb
NORDUnet-
GLORIAD 10Gb
Copenhagen
NorthernLight
NORDUnet 50Gb
Amsterdam
NetherLight
Hamburg
UKLight
London
Muenster
CESNET 10Gb
Aachen
Frankfurt
CzechLight
Prague
SURFnet
50Gb
Paris
DAS3-
Grid'5000
10Gb
CERN
Geneva
CERN/TIF
Barcelona
CATLight-I2CAT 10Gb

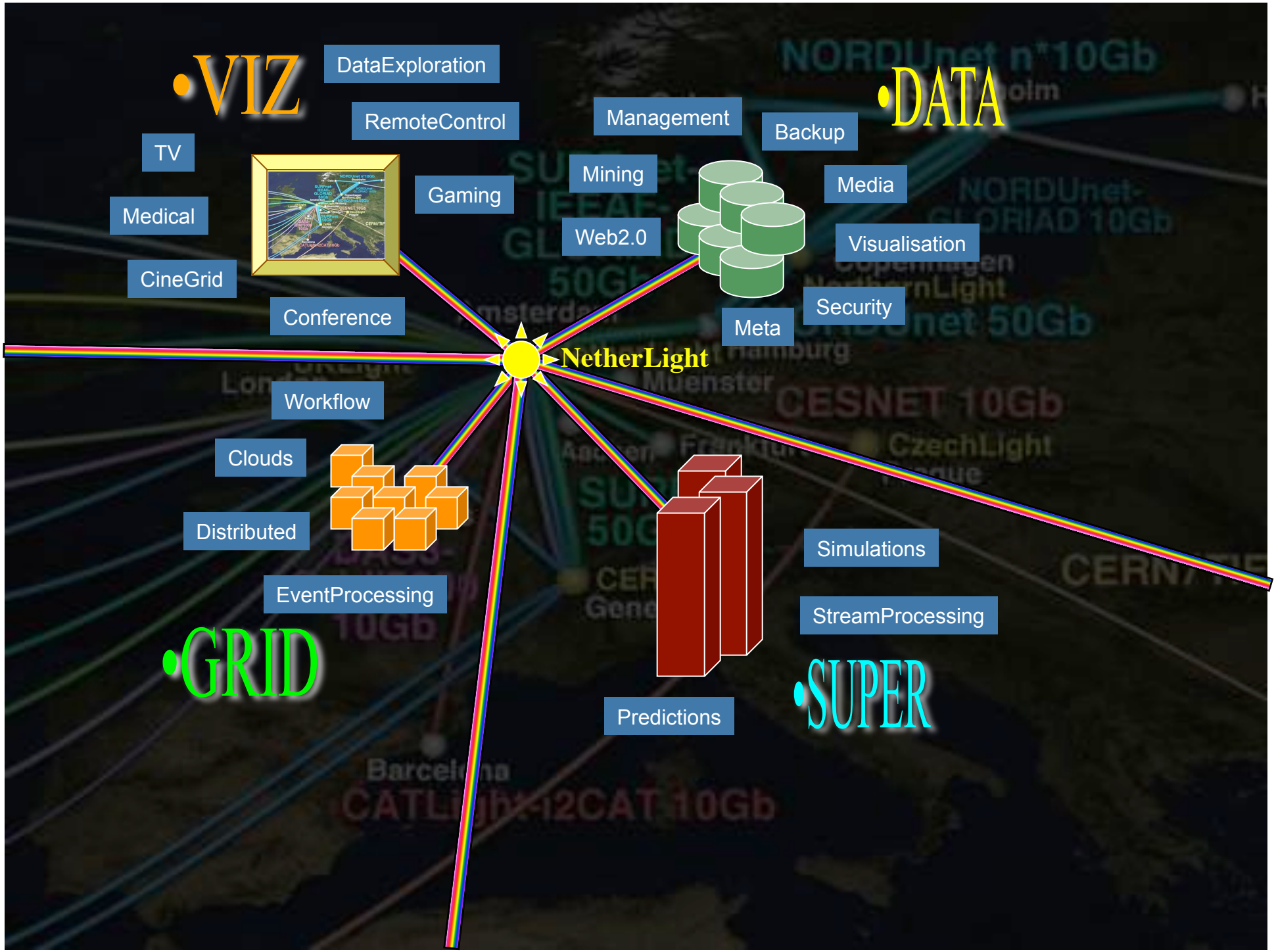
Optical Exchange as Black Box



Freek Dijkstra, Cees de Laat, "Optical Exchanges", GRIDNETS conference proceedings, oct 2004

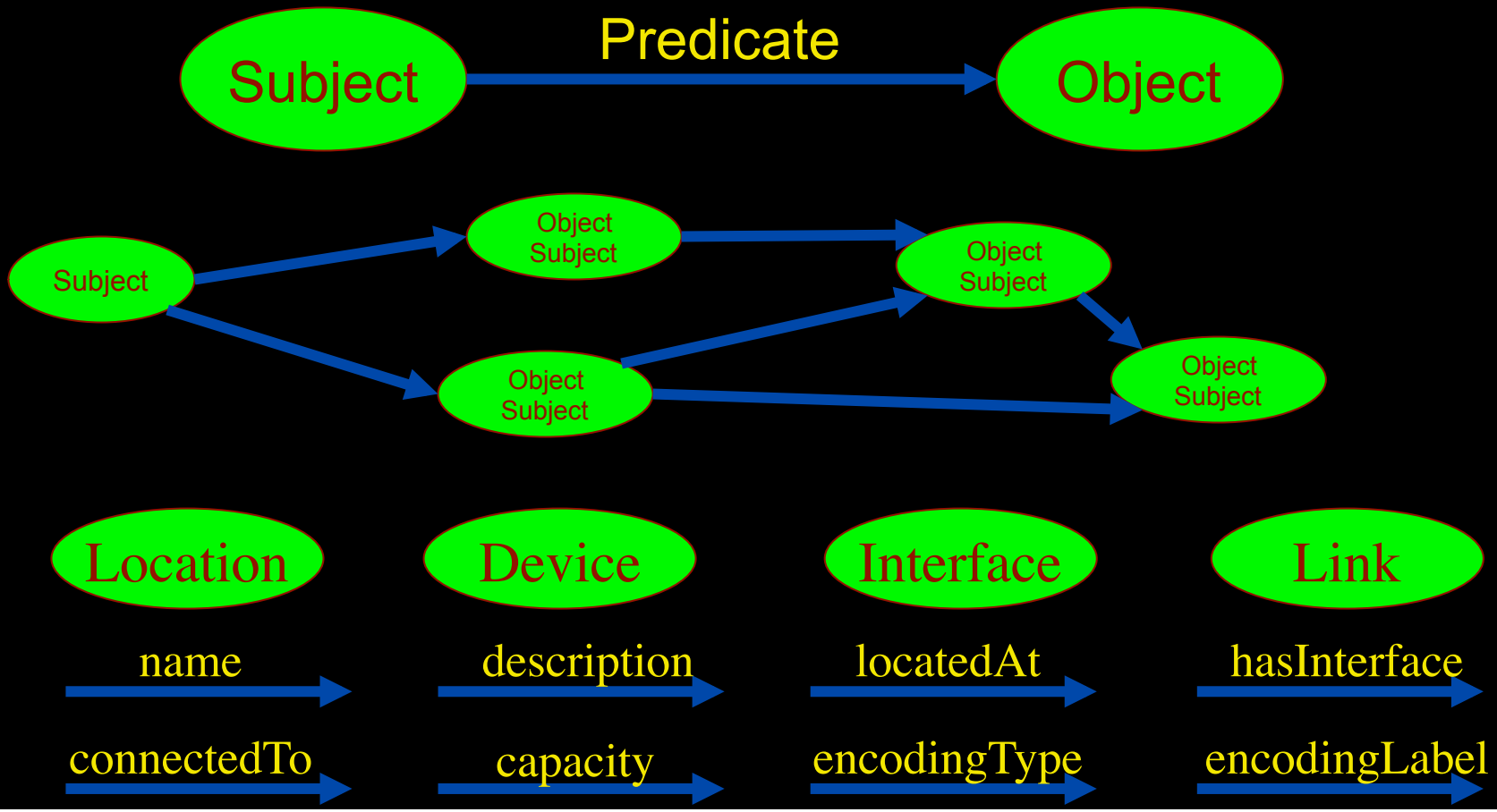
Service Matrix

To / From	WDM (multiple λ)	Single λ, any bitstream	SONET/ SDH	1 Gb/s Ethernet	LAN PHY Ethernet	WAN PHY Ethernet	VLAN tagged Ethernet	IP over Ethernet
WDM (multiple λ)	cross-connect multicast, regenerate, multicast	WDM demux	WDM demux*	WDM demux *	WDM demux *	WDM demux *	WDM demux *	WDM demux *
Single λ, any bitstream	WDM mux	cross-connect multicast, regenerate, multicast	N/A *	N/A *	N/A *	N/A *	N/A *	N/A *
SONET/SDH	WDM mux	N/A *	SONET switch, +	TDM demux *	TDM demux[6]	SONET switch	TDM demux *	TDM demux *
1 Gb/s Ethernet	WDM mux	N/A *	TDM mux	aggregate, Ethernet conversion +	aggregate, eth. convert	aggregate, Ethernet conversion	aggregate, VLAN encap	L3 entry *
LAN PHY Ethernet	WDM mux	N/A*	TDM mux[6]	aggregate, Ethernet conversion	aggregate, Ethernet conversion +	Ethernet conversion	aggregate, VLAN encap	L3 entry *
WAN PHY Ethernet	WDM mux	N/A *	SONET switch	aggregate, Ethernet conversion	Ethernet conversion	aggregate, Ethernet conversion +	aggregate, VLAN encap	L3 entry *
VLAN tagged Ethernet	WDM mux	N/A *	TDM mux	aggregate, VLAN decap	aggregate, VLAN decap	aggregate, VLAN decap	Aggregate, VLAN decap & encap +	N/A
IP over Ethernet	WDM mux	N/A *	TDM mux	L3 exit *	L3 exit *	L3 exit *	N/A	Store & forward, L3 entry/exit+


