e-Infrastructure aware Topology handling in the Global Lambda Integrated Facility

Cees de Laat

EU

SURFnet

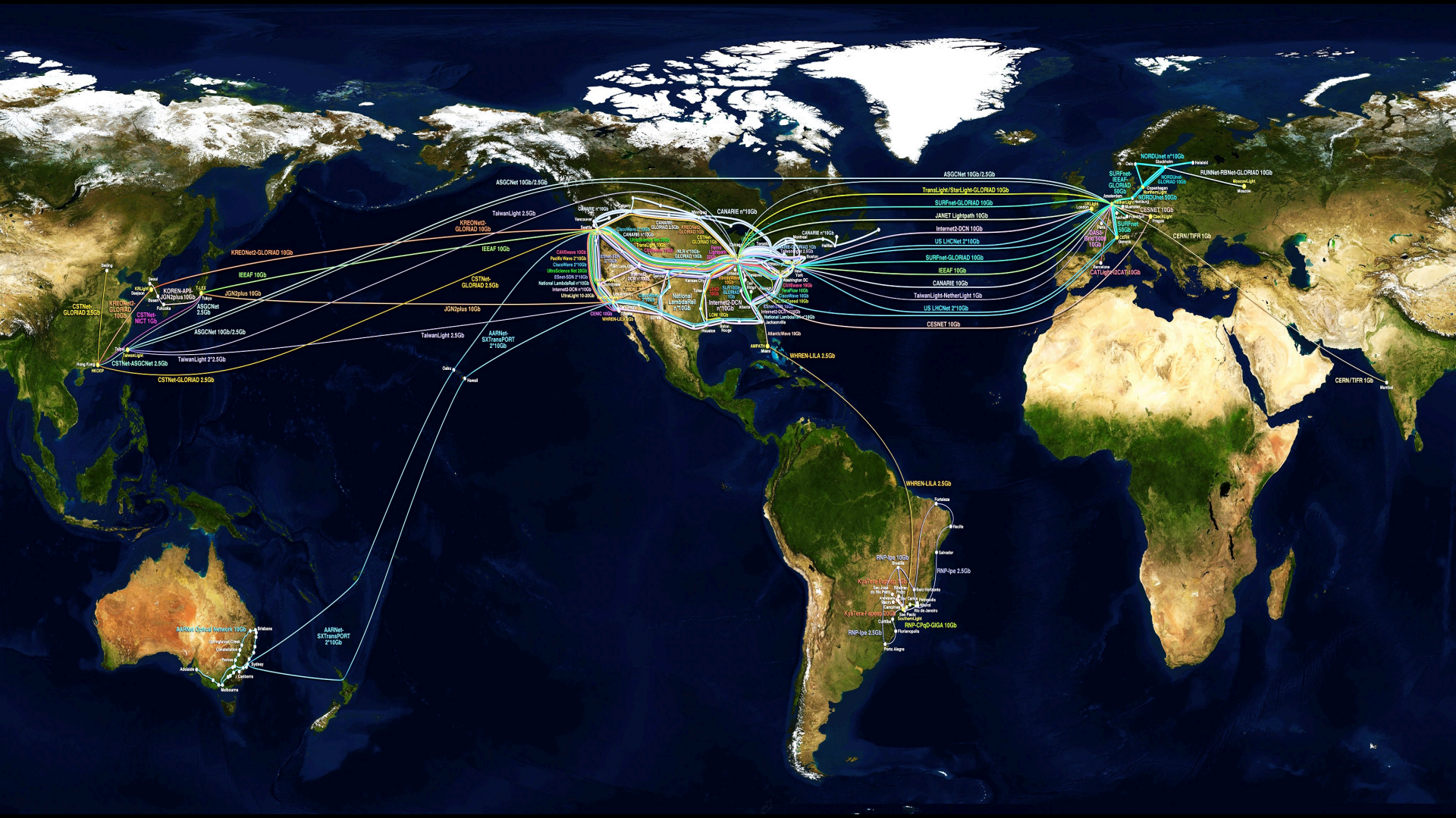
SURF-eScience

NWO

University of Amsterdam

TNO

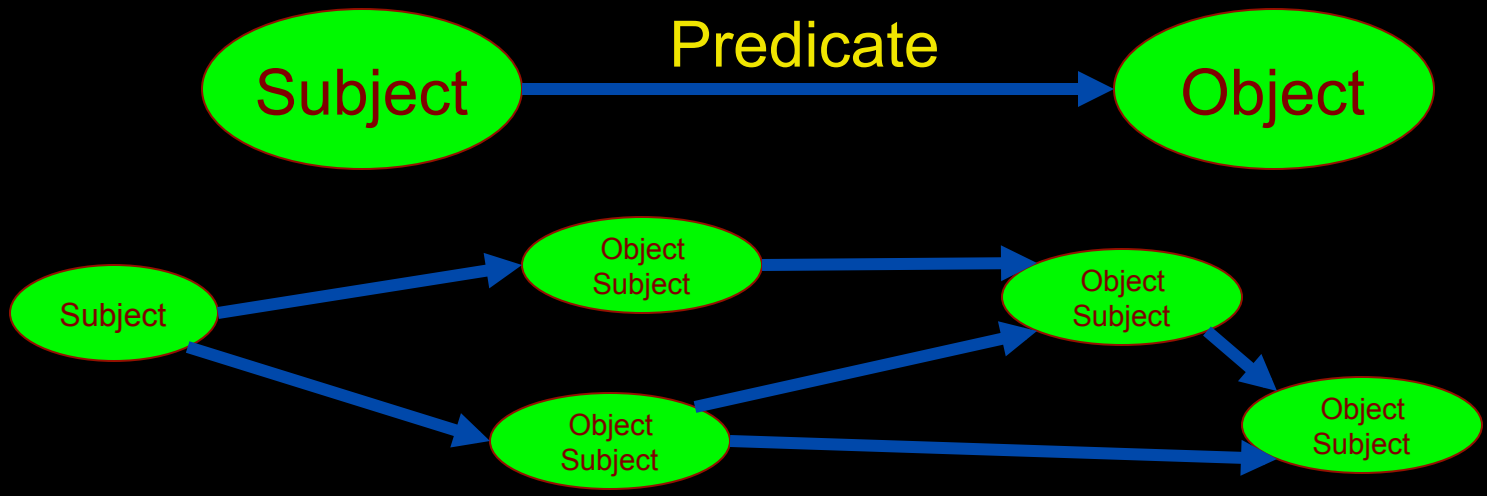
NCF

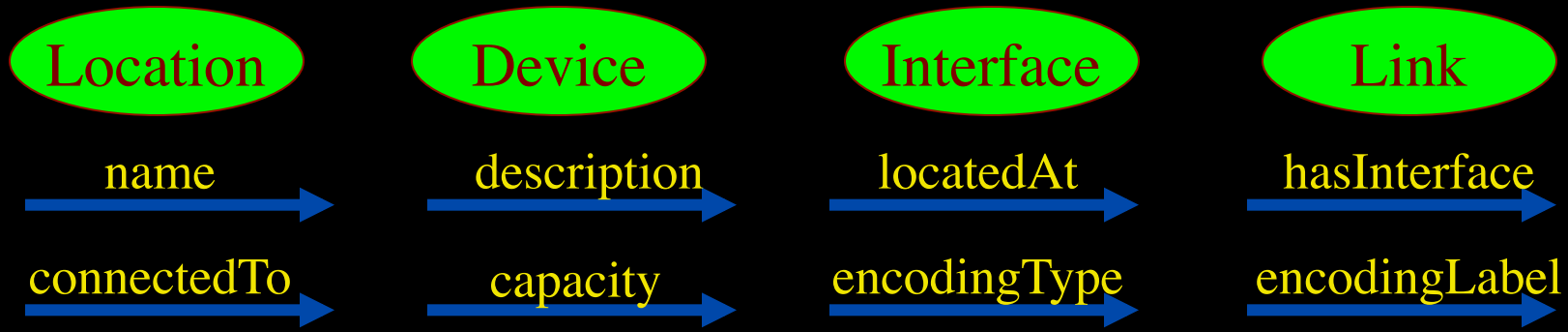


We zoeken: TOMTOM voor complexe netwerken!

