Mastering Complex Cyber Infrastructure

Cees de Laat

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TNO
Informatics Institute

- CSA: Computer Systems Architecture (dr. A.D. Pimentel)
- FCN: Federated Collaborative Networks (Prof. dr. H. Afsarmanesh)
- IAS: Intelligent Autonomous Systems (Prof. dr. ir. F.C.A. Groen)
- ILPS: Information and Language Processing Systems (Prof. dr. M. de Rijke)
- ISIS: Intelligent Sensory Information Systems (Prof. dr. ir. A.W.M. Smeulders)
- SCS: Section Computational Science (Prof. dr. P.M.A. Sloot)
- SNE: System and Network Engineering (Prof. dr. ir. C.T.A.M. de Laat)
- TCS: Theory of Computer Science (Prof. dr. J.A. Bergstra)
... more users!

Internet developments

... more data!

... more realtime!
Internet developments

... more data!

Speed

Volume

Deterministic

Real-time

Scalable

Secure

... more users!
We investigate: for complex networks!
The GLIF – lightpaths around the world
In the Intercloud virtual servers and networks become software

- Virtual Internets adapt to the environment, grow to demand, iterate to specific designs
- Network support for application specific interconnections are merely optimizations: Openflow, active networks, cisco distributed switch
- But how to control the control loop?
Interactive Networks

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Complex e-Infrastructure!
Why?

I want to:

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

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Why?

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.
The Ten Problems with the Internet

1. Energy Efