Towards the Future Internet

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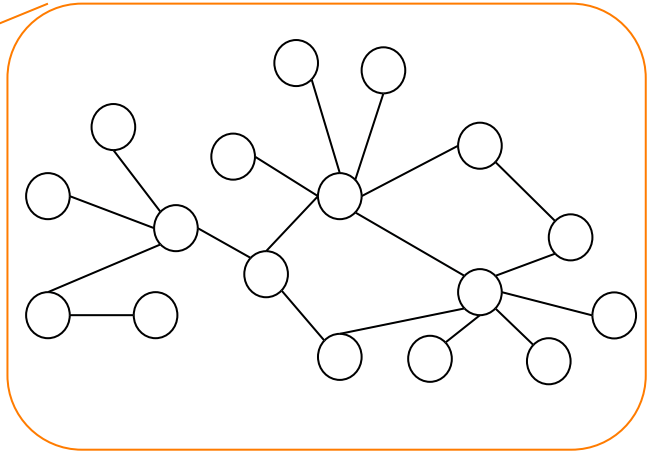
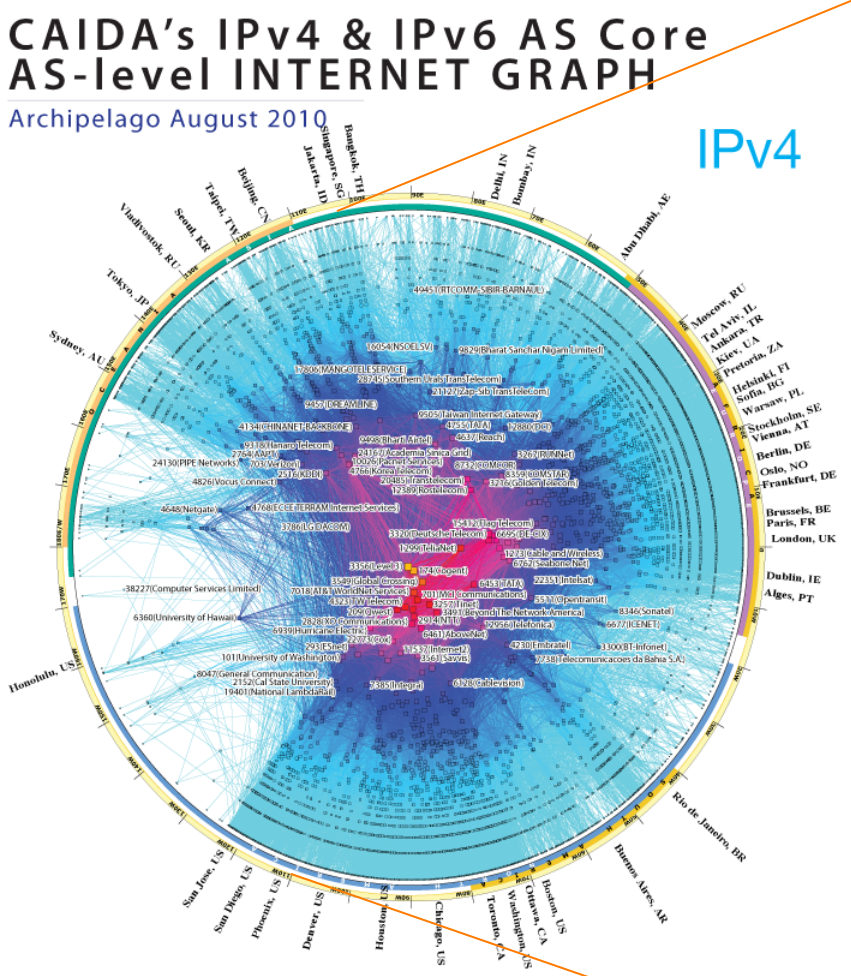
- Vertices and edges