Network Description Language

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





NetherLight in RDF

```
<?xml version="1.0" encoding="UTF-8"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
      xmlns:ndl="http://www.science.uva.nl/research/air/ndl#">
<!-- Description of Netherlight -->
<ndl:Location rdf:about="#Netherlight">
      <ndl:name>Netherlight Optical Exchange</ndl:name>
</ndl:Location>
<!-- TDM3.amsterdam1.netherlight.net -->
<ndl:Device rdf:about="#tdm3.amsterdam1.netherlight.net">
      <ndl:name>tdm3.amsterdam1.netherlight.net</ndl:name>
      <ndl:locatedAt rdf:resource="#amsterdam1.netherlight.net"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:501/1"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:501/3"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:501/4"/>
      <ndl:hasInterface rdf:resource="#tdm3.amsterdam1.netherlight.net:503/1"/>
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```
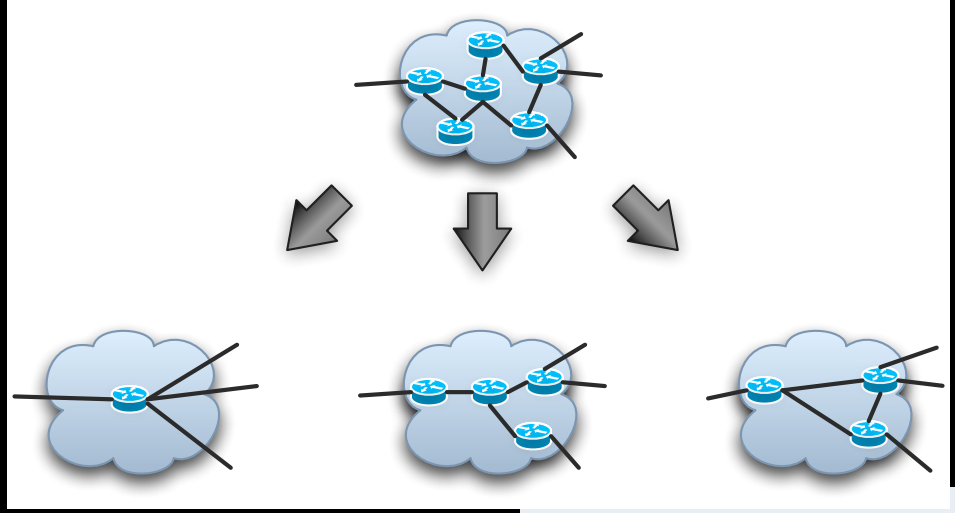
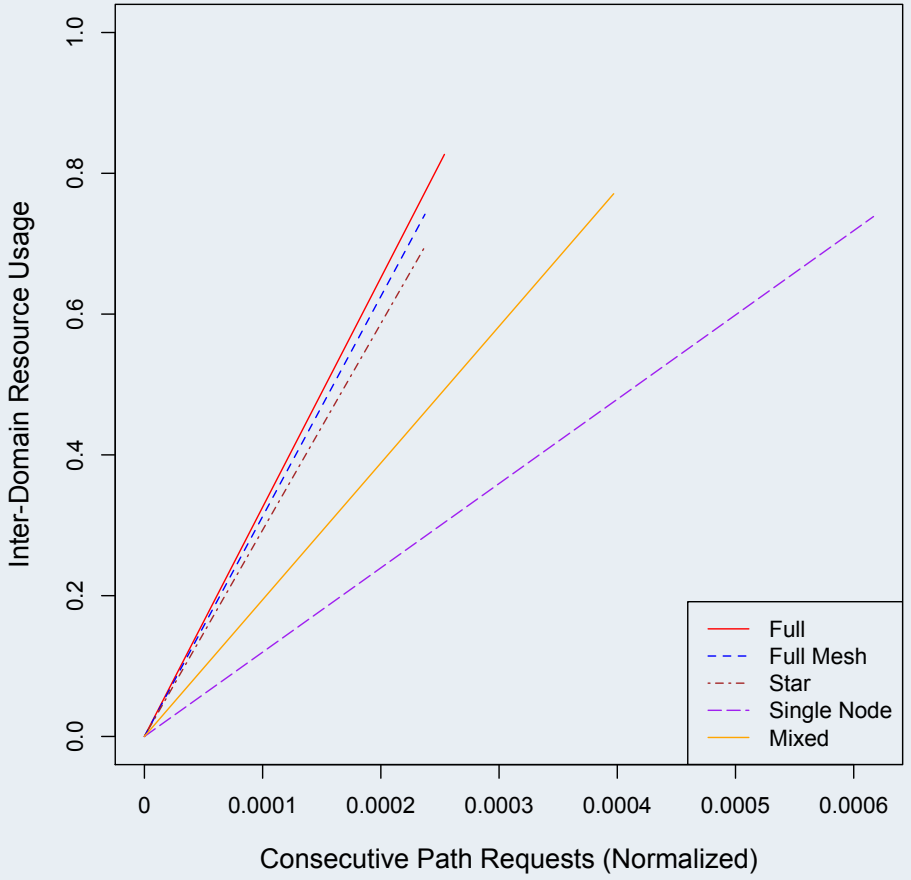
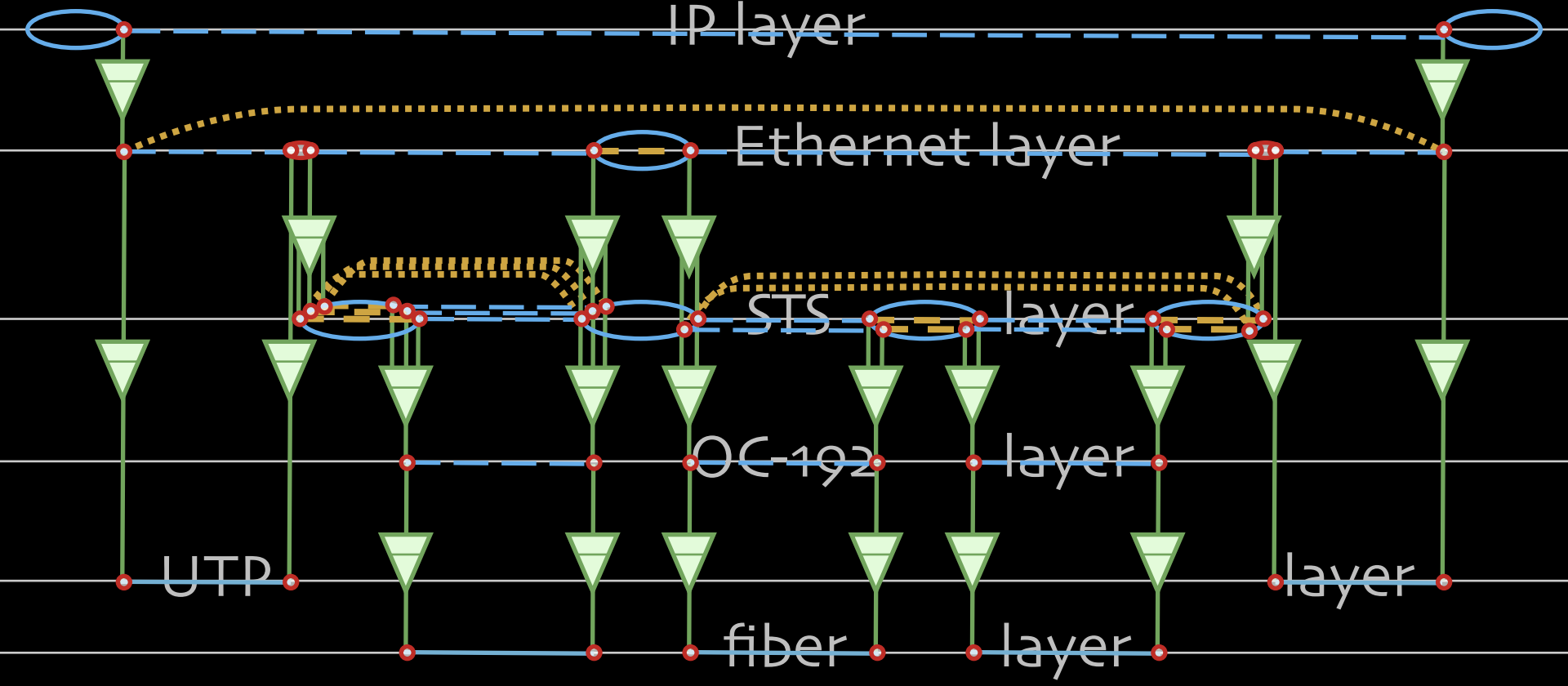

```
<!-- all the interfaces of TDM3.amsterdam1.netherlight.net -->

<ndl:Interface rdf:about="#tdm3.amsterdam1.netherlight.net:501/1">
            <ndl:name>tdm3.amsterdam1.netherlight.net:POS501/1</ndl:name>
            <ndl:connectedTo rdf:resource="#tdm4.amsterdam1.netherlight.net:5/1"/>
</ndl:Interface>
<ndl:Interface rdf:about="#tdm3.amsterdam1.netherlight.net:501/2">
            <ndl:name>tdm3.amsterdam1.netherlight.net:POS501/2</ndl:name>
            <ndl:connectedTo rdf:resource="#tdm1.amsterdam1.netherlight.net:12/1"/>
</ndl:Interface>
```

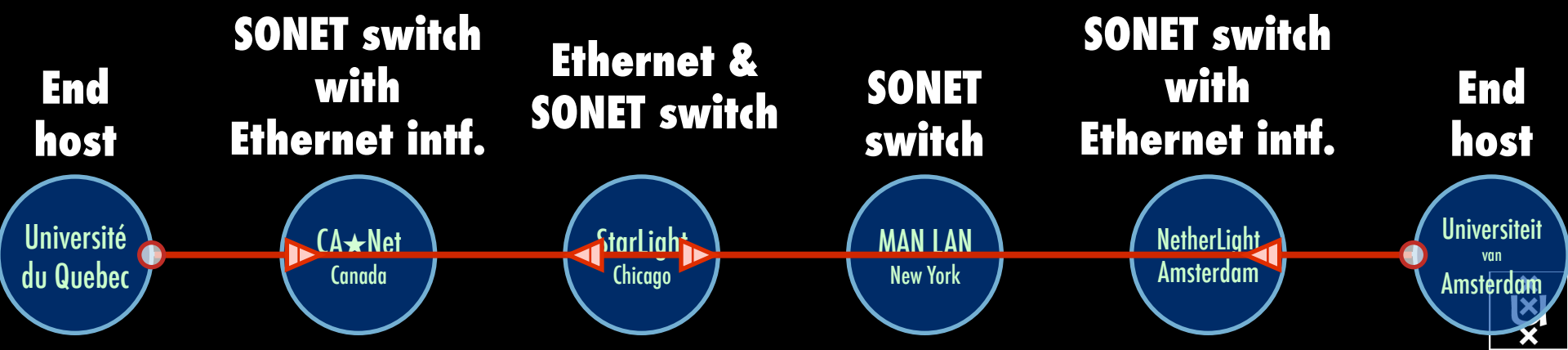
Topology Aggregation



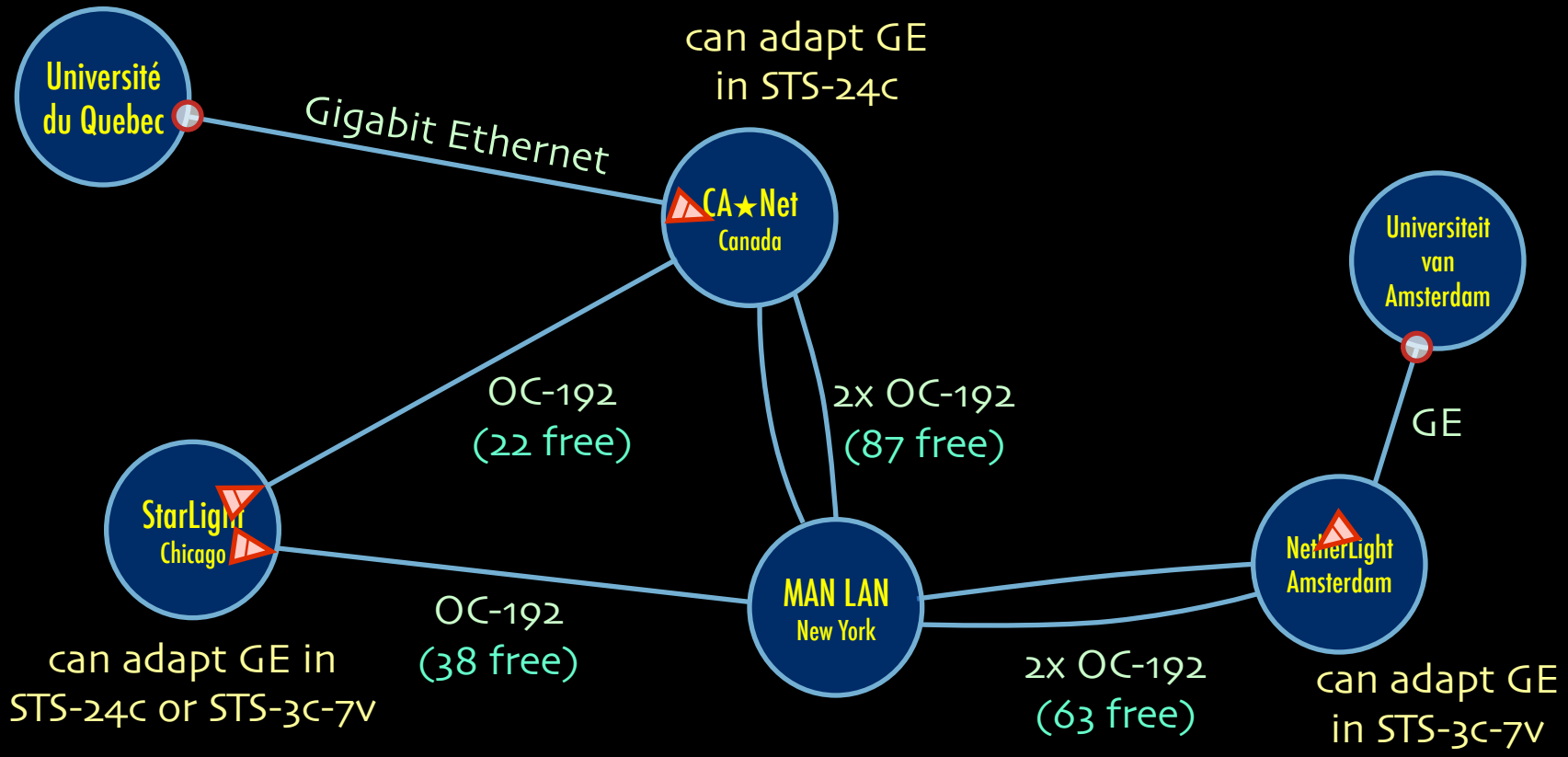


Multi-layer descriptions in NDL



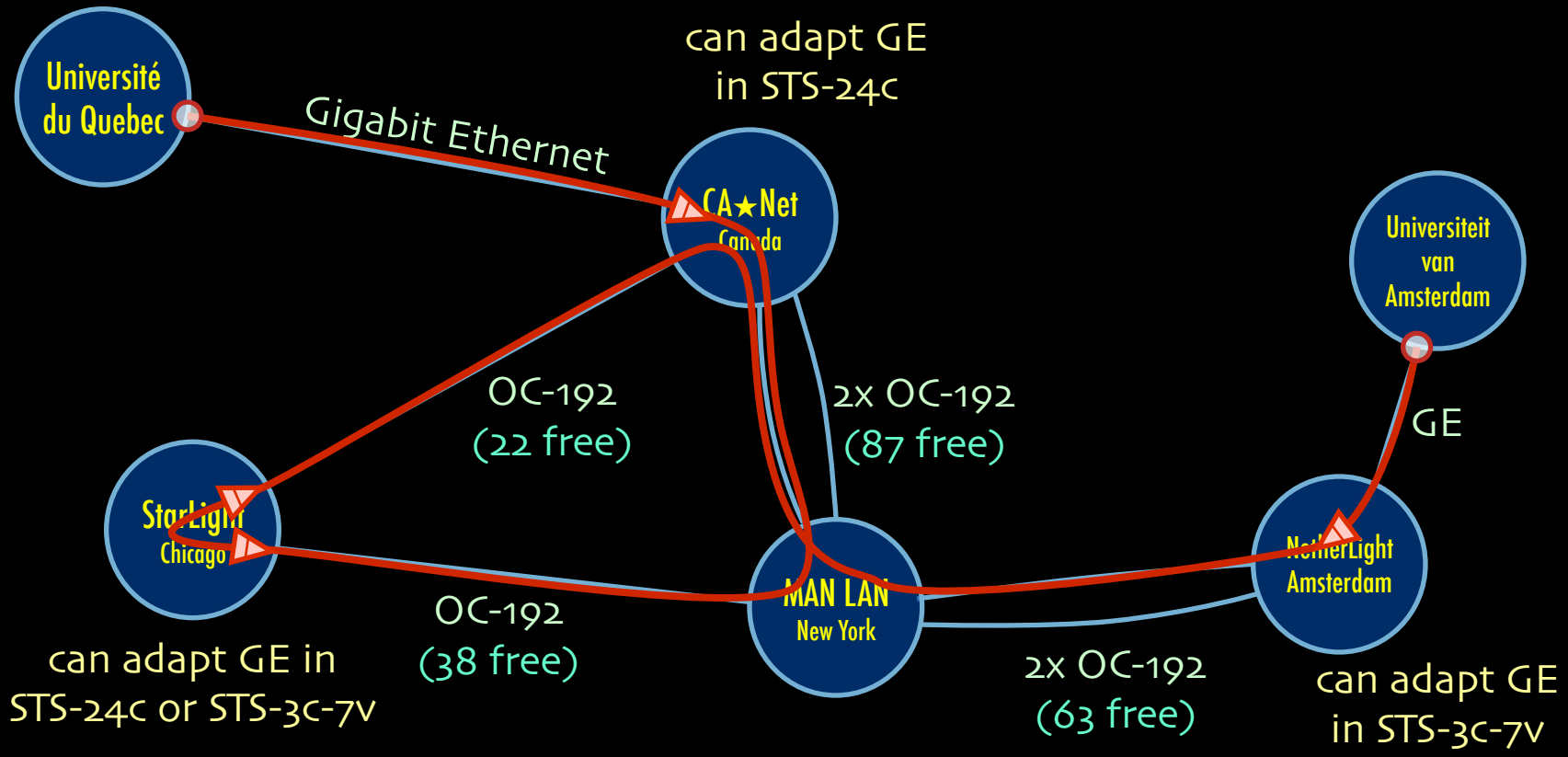


A weird example



Thanks to Freek Dijkstra & team

A weird example