•VIZ
DataExploration
RemoteControl
TV
Medical
CineGrid
Conference
Gaming
•DATA
Management
Backup
Mining
Media
Web2.0
Visualisation
Security
Meta
NetherLight
Workflow
Clouds
Distributed
EventProcessing
•GRID
Simulations
StreamProcessing
Predictions
•SUPER

Network Description Language

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

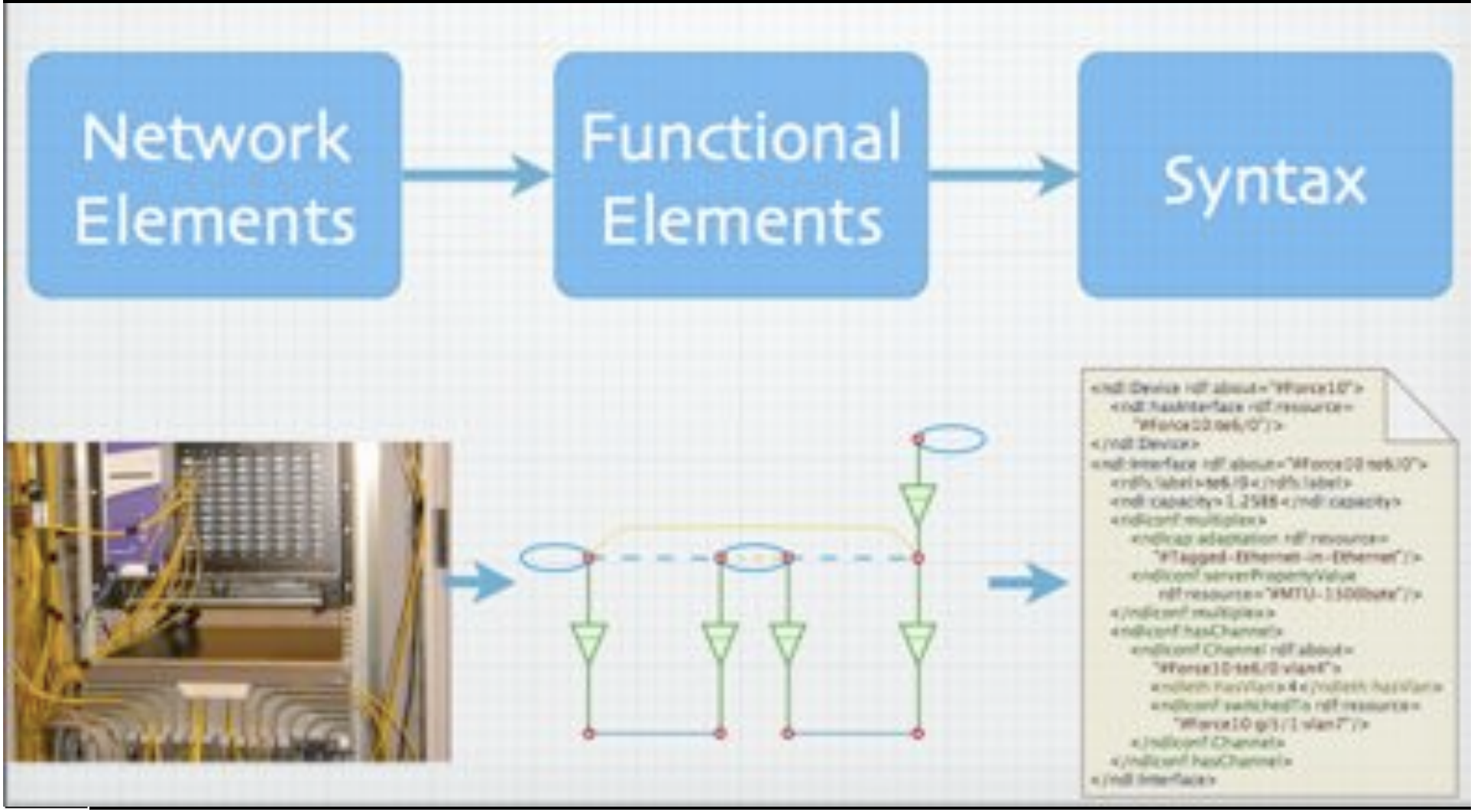


Network Description Language

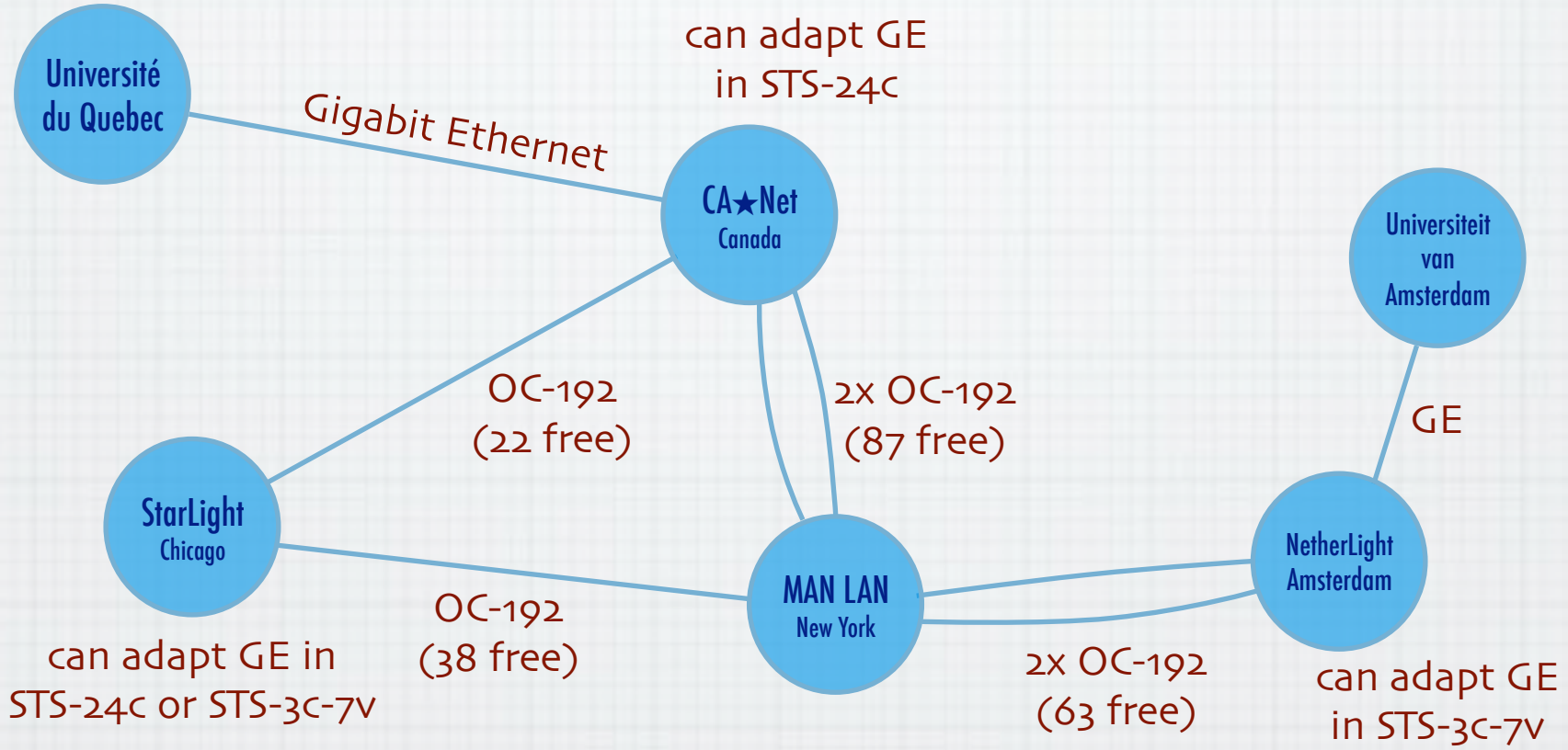
Choice of RDF instead of XML syntax

Grounded modeling based on G0805 description:

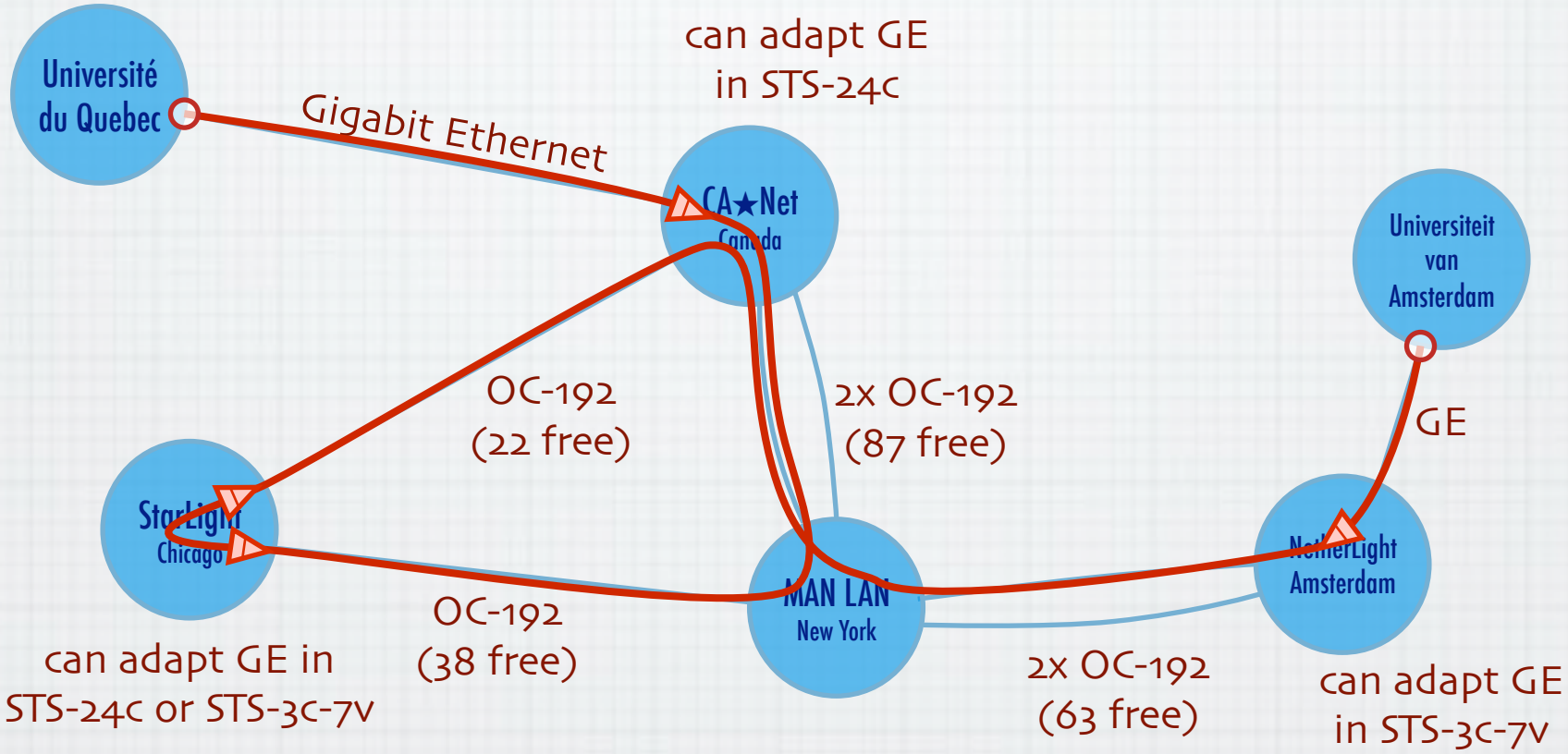
Article: F. Dijkstra, B. Andree, K. Koymans, J. van der Ham, P. Grosso, C. de Laat, *"A Multi-Layer Network Model Based on ITU-T G.805"*