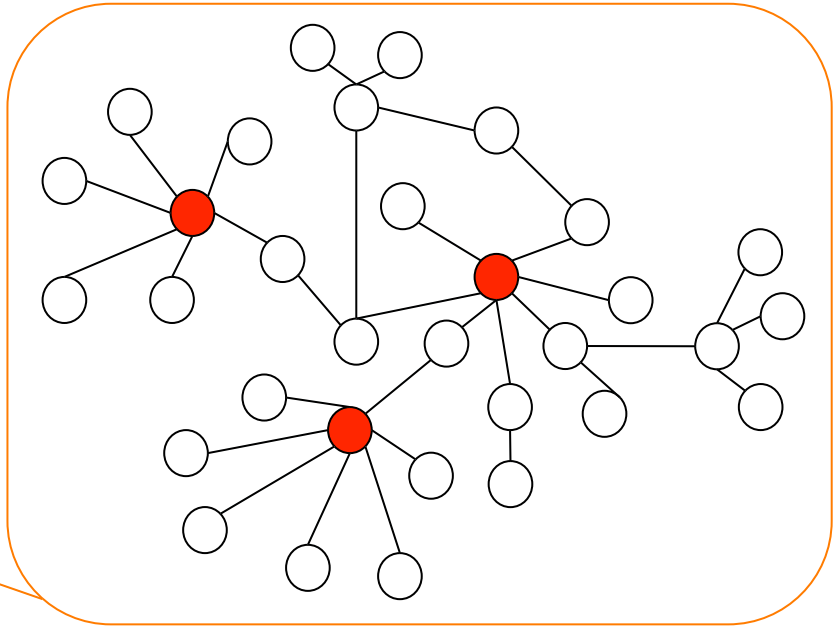


Path finding algorithms



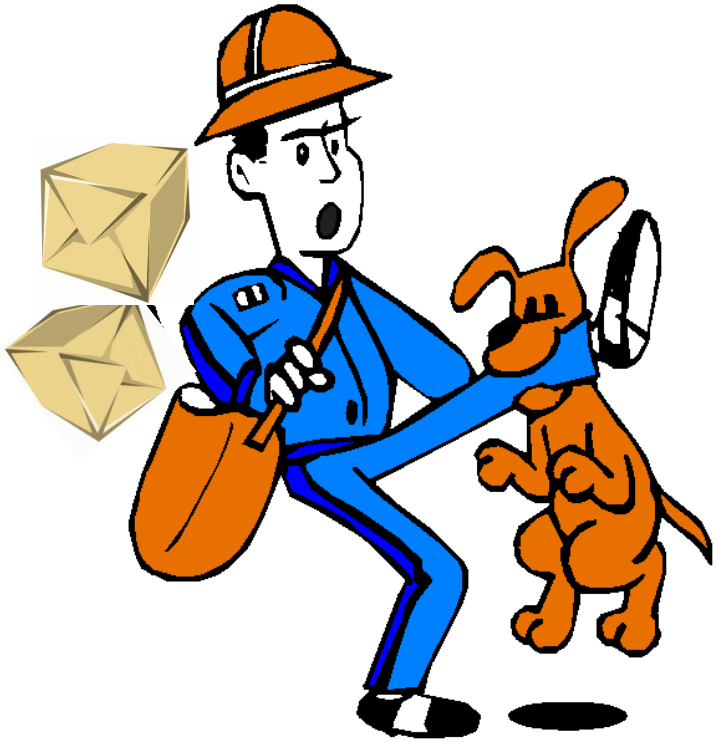
- Scale-free properties

Models

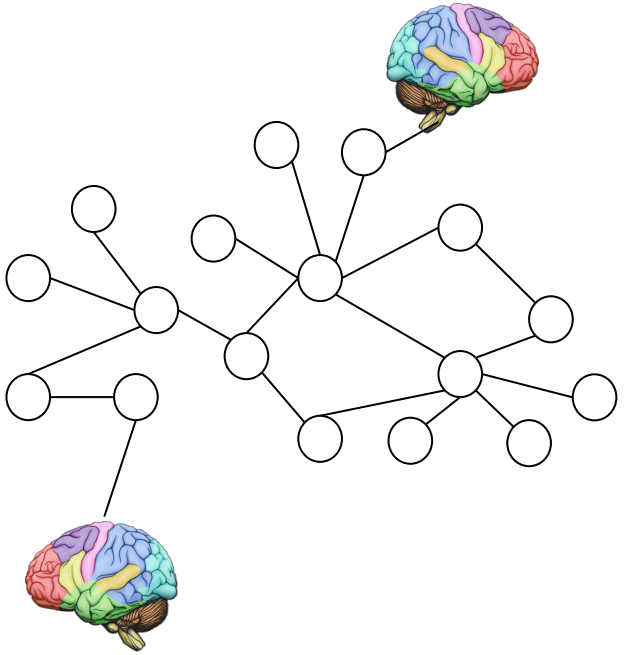


Two features of the current Internet

- Best effort delivery



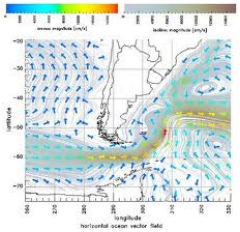
- End to end principle.



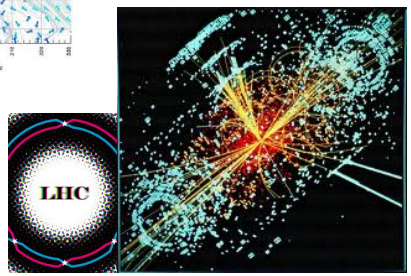
H. Saltzer, D. P. Reed, and D. D. Clark.
End-to-end arguments in system design.
In: ACM Trans. Comput. Syst. 2, 4 (Nov. 1984)

Many demands….

… more data!



Google



… more realtime!

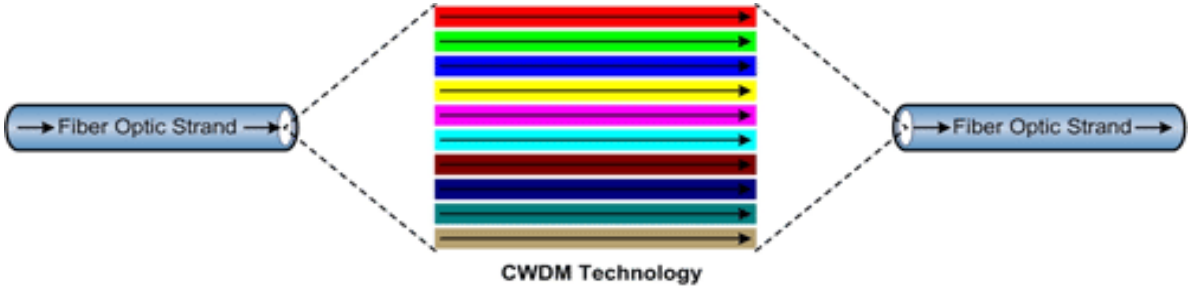
LinkedIn

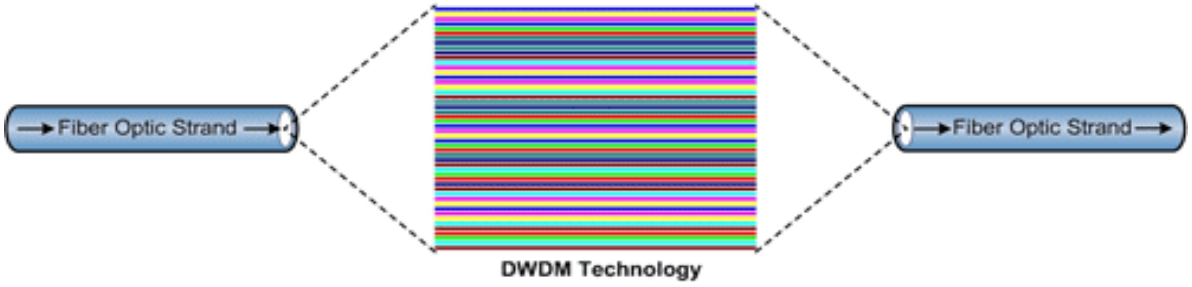
Hyves

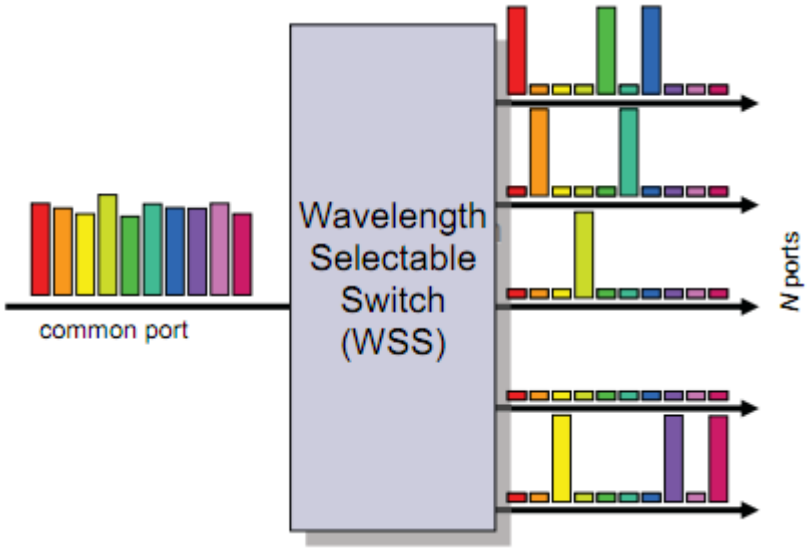
… more users!