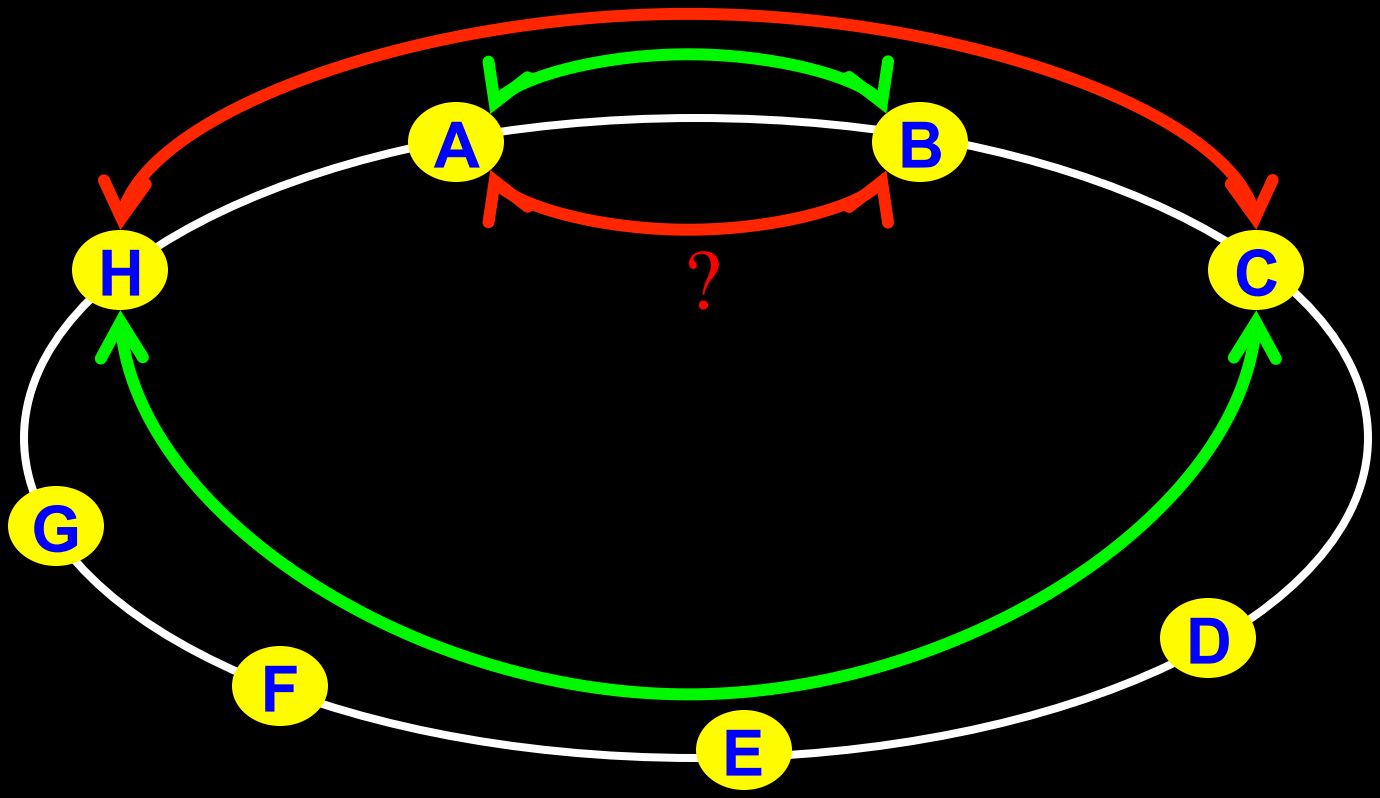
Thanks to Freek Dijkstra & team

The Problem

I want HC and AB

Success depends on the order

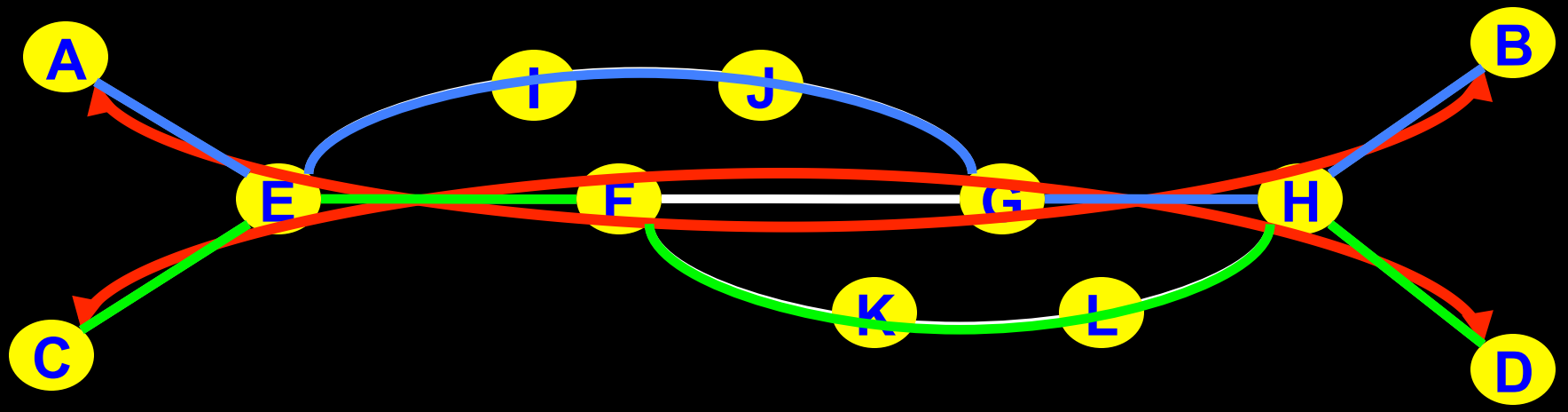
Wouldn't it be nice if I could request [HC, AB, ...]



Another one ☺

I want AB and CD

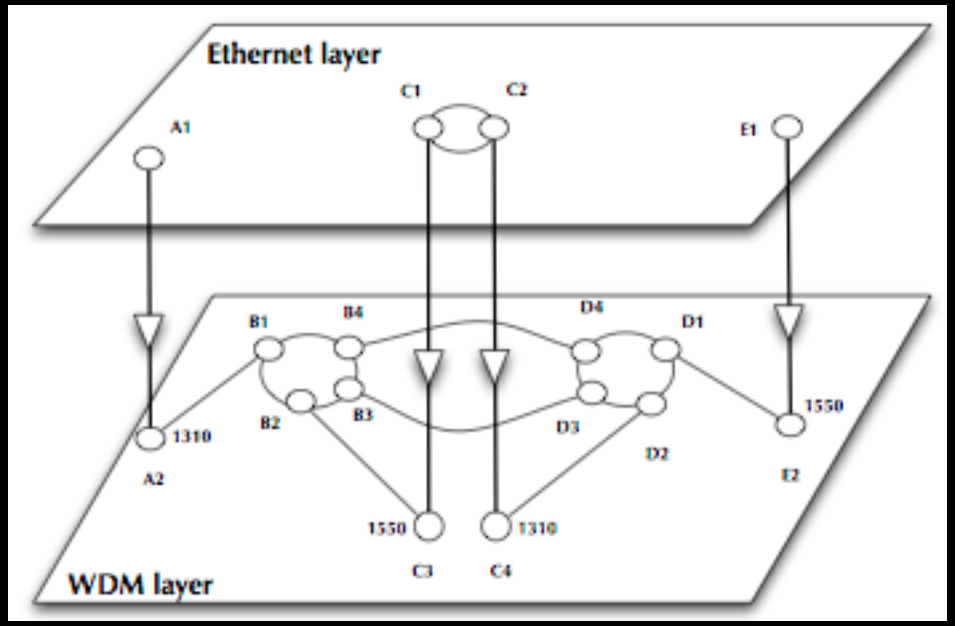
Success does not even depend on the order!!!

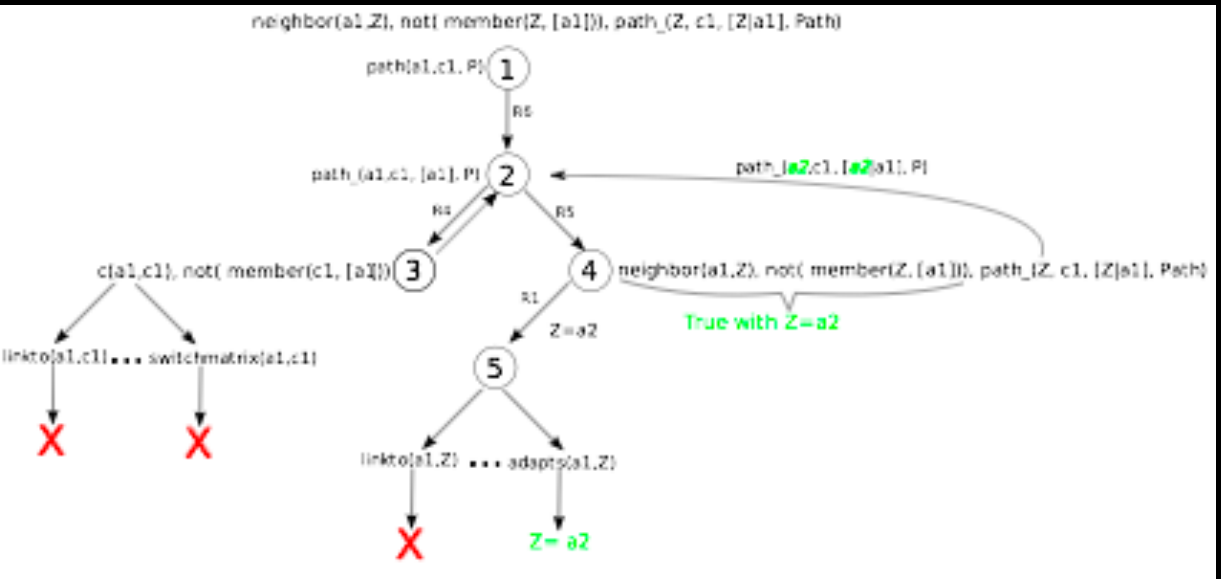


NDL + PROLOG

Research Questions:

- order of requests
- complex requests
- usable leftovers

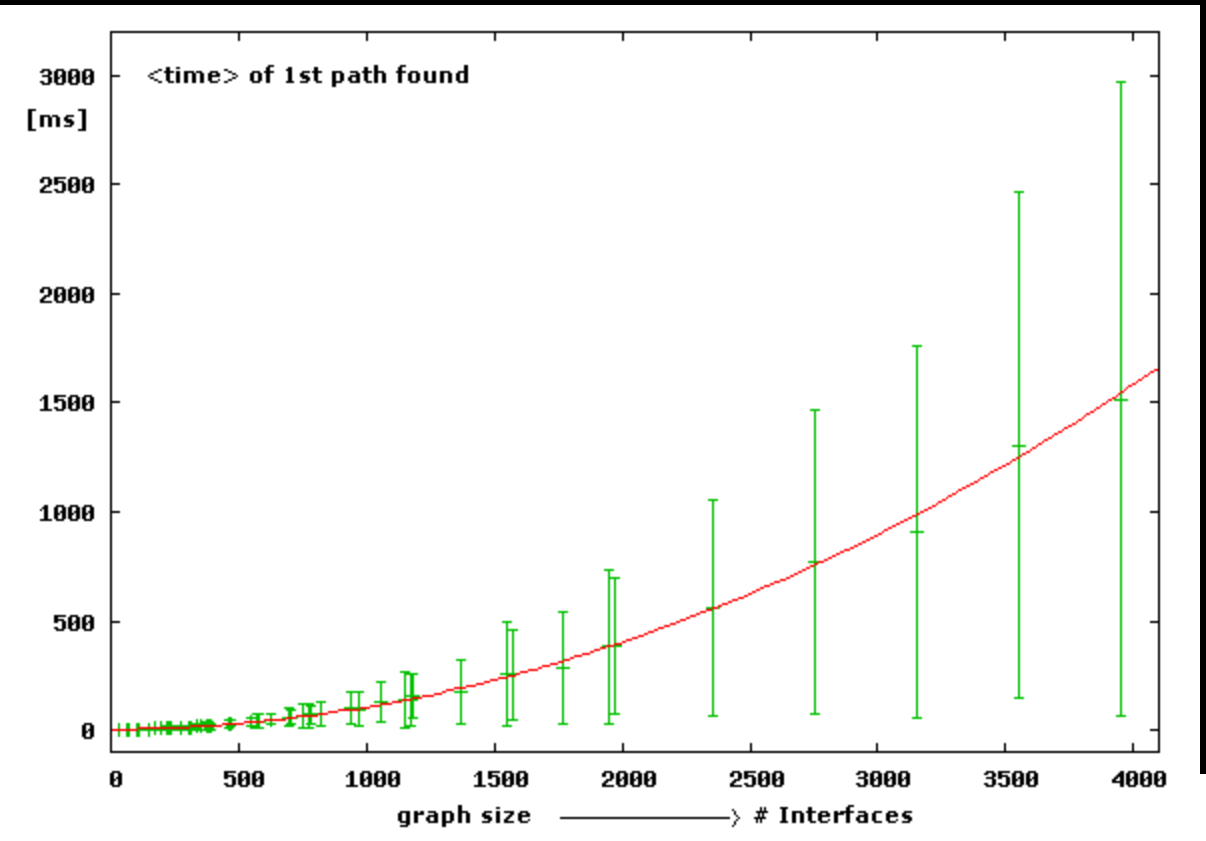




- Reason about graphs
- Find sub-graphs that comply with rules

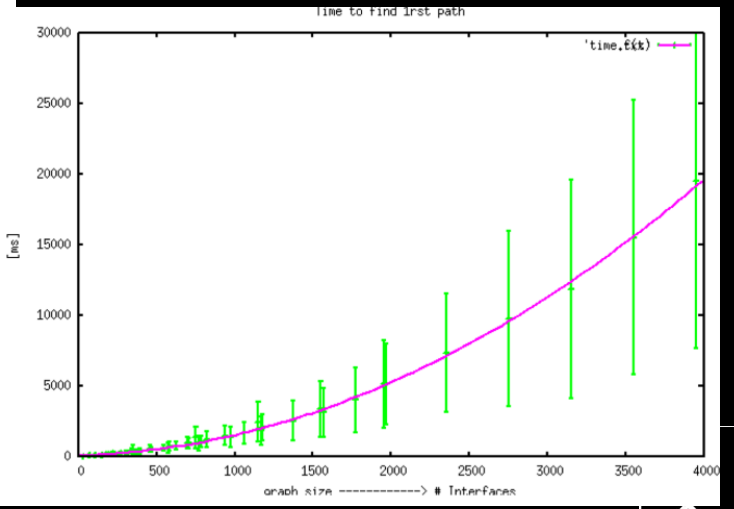
- Network descriptions are in NDL
- Use Prolog , a *logical programming* language:
  - clauses: facts and rules
  - goals: reached through backward chaining (goal-driven)