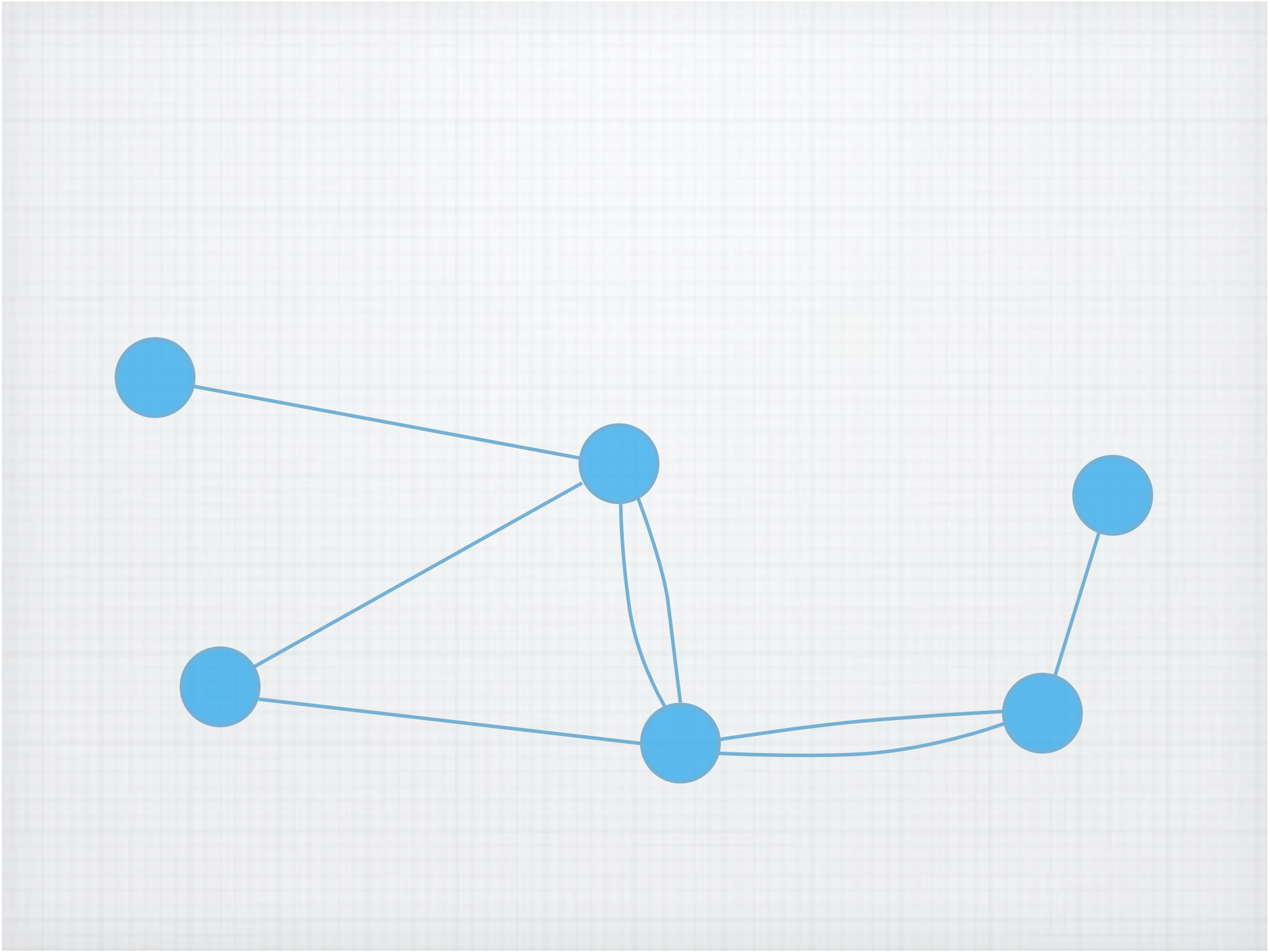
A weird example

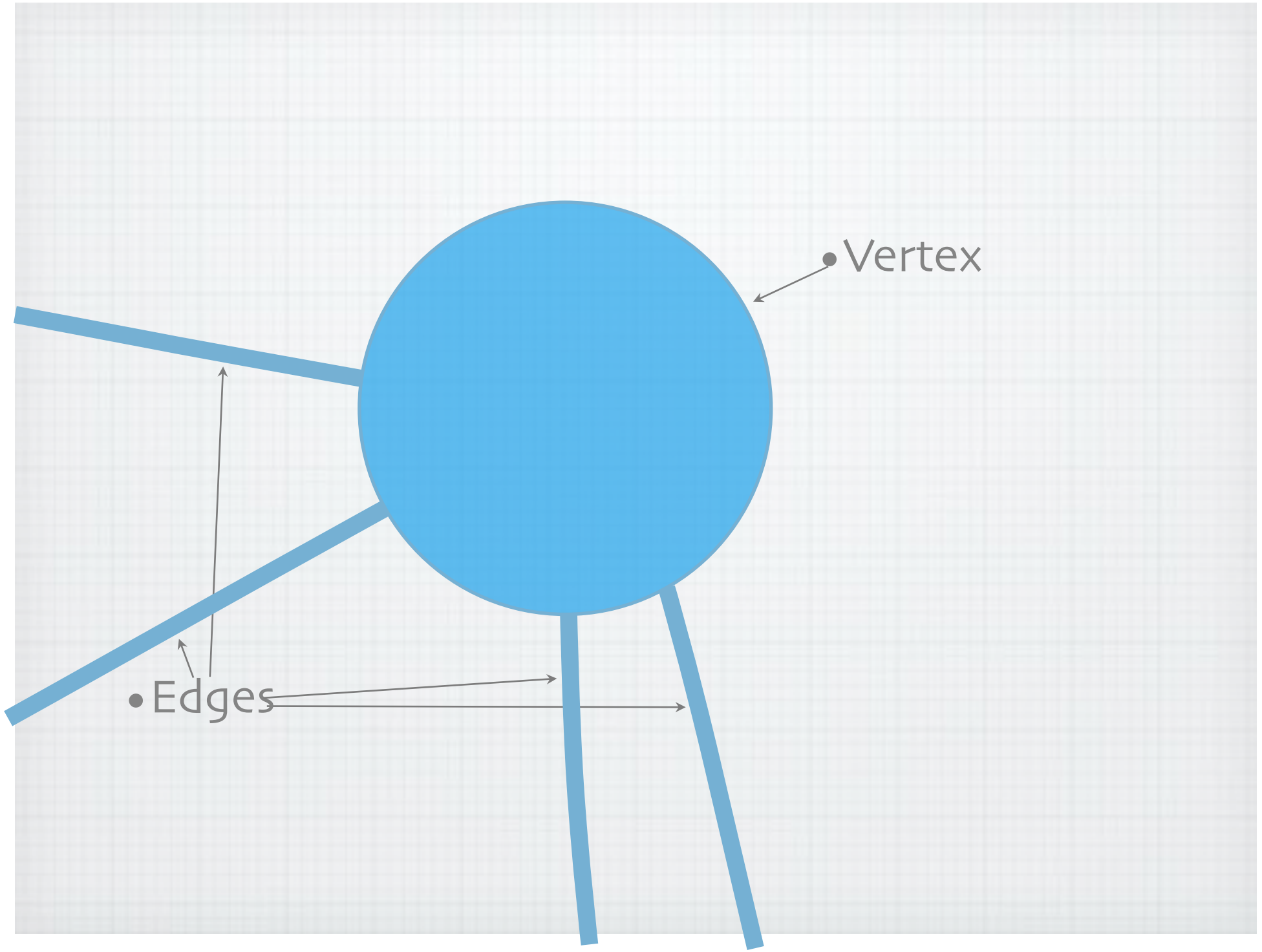


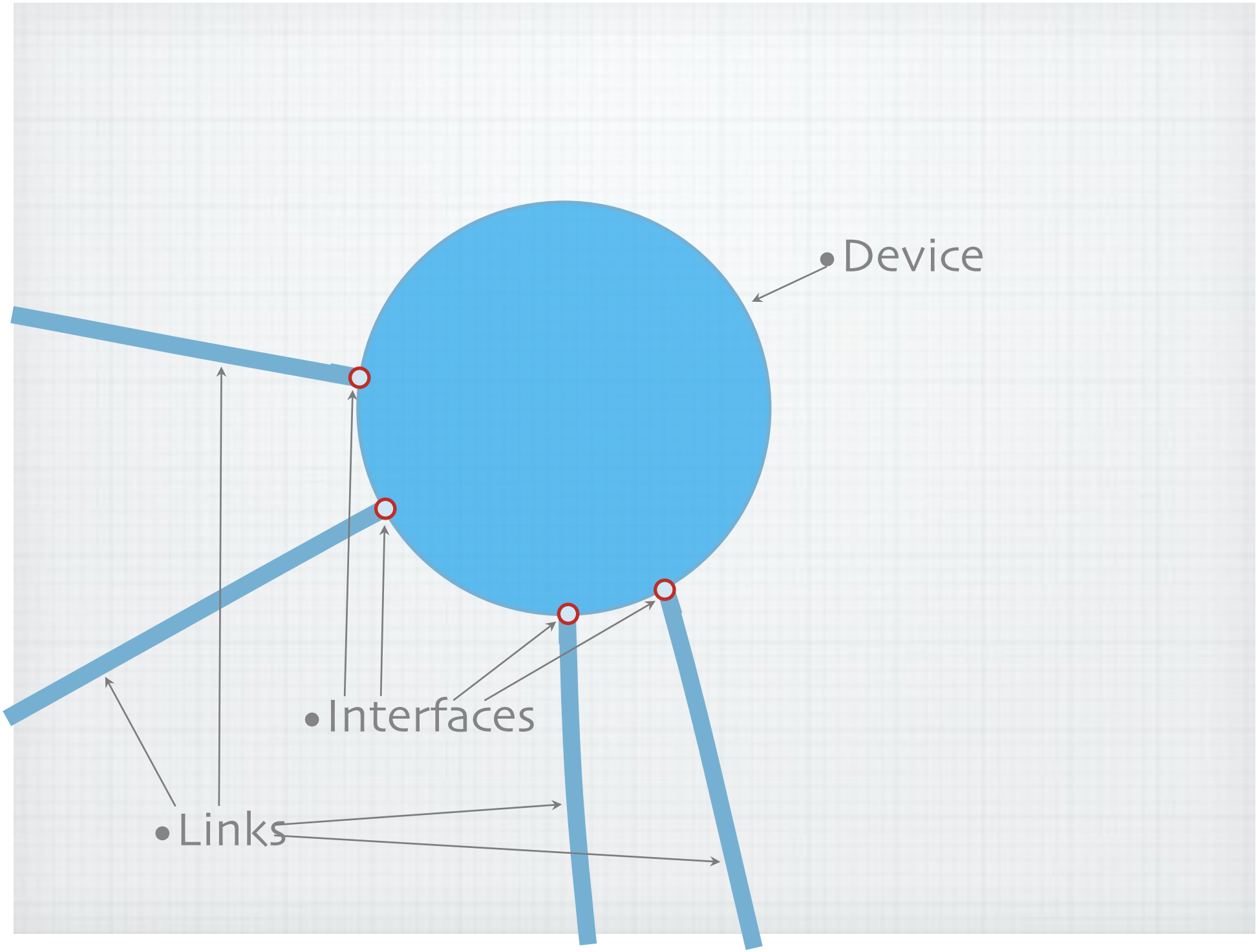
The result :-)