... more possibilities

Optical transmission

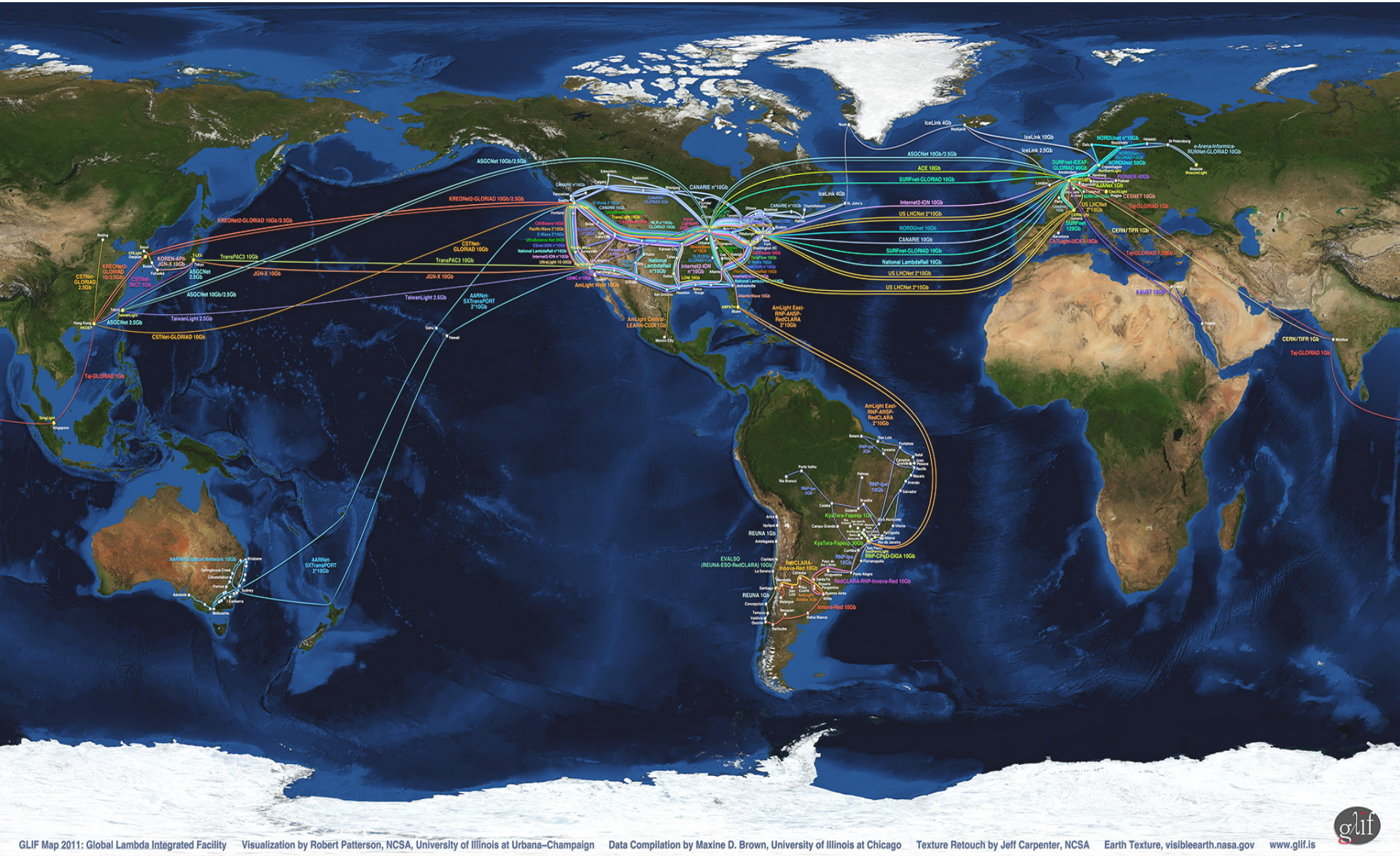






Virtualization

The GLIF – lightpaths around the world



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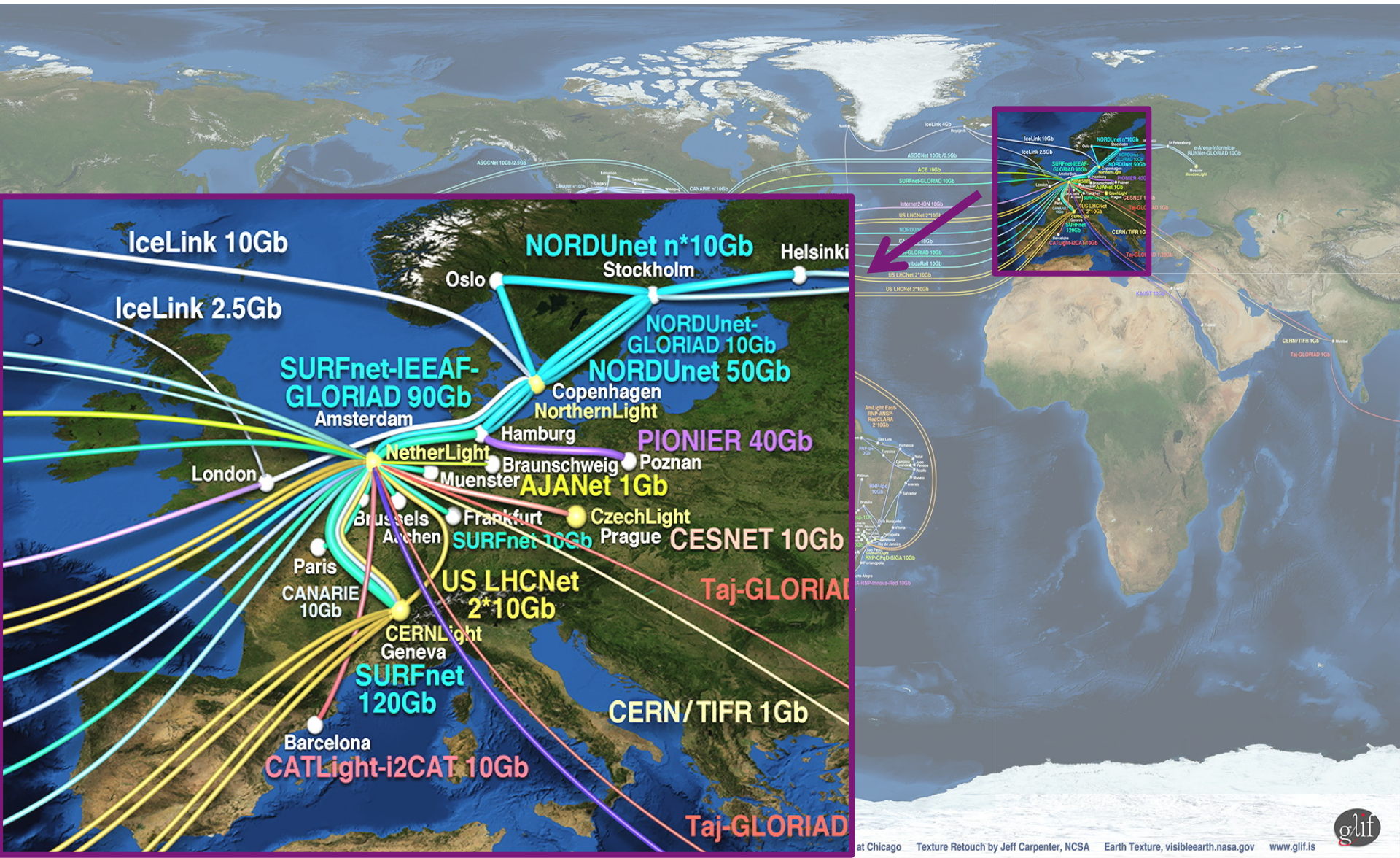