- Multi-layer pathfinding is a combinatorial bomb.
- Need features of networks to force Prolog to backtrack if it looks for an unnecessary long path.
- Introducing features (heuristics) speeds up the pathfinding but may lead to false negatives too.

Single layer networks: results



- *Number of interfaces,*
- *given N nodes per domain D*
- *4*(D-2) + D*4*(N-2) for D > 2*

Pynt-based DFS



Prolog DFS

- Prolog time to find first path shorter than Python time.
- We observe a quadratic dependence.
- Length of paths found comparable.

Multi-domain 2-layer networks

How do multi-domain 2-layer networks look like?

Guess: Projection algorithm (2-layer: Ethernet /WDM)

Steps:

1. Generate a multi-domain graph by BA-algorithm
2. Generate a graph for each domain by BA-algorithm
3. For each domain graph project random nodes onto WDM layer
4. Connect the domains at each layer according to the multi-domain graph
5. Assign random wavelengths to the adaptation links

Advantage:

- Number of adaptations determined by the degree of the projected nodes
- Multi-domain Ethernet-layer as well as the multi-domain WDM-layer graph are not necessarily connected.

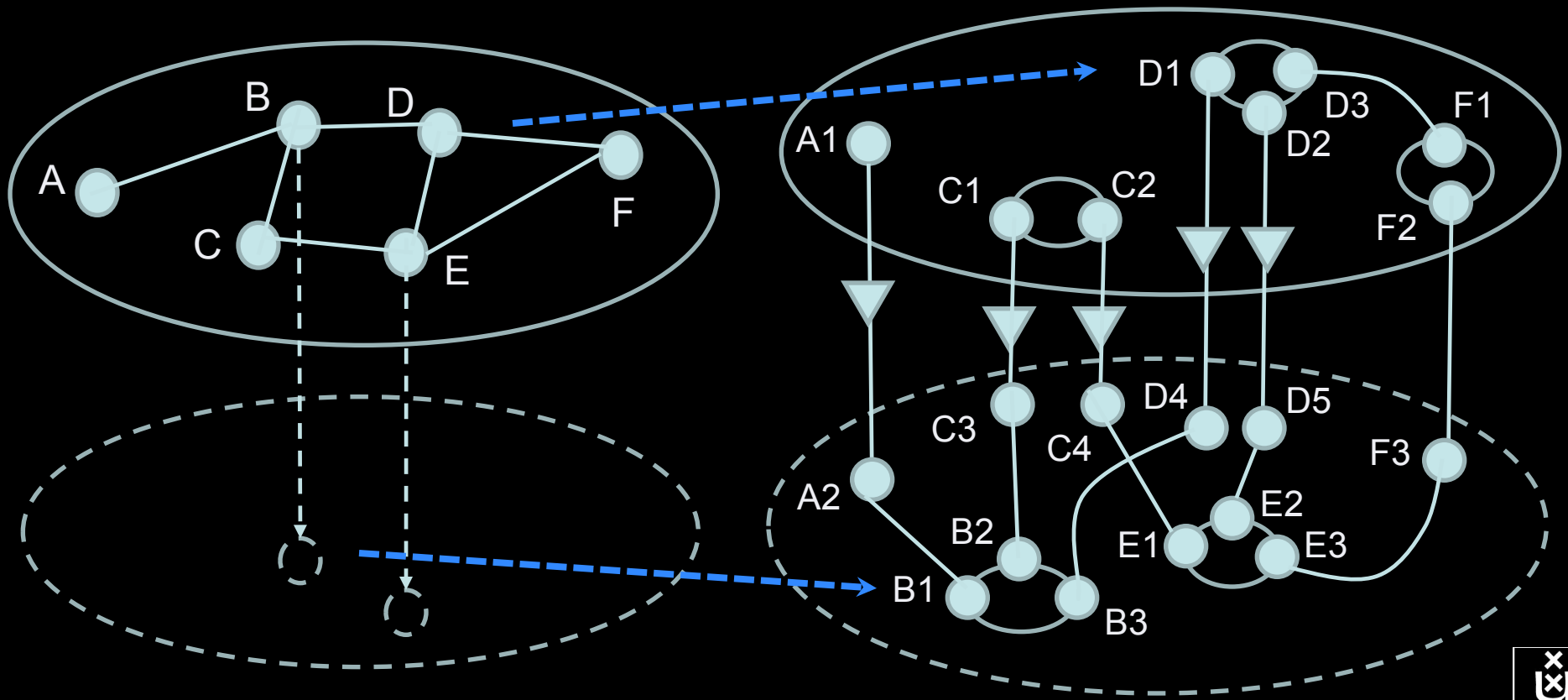
Input parameters:

- Number domains, number of nodes(devices) per domain
- Ratio of Ethernet-devices over WDM-devices per domain
- Distribution of wavelength

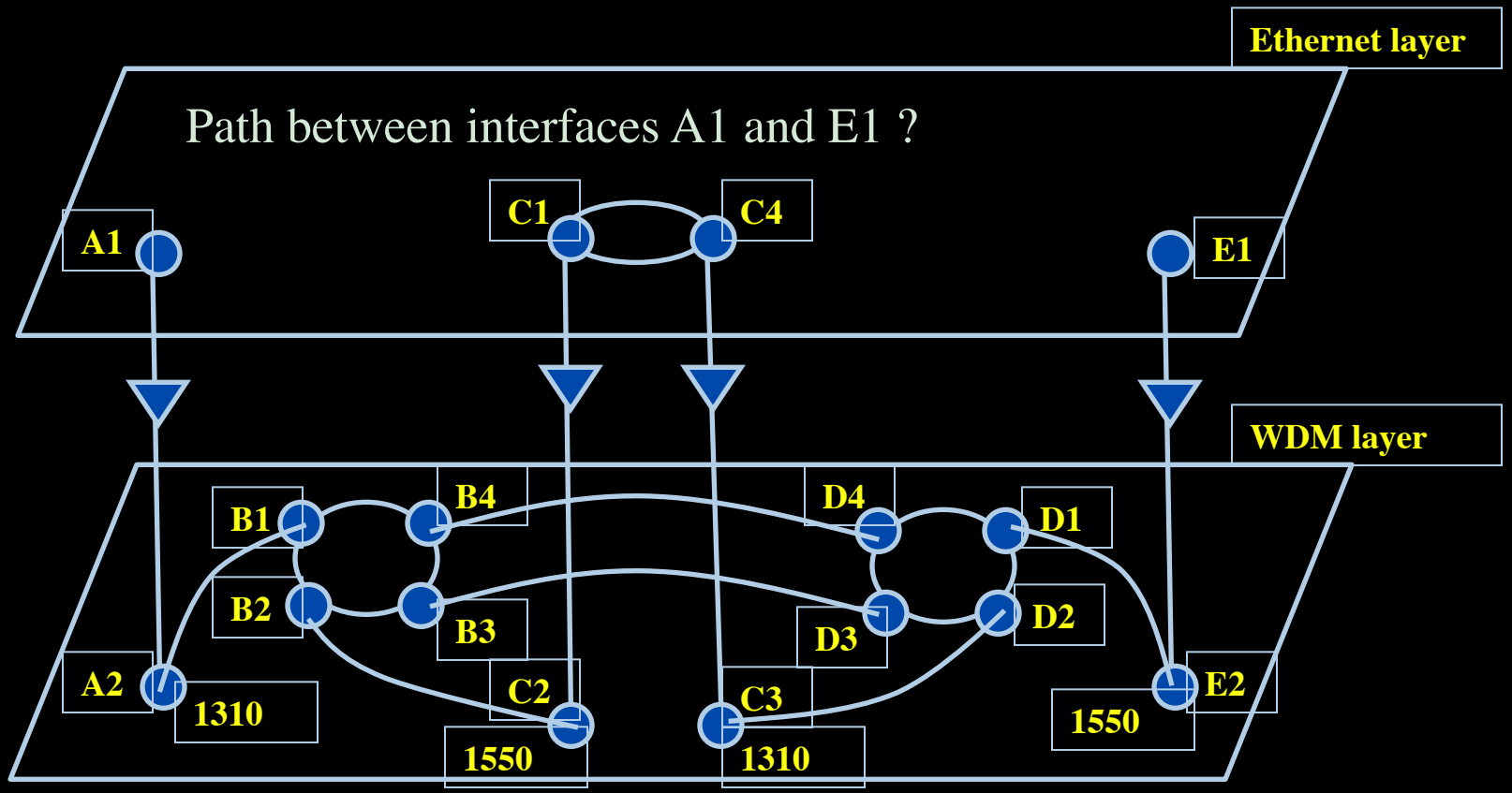
Multi-domain 2-layer networks

Projection algorithm

BA-algorithm to generate a graph for each domain
Project random nodes onto WDM layer



Multi-layer Network PathFinding



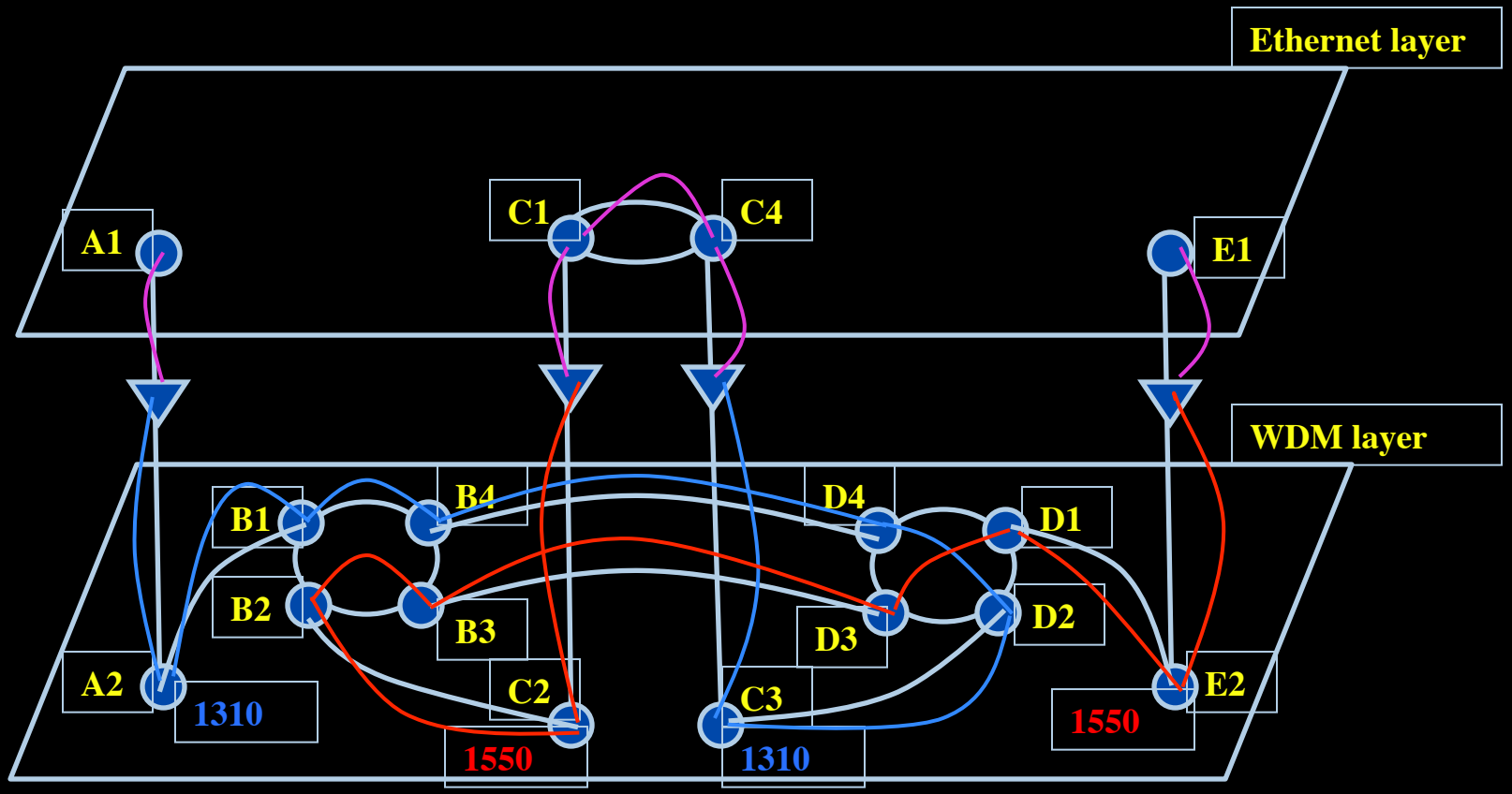
Prolog rule:

```
linkedto( Intf1, Intf2, CurrWav ):-                  %-- is there a link between  Intf1 and Intf2 for wavelength CurrWav ?
    rdf_db:rdf( Intf1, ndl:'layer', Layer ),         %-- get layer of interface Intf1 → Layer
    Layer == 'wdm#LambdaNetworkElement',             %-- are we at the WDM-layer ?
    rdf_db:rdf( Intf1, ndl:'linkedTo', Intf2 ),      %-- is Intf1 linked to Intf2 in the RDF file?
    rdf_db:rdf( Intf2, wdm:'wavelength', W2 ),       %-- get wavelength of Intf2 → W2
    compatible_wavelengths( CurrWav, W2 ).           %-- is CurrWav compatible with W2 ?
```

linkedto(B4, D4, CurrWav) is true for any value of CurrWav

linkedto(D2, C3, CurrWav) is true if CurrWav == 1310

Multi-layer Network PathFinding

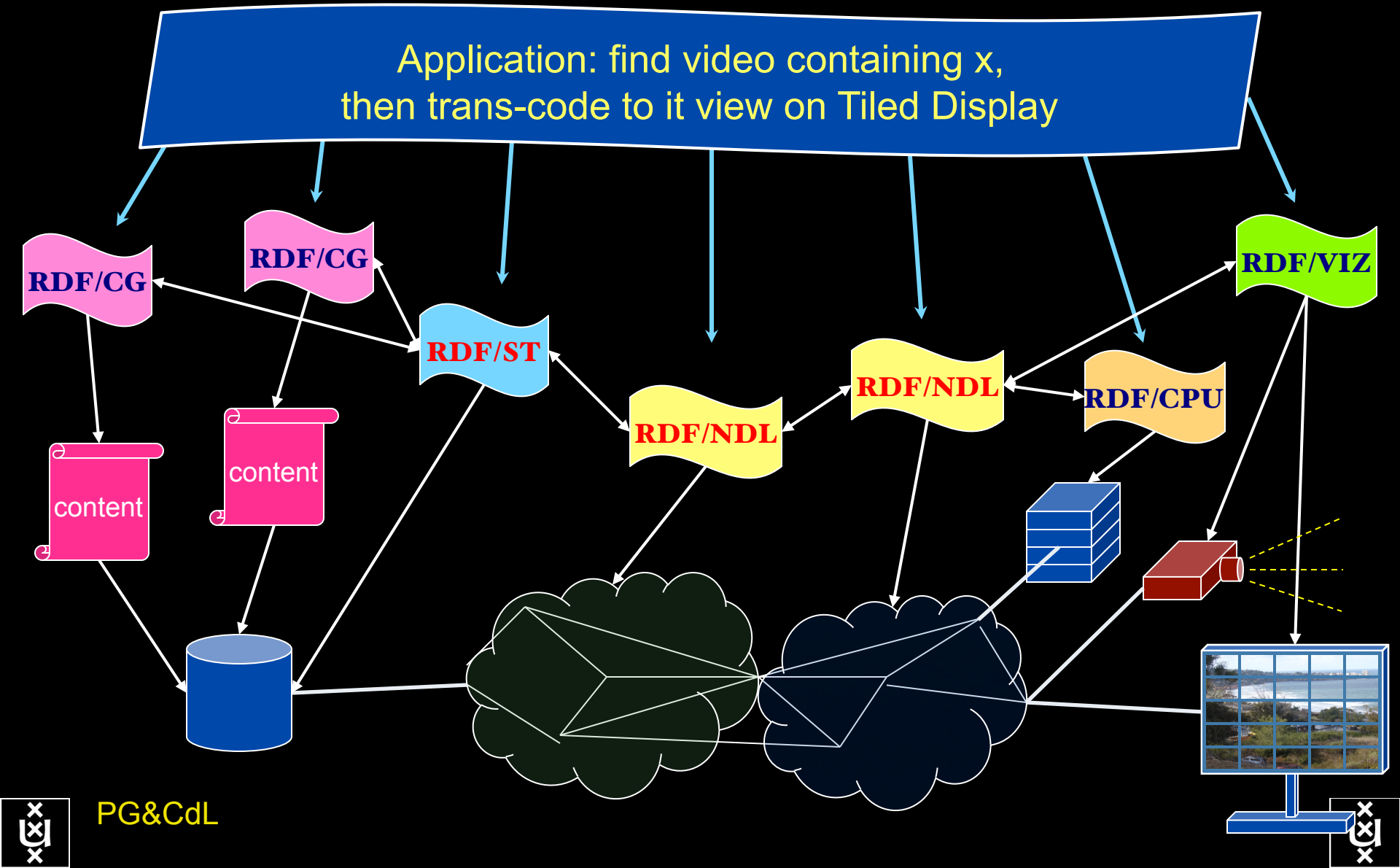


Path between interfaces A1 and E1:

A1-A2-B1-B4-D4-D2-C3-C4-C1-C2-B2-B3-D3-D1-E2-E1

Scaling: Combinatorial problem

RDF describing Infrastructure



PG&CdL

Applications and Networks become aware of each other!

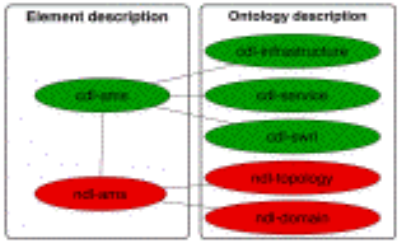
CineGrid Description Language

CineGrid is an initiative to facilitate the exchange, storage and display of high-quality digital media.

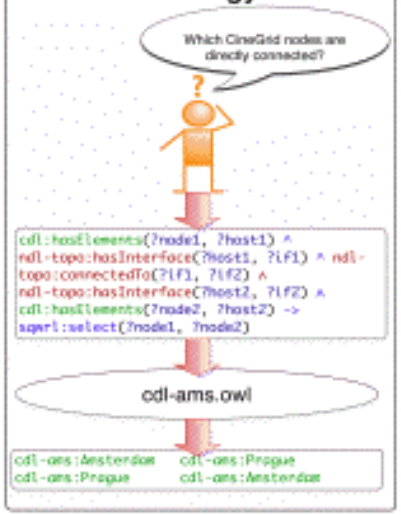
The CineGrid Description Language (CDL) describes CineGrid resources. Streaming, display and storage components are organized in a hierarchical way.

CDL has bindings to the NDL ontology that enables descriptions of network components and their interconnections.

With CDL we can reason on the CineGrid infrastructure and its services.



SQWRL is used to query the Ontology.



UML representation of CDL

CDL links to ***NDL*** using the ***owl:SameAs*** property. ***CDL*** defines the services, ***NDL*** the network interfaces and links. The combination of the two ontologies identifies the host pairs that support matching services via existing network connections.