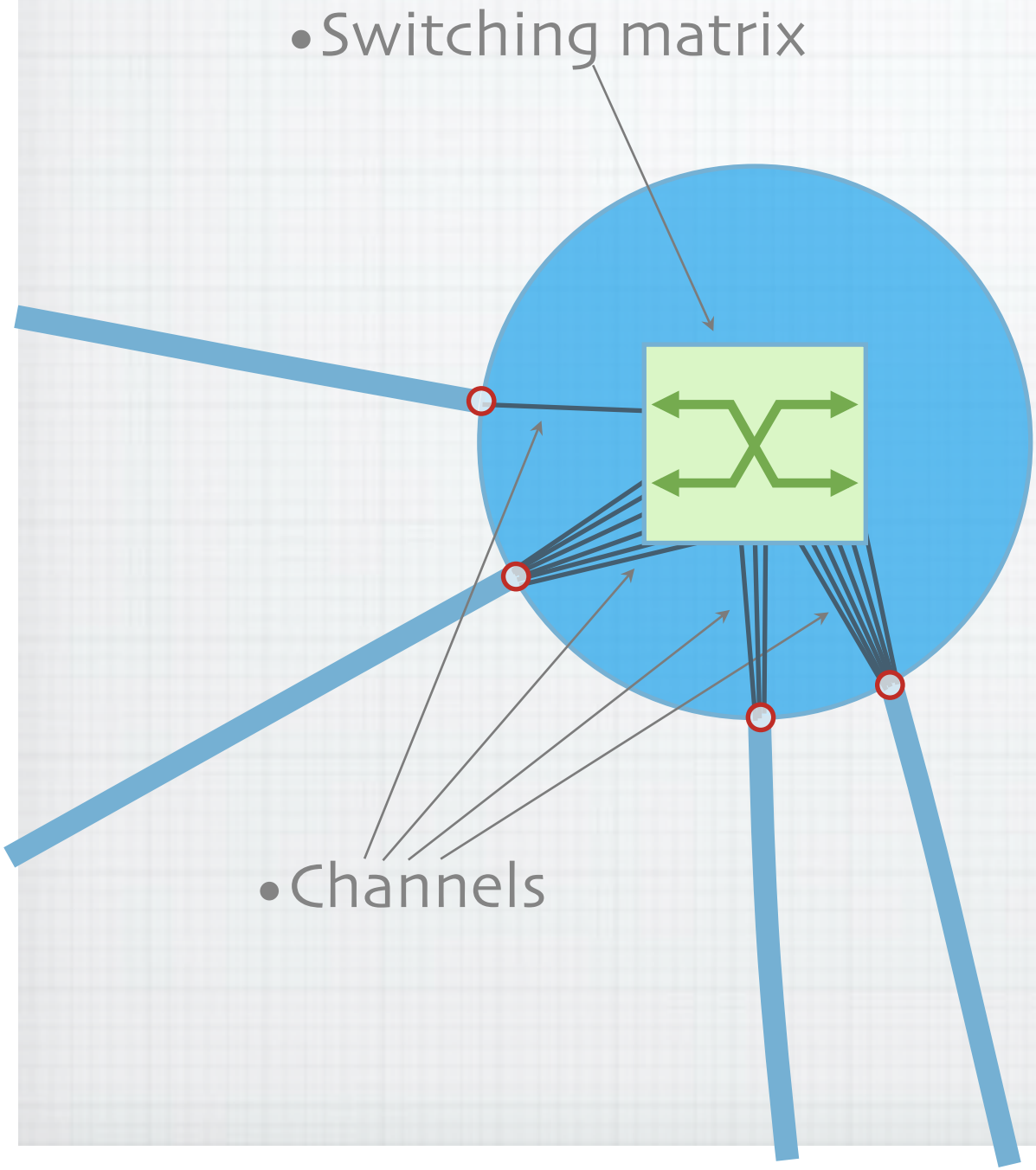


Thanks to Freek Dijkstra & team

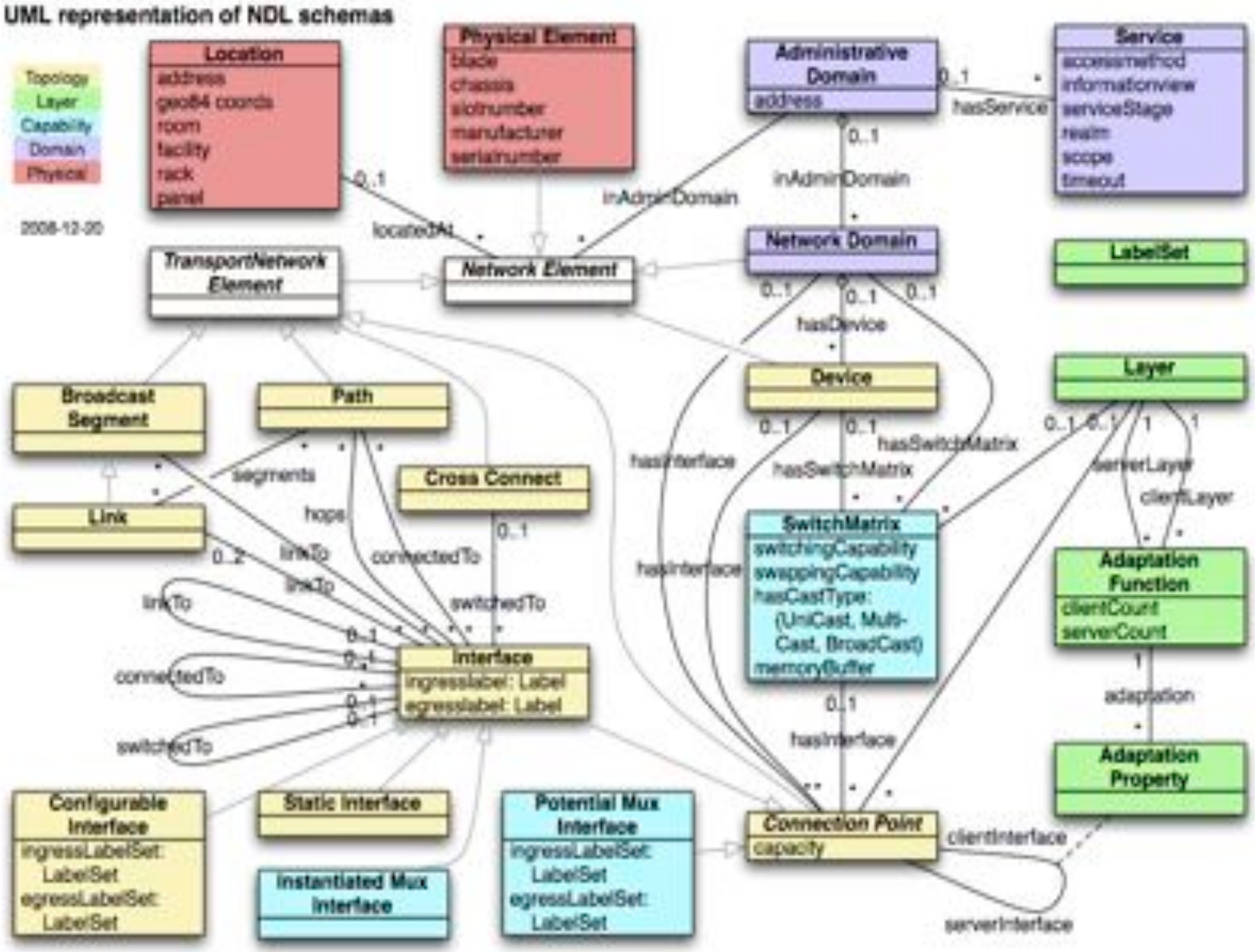



Vertex
Edges

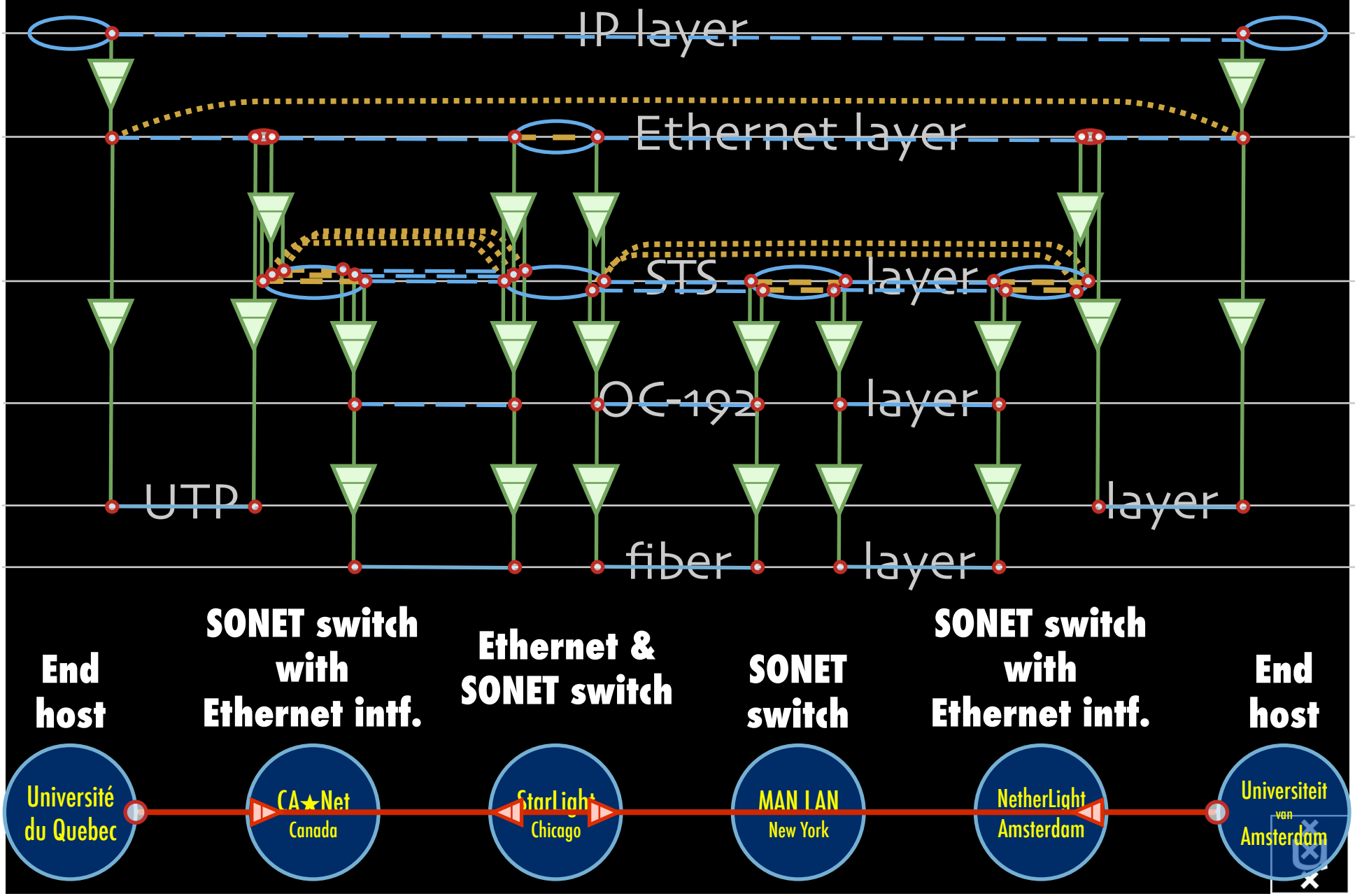

Device
Interfaces
Links



- A devices switches data based on:
  - The source interface
  - One or more labels
- Example label types:
  - Ethernet VLAN
  - SONET STS Channel
  - Wavelength (λ)
- For example, all data from channel 31 of interface 2 is forwarded to channel 28 of interface 4.

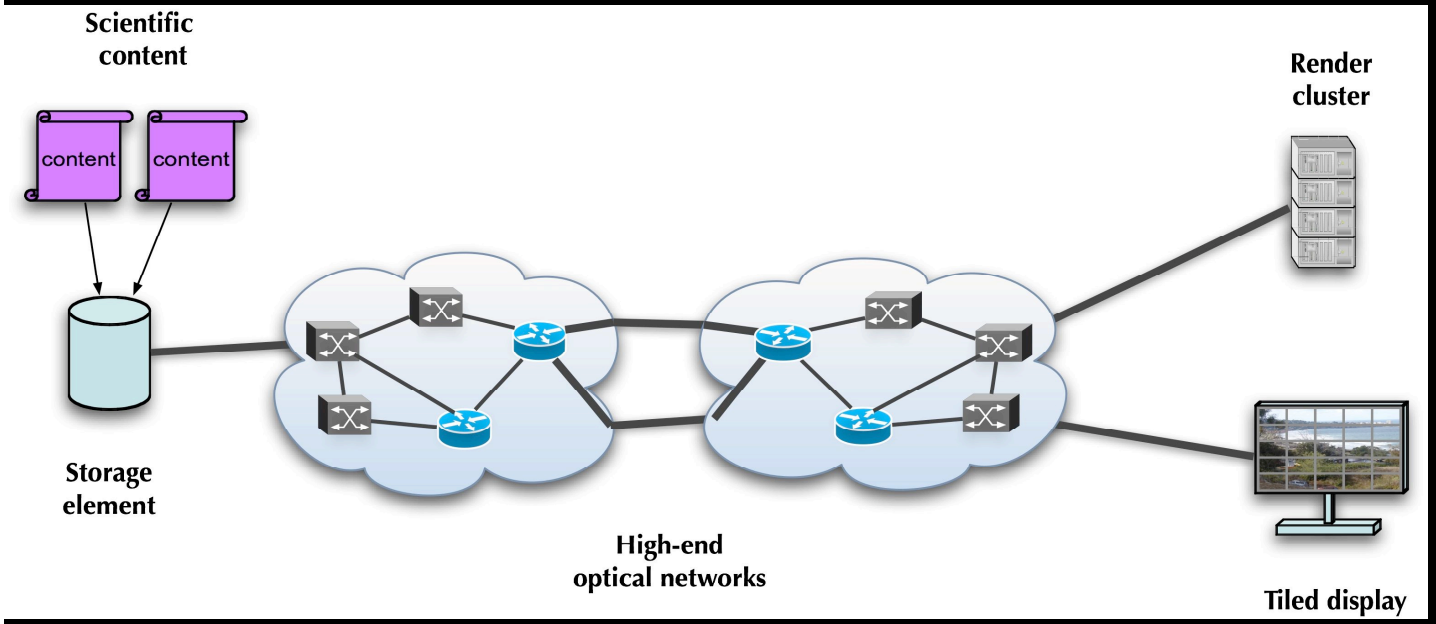

UML representation of NDL schemas
Topology
Layer
Capability
Domain
Physical
2008-12-20
Location
address
geo84 coords
room
facility
rack
panel
Physical Element
blade
chassis
slotnumber
manufacturer
serialnumber
Administrative Domain
address
Service
accessmethod
informationview
serviceStage
realm
scope
timeout
hasService
inAdminDomain
locatedAt
TransportNetwork Element
Network Element
Network Domain
LabelSet
hasDevice
Device
Layer
Broadcast Segment
Path
Cross Connect
Link
segments
hops
linkTo
connectedTo
switchedTo
hasInterface
hasSwitchMatrix
SwitchMatrix
switchingCapability
swappingCapability
hasCastType:
(UniCast, Multi-
Cast, BroadCast)
memoryBuffer
Adaptation Function
clientCount
serverCount
adaptation
Adaptation Property
Interface
ingressLabel: Label
egressLabel: Label
Configurable Interface
ingressLabelSet:
LabelSet
egressLabelSet:
LabelSet
Static Interface
Instantiated Mux Interface
Potential Mux Interface
ingressLabelSet:
LabelSet
egressLabelSet:
LabelSet
Connection Point
capacity
clientInterface
serverInterface

Multi-layer extensions to NDL



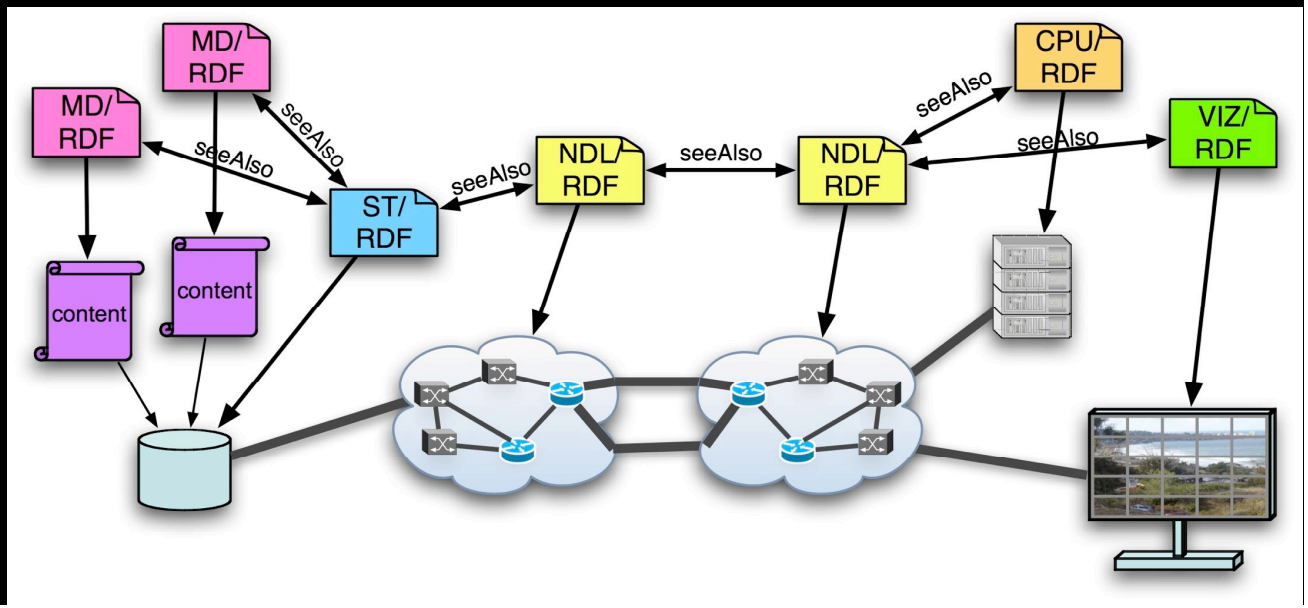

Map
Satellite
Hybrid
Greenland
Canada
United States
North Pacific Ocean
North Atlantic Ocean
Mexico
Cuba
Venezuela
Colombia
Brasil
Peru
Bolivia
Chile
Argentina
Australia
Indonesia
Papua New Guinea
South Pacific Ocean
South Atlantic Ocean
Algeria
Libya
Mauritania
Mali
Niger
Nigeria
Chad
Namibia
Norge
España
Italia
Google

From network to applications

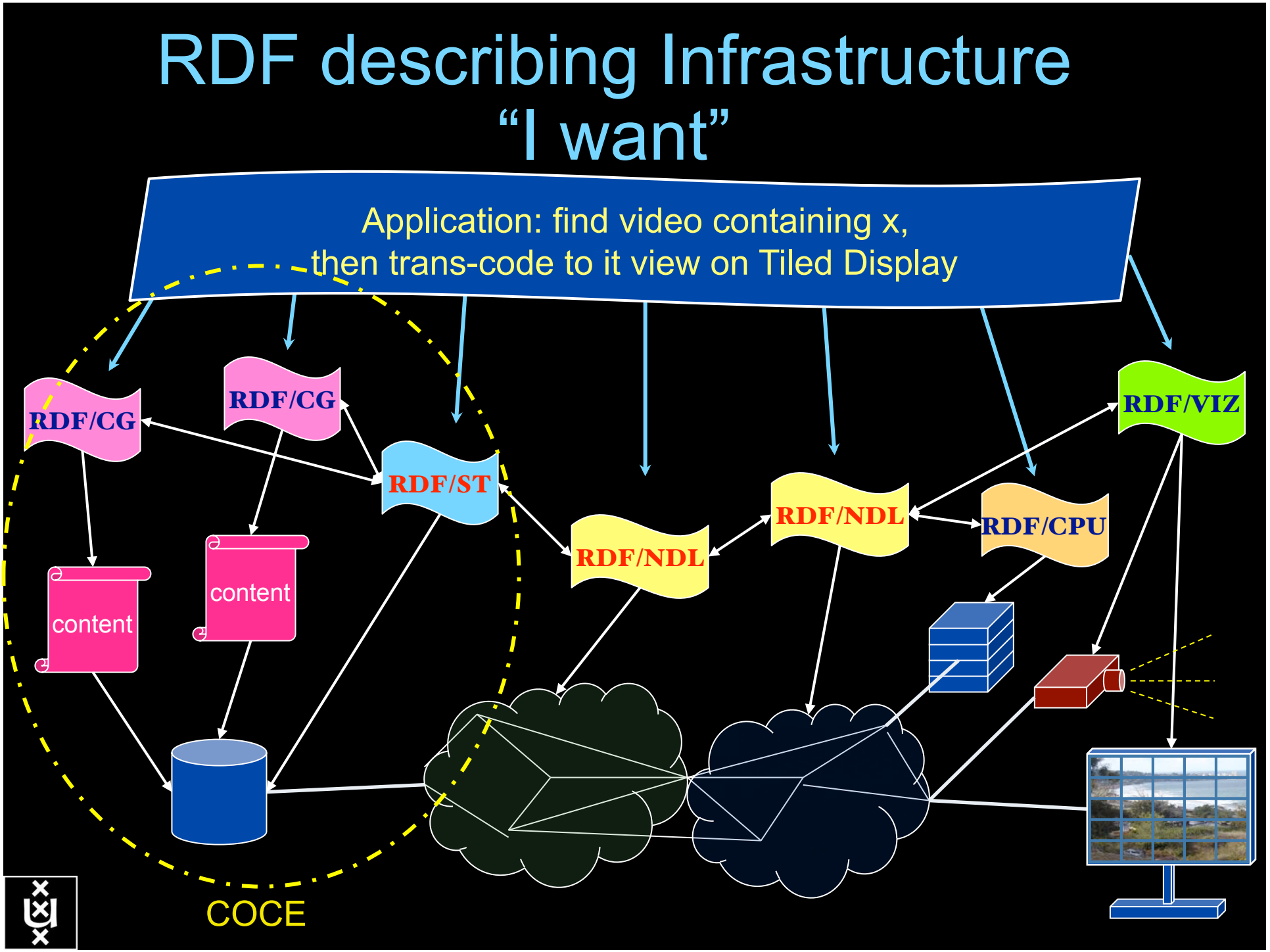


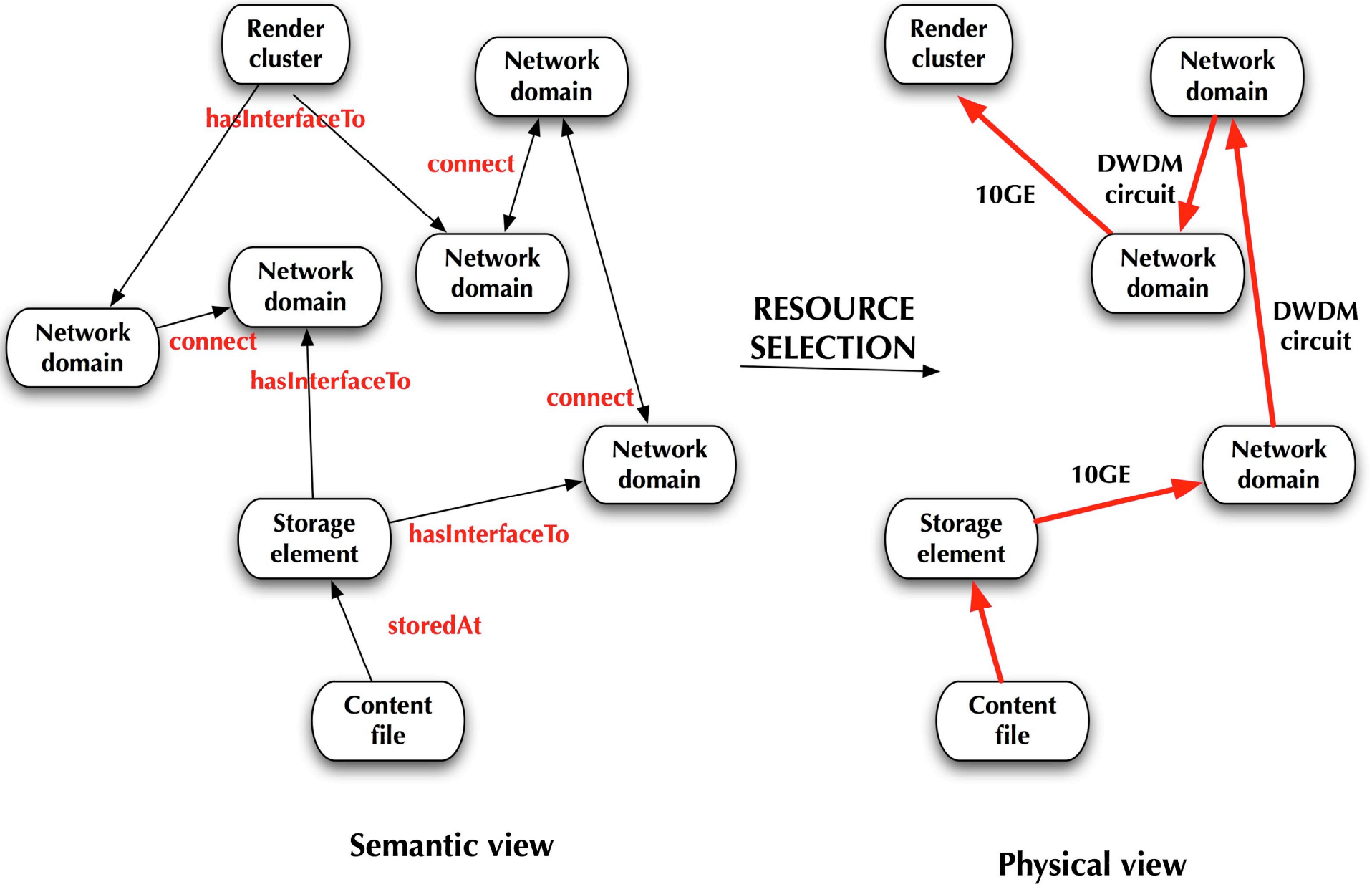
From the physical architecture

To the semantic model for the architecture



RDF describing Infrastructure
"I want"