Our research : a new model for the internet

What we have now

Best effort delivery

End to end principle

What we want

- **Deterministic** behavior
- Flexible and dynamic communication

- More intelligence **in** the network
- **Solve the computing problem** (including storage and CPU) not just the communication problem

How?

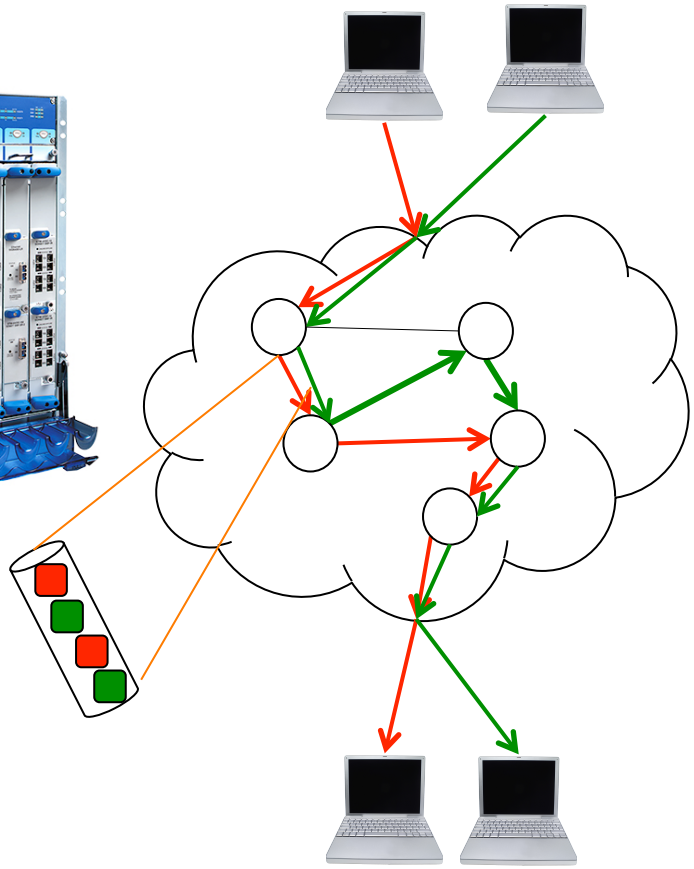
Hybrid networks

Smart infrastructures

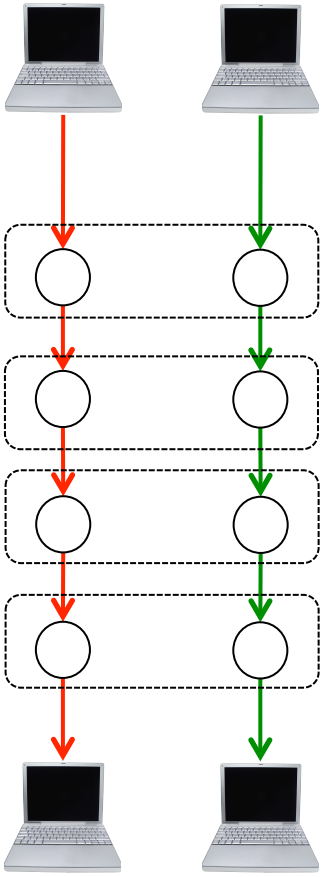
Information models

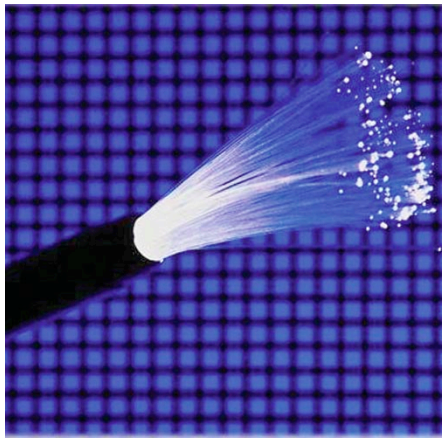
Hybrid networks – allow both packet and circuit switching

Packet switching



Circuit switching



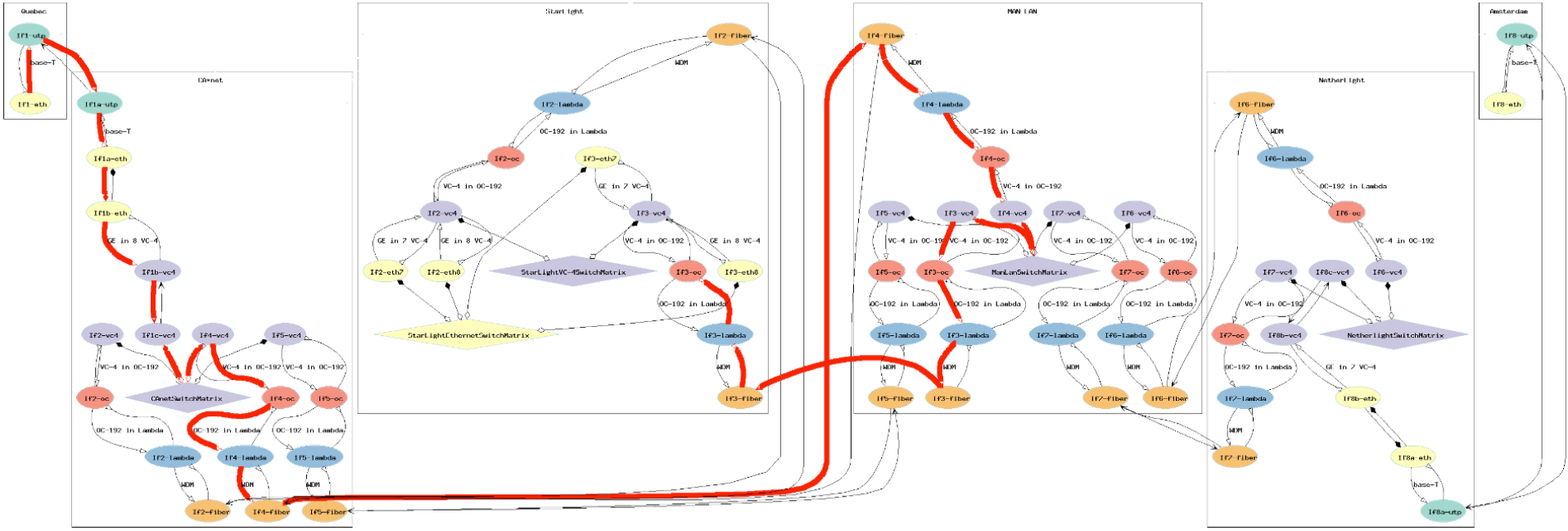


A good analogy is traffic on highways;
With circuits, you can achieve high bandwidth and guaranteed response times for applications that need it

Path finding in multi-layer multi-domain networks

Finding paths/circuits poses new challenges and needs research:

- Heterogeneous hardware (*multi-layer*)
  - **Technology agnostic** algorithm
- Different control planes (*multi-domain*)
  - Deal with different level of **abstraction** and information **filtering**
- Fully allocated is a new challenge for the algorithm!
  - Strike a balance between **efficiency** and **stability** (*dynamic reroute circuits*)



F. Dijkstra, J. van der Ham, P. Grosso and C. de Laat.
A path finding implementation for multi-layer networks, In: Future Generation Computer Systems, Vol.25, Issue 2, Feb. 2009, pp.142-146

A. Taal, P. Grosso, J. van der Ham and C de Laat
Path finding strategies for multi-domain multi-layer network architectures
In: Proceedings of the Cracow Grid workshop 2010

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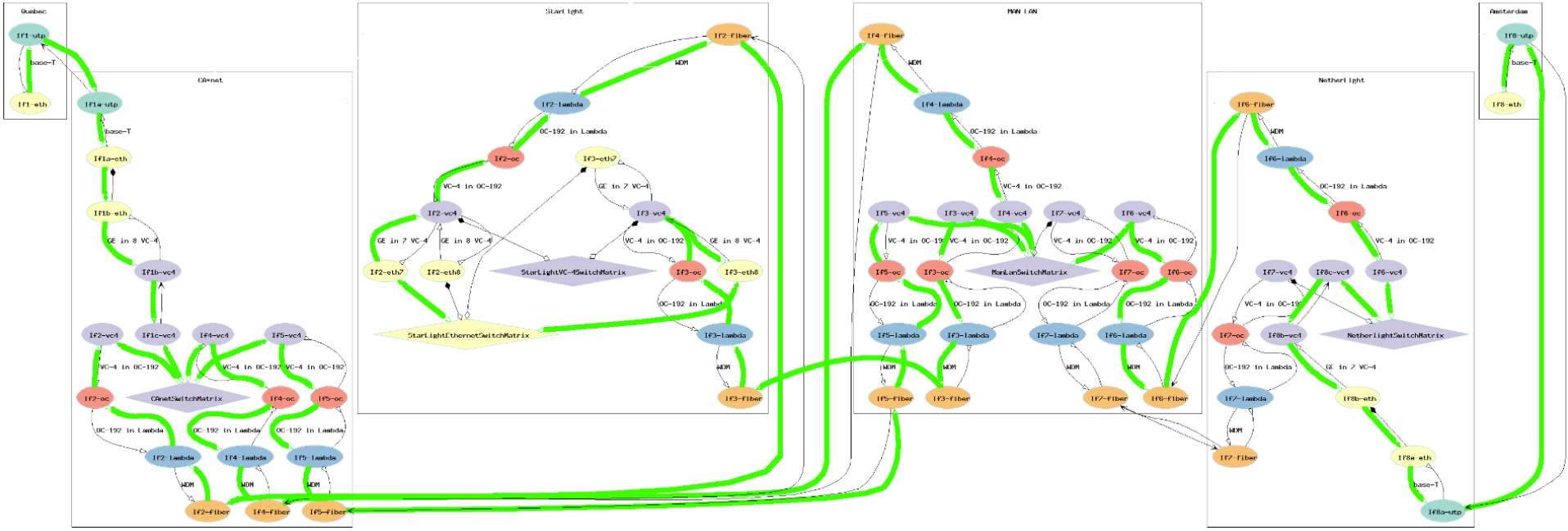

