Photonic Technology for 100G Networks; the Computer Science Perspective

Cees de Laat

EU COMMIT UvA

NWO
PID/EFRO
SURFnet
NLESC
TNO
SURF
Why?

Because we can!
I want to...

“Show Big Bug Bunny in 4K on my Tiled Display using green Infrastructure”

• Big Bugs Bunny can be on multiple servers on the Internet.
• Movie may need processing / recoding to get to 4K for Tiled Display.
• Needs deterministic Green infrastructure for Quality of Experience.
• Consumer / Scientist does not want to know the underlying details.
  ➔ His refrigerator also just works.
Cloud Computing

+ ML + reasoning (ProLog?) + Scheduling + ...

Service Plane

Domain Apps

Domain Apps

Domain Apps

Domain Apps

eScience Middleware

SAGE

CGLX

Cromium

SAGE

OCCI

JSDL

SAGA

GIR

UR

NSI

NetConf

SNMP

OpenFlow

PerfSonar

DIAS

ByteIO

iRODs

OGSA

WebServ

Cloud Computing

Diagram showing the integration of various middleware and applications in an eScience environment, including SAGE, CGLX, Cromium, OCCI, JSDL, SAGA, GIR, UR, NSI, NetConf, SNMP, OpenFlow, PerfSonar, DIAS, ByteIO, iRODs, OGSA, and WebServ. The diagram emphasizes the role of ML, reasoning, and scheduling in a domain-applications context, with Cloud Computing as a broader context.
TeraThinking

- What constitutes a Tb/s network?
- CALIT2 has 8000 Gigabit drops ?->? Terabit Lan?
- look at 80 core Intel processor
  - cut it in two, left and right communicate 8 TB/s
- think back to teraflop computing!
  - MPI turns a room full of pc’s in a teraflop machine
- massive parallel channels in hosts, NIC’s
- TeraApps programming model supported by
  - TFlops -> MPI / Globus
  - TBytes -> OGSA/DAIS
  - TPixels -> SAGE
  - TSensors -> LOFAR, LHC, LOOKING, CineGrid, ...
  - Tbit/s -> ?

ref Larry Smarr & CdL
User Programmable Virtualized Networks allows the results of decades of computer science to handle the complexities of application specific networking.

- The network is virtualized as a collection of resources
- UPVNs enable network resources to be programmed as part of the application
- Mathematica, a powerful mathematical software system, can interact with real networks using UPVNs
Mathematica enables advanced graph queries, visualizations and real-time network manipulations on UPVN

Topology matters can be dealt with algorithmically
Results can be persisted using a transaction service built in UPVN

**Initialization and BFS discovery of NEs**

```mathematica
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 neighbours of: 139.63.145.94
Internal links: {192.168.0.1, 139.63.145.94}

(...)

Getting neighbours of:192.168.2.3

**Transaction on shortest path with tokens**

Internal links: {192.168.2.3}

```
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 Virtualized Networks, accepted for publication to the IEEE e-Science 2006 conference Amsterdam.
ECO-Scheduling

What type of route should be planned?

- Fastest route
- Eco route
- Shortest route
- Avoid motorways
- Walking route
Conclusion

I want a MIS system!

Make it so!

Catchphrase first used in "Encounter At Farpoint" (28 September 1987) by Gene Roddenberry, and thereafter used in many episodes and films, instructing a crew member to execute an order.
Speakers

- Hiroshi Onaka, Fujitsu
- Kim Roberts, Ciena
- Inder Monga, ESnet