GigaPort

CineGrid portal

100 Tbyte
Cache & Store & Forward

CineGrid **distribution center Amsterdam**

Home | About | Browse Content | cinegrid.org | cinegrid.nl

Amsterdam Node Status:

node41:
Disk space used: 8 GiB
Disk space avaliable: 10 GiB

Search node:

Search

Browse by tag:

amsterdam animation antonacci blender boat bridge bunny cgi dalsa holland hollandfestival leidschestraat muziekgebouw nieuwmarkt opera prague ship train tram trams waag

UvA Universiteit van Amsterdam

CineGrid Amsterdam

Welcome to the Amsterdam CineGrid distribution node. Below are the latest additions of super-high-quality video to our node.

For more information about CineGrid and our effords look at the about section.

Latest Additions

Wypke

Wypke

Avaliable formats:
4k dxt (4.0 KB)
Duration: 1 hour and 8 minutes
Created: 1 week, 2 days ago
Author: Wypke
Categories:

Prague Train

Steam locomotive in Prague.

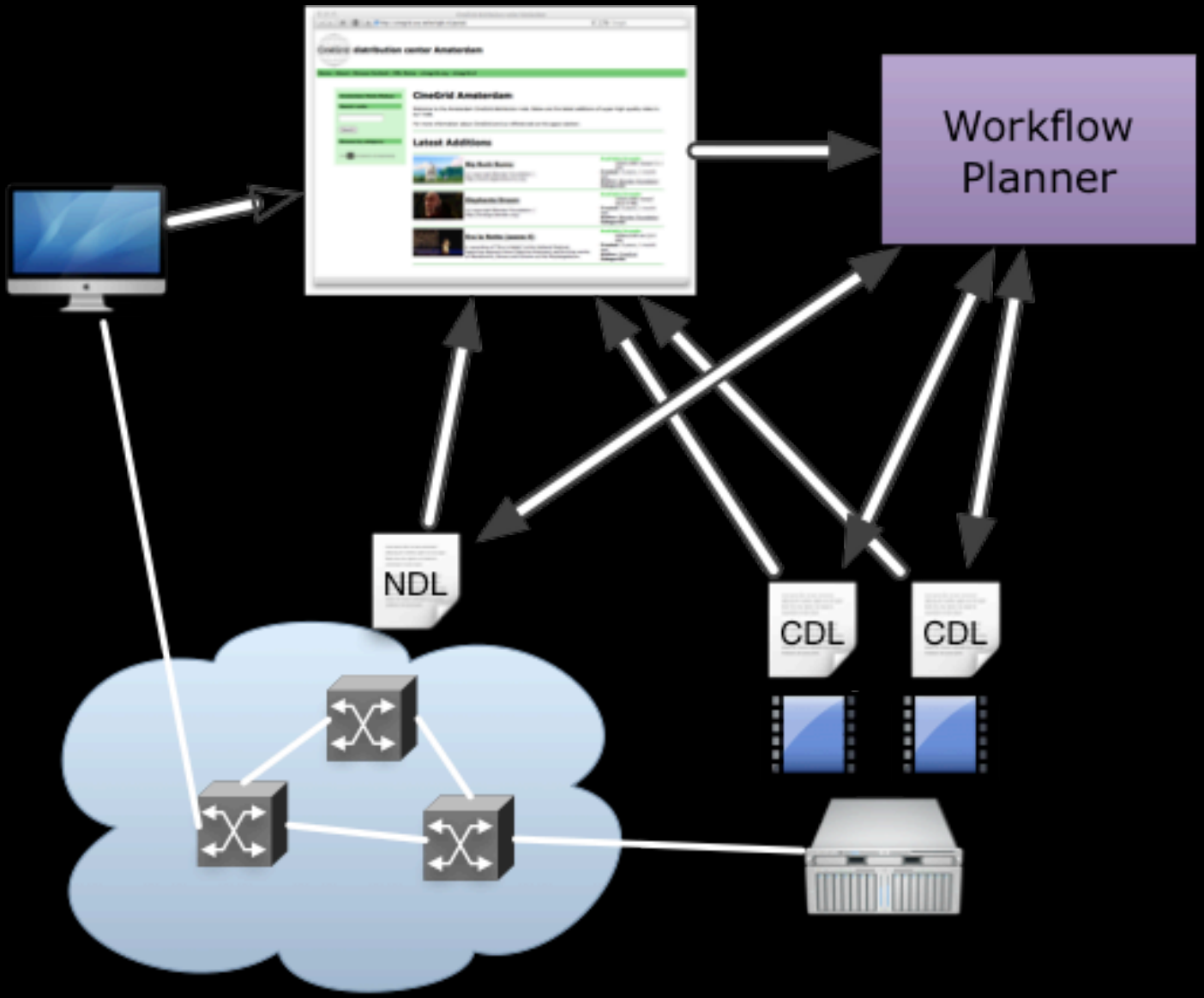
Avaliable formats:
4k dxt (3.9 KB)
Duration: 27 hours and 46 minutes
Created: 1 week, 2 days ago
Author: CineGrid
Categories: dalsa prague train

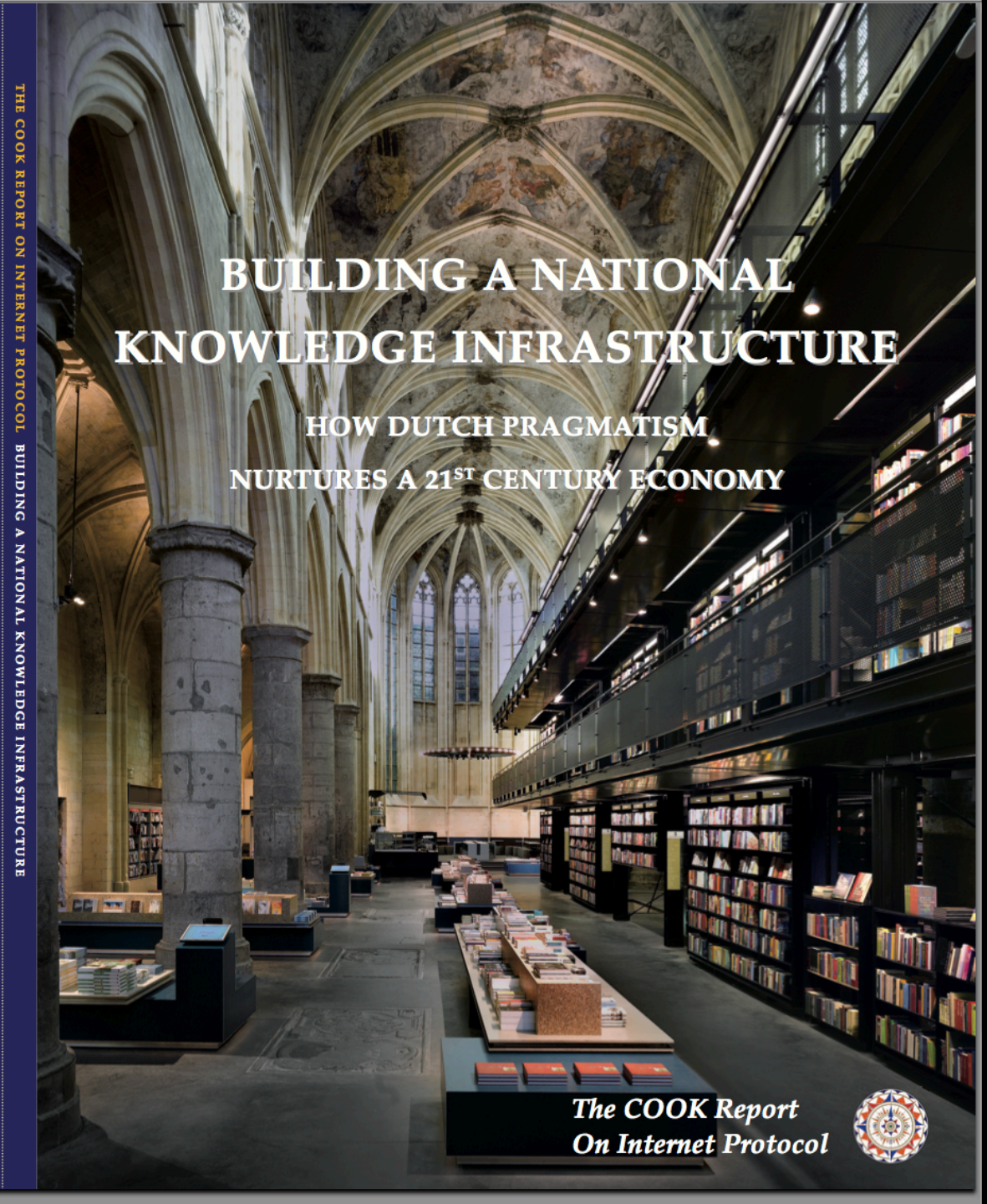
VLC: Big Buck Bunny

(c) copyright Blender Foundation | http://www.bigbuckbunny.org

Avaliable formats:
1080p MPEG4 (1.1 GB)
Duration: 1 hour and 0 minutes
Created: 1 month, 1 week ago
Author: Blender Foundation
Categories: animation blender bunny cgi

CineGrid Workflow Planner





Questions ?

CookReport
feb 2009 and feb-mar 2010

november '08
interview with
Kees Neggers (SURFnet),
Cees de Laat (UvA)

and furthermore
on november '09

Wim Liebrandt (SURF),
Bob Hertzberger (UvA) and
Hans Dijkman (UvA)

BSIK projects
GigaPort &
VL-e / e-Science

SURF NET

ext.delaat.net