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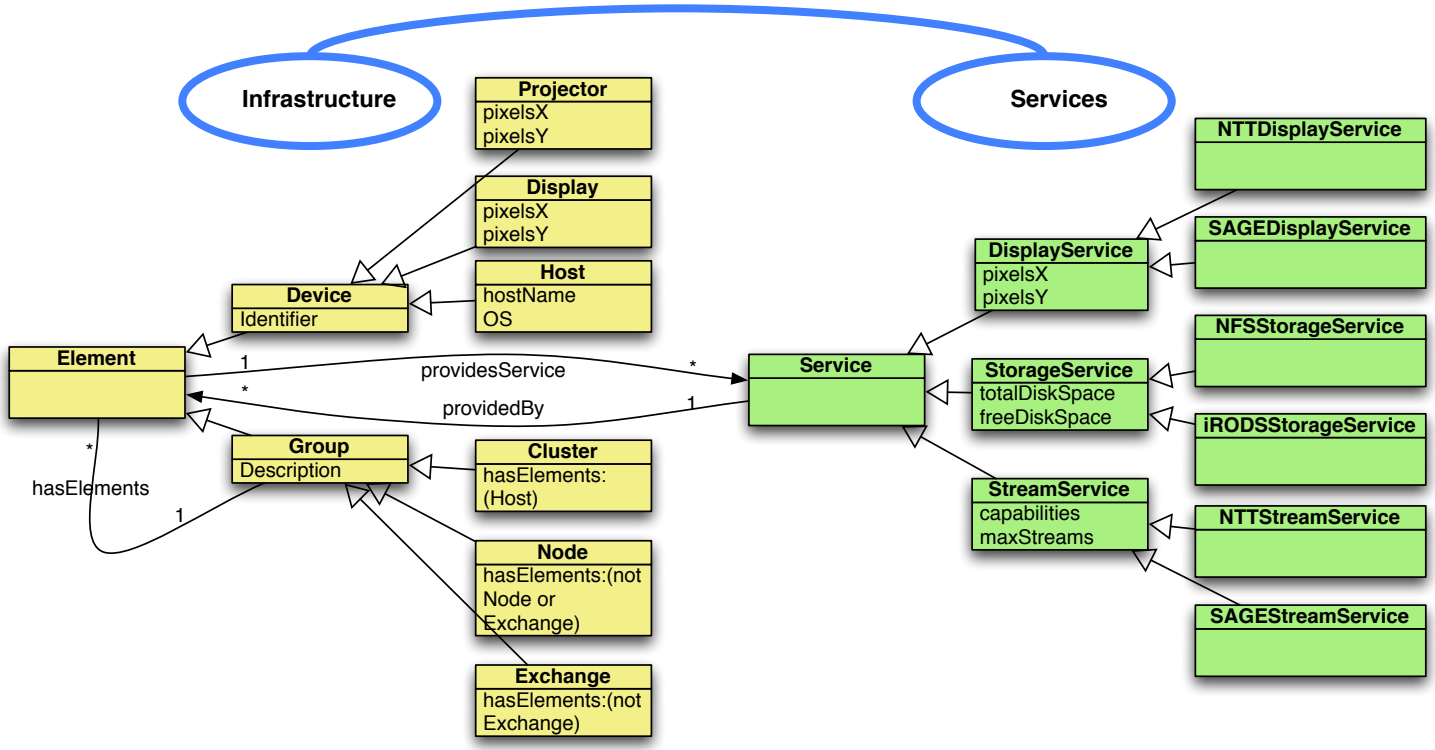
Information Modeling

Define a common information model for ***infrastructures*** and ***services***. Base it on Semantic Web.