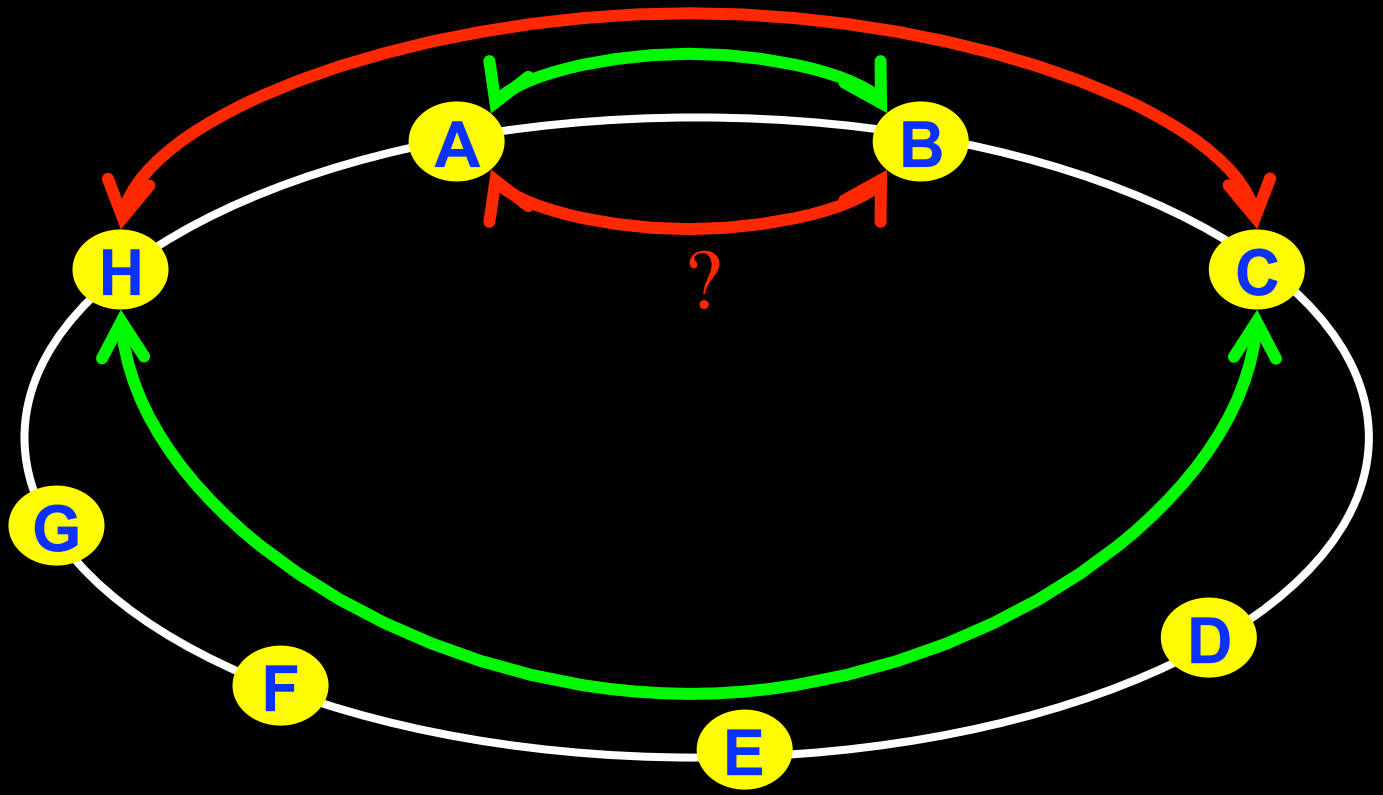
Semantic Reasoning

The Problem

I want HC and AB

Success depends on the order

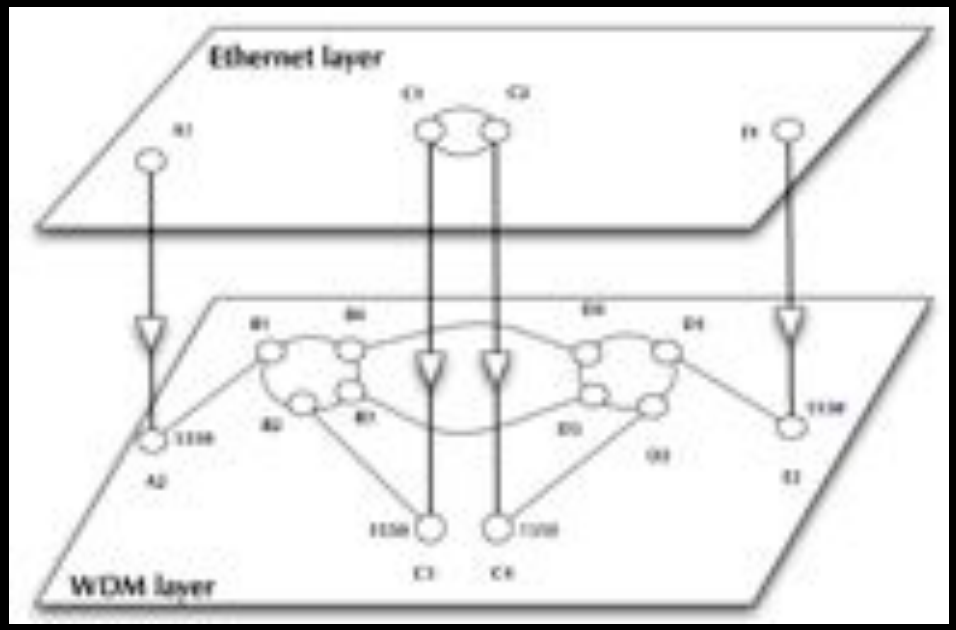
Wouldn't it be nice if I could request [HC, AB, ...]

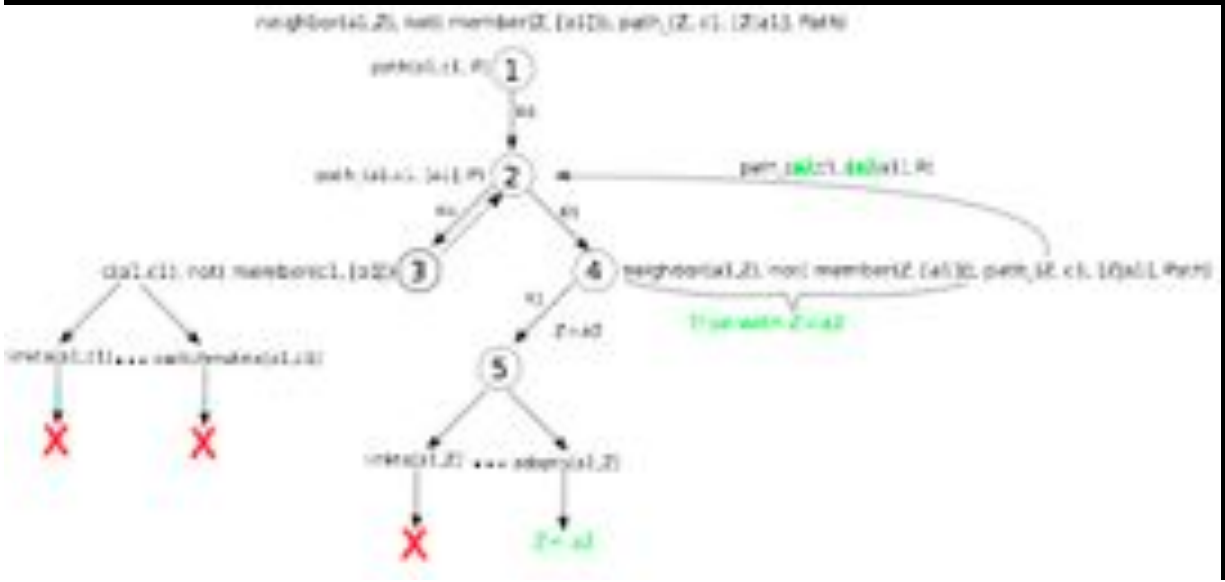


NDL + PROLOG

Research Questions:

- order of requests
- complex requests
- Usable leftovers





- Reason about graphs
- Find sub-graphs that comply with rules

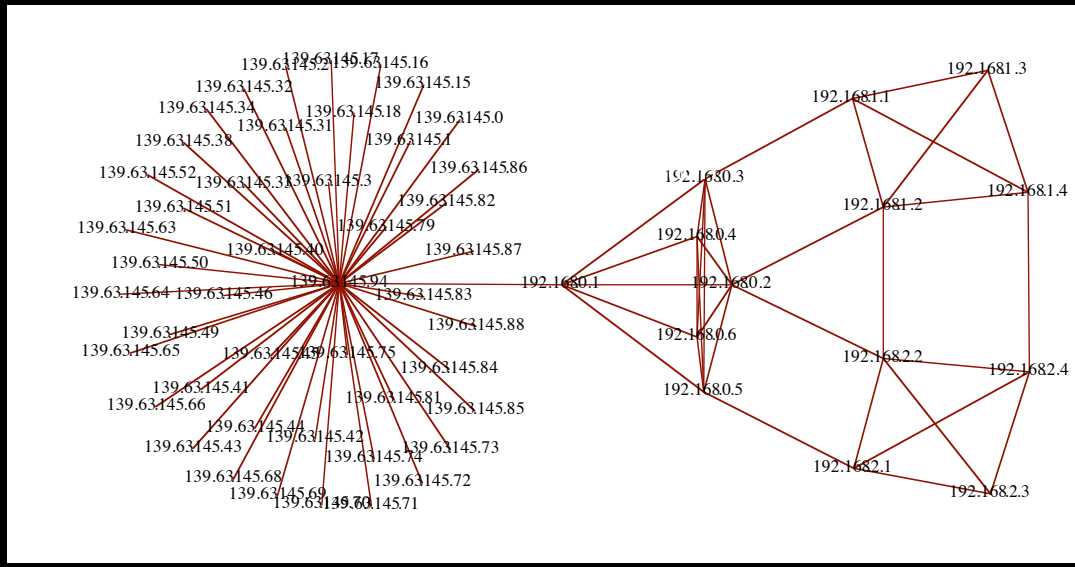
Mathematica enables advanced graph queries, visualizations and real-time network manipulations on UPVNs

Topology matters can be dealt with algorithmically

Results can be persisted using a transaction service built in UPVN

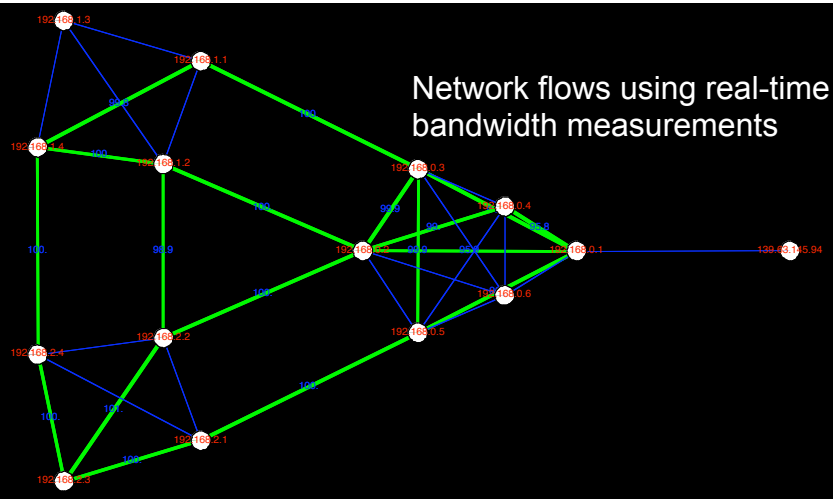
Initialization and BFS discovery of NEs

```
Needs["WebServices`"]
<<DiscreteMath`Combinatorica`
<<DiscreteMath`GraphPlot`
InitNetworkTopologyService["edge.ict.tno.nl"]

Available methods:


{DiscoverNetworkElements,GetLinkBandwidth,GetAllIpLinks,Remote,
NetworkTokenTransaction}

Global`upvnverbose = True;

AbsoluteTiming[nes = BFSDiscover["139.63.145.94"];][[1]]

AbsoluteTiming[result = BFSDiscoverLinks["139.63.145.94", nes];][[1]]

Getting neigbours of: 139.63.145.94
Internal links: {192.168.0.1, 139.63.145.94}
(...)
Getting neigbours of:192.168.2.3
Internal links: {192.168.2.3}
```



Transaction on shortest path with tokens

```
nodePath = ConvertIndicesToNodes[
           ShortestPath[     g,
                        Node2Index[nids,"192.168.3.4"],
                        Node2Index[nids,"139.63.77.49"]],
                        nids];
Print["Path: ", nodePath];
If[NetworkTokenTransaction[nodePath, "green"]==True,
      Print["Committed"], Print["Transaction failed"]];

Path:
{192.168.3.4,192.168.3.1,139.63.77.30,139.63.77.49}

Committed
```



Network flows using real-time bandwidth measurements

ref: Robert J. Meijer, Rudolf J. Strijkers, Leon Gommans, Cees de Laat, User Programmable Virtualiized Networks, accepted for publication to the IEEE e-Science 2006 conference Amsterdam.

StarPlane

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.

SURF NET