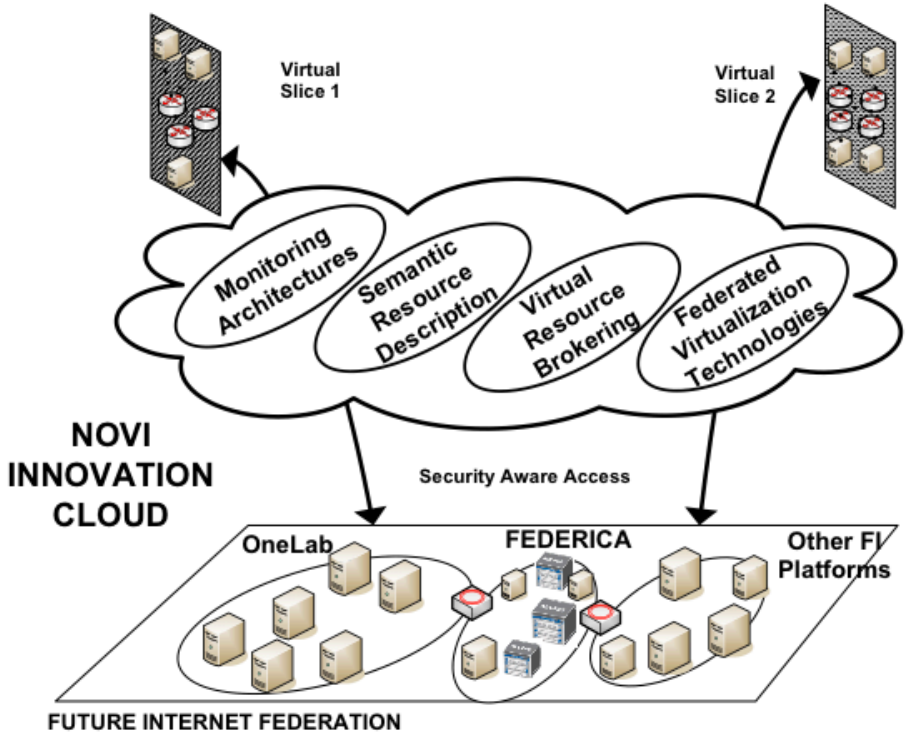
J. van der Ham, F. Dijkstra, P. Grosso, R. van der Pol, A. Toonk, C. de Laat
A distributed topology information system for optical networks based on the semantic web,
In: Elsevier Journal on Optical Switching and Networking, Volume 5, Issues 2-3, June 2008, Pages 85-93

R.Koning, P.Grosso and C.de Laat
Using ontologies for resource description in the CineGrid Exchange
In: Future Generation Computer Systems (2010)

NOVI
Networking Innovations Over Virtualized Infrastructures

You can gain more by take all pieces of the puzzle into account.

1. describe ***all*** computing resources
   (networks, computing and storage facilities)
2. *optimize the computing problem*, instead of only its network aspect



J. van der Ham, C. Papagianni, J. Steger, P.Matray, Y. Kryftis, P. Grosso and L. Lymberopoulos
Challenges of an Information Model for Federating Virtualized Infrastructures
In: 5th International DMTF Academic Alliance Workshop on Systems and Virtualization Management: Standards and the Cloud, Paris 24 Oct. 2011

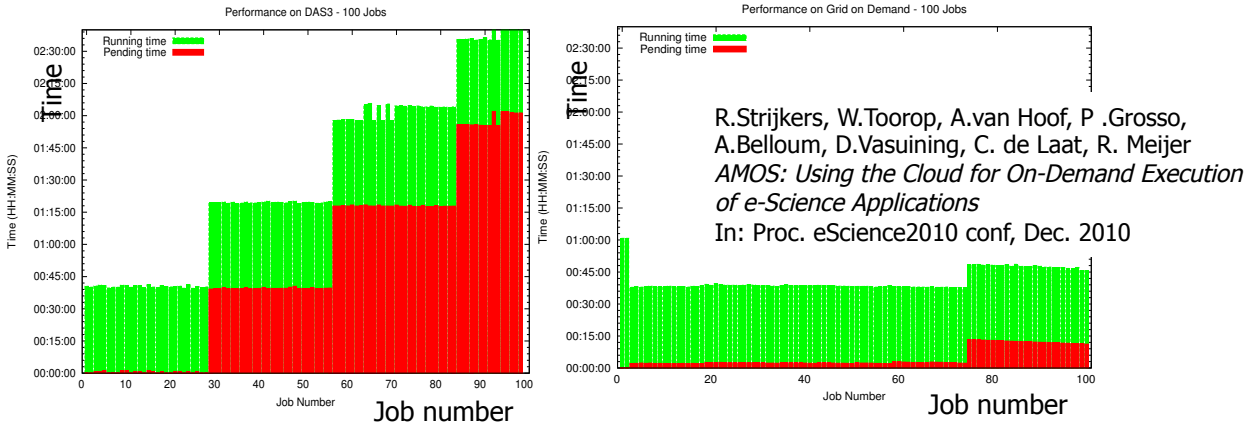
L. Lymberopoulos , P. Grosso, D. Kalogeras , C.Papagianni , C. de Laat , and V. Maglaris
Ontology-based Policy Based Management for Federated Virtualised Platforms
Third IFIP/IEEE International Workshop on Management of the Future Internet - May 2011

Demonstration of *optimizing the computing problem* ("Clouds")

If computing is 'infinite' and movable, then workflows and applications can ***program*** the network.

You can also introduce new metrics when creating and optimizing these infrastructures (*e.g* power consumption)

Grid-on-demand



R.Strijkers, W.Toorop, A.van Hoof, P .Grosso, A.Belloum, D.Vasuining, C. de Laat, R. Meijer
AMOS: Using the Cloud for On-Demand Execution of e-Science Applications
In: Proc. eScience2010 conf, Dec. 2010

User programmable networks

- The current Internet is a communication facility.

- Hybrid networks allow enormous improvements in service quality,

but require new approaches to path finding algorithms and infrastructure descriptions.

- The Future Internet is an integrated information and application facility.

We want to solve the combined allocation of communications paths, computing and storage.

www.science.uva.nl/~grosso
www.science.uva.nl/research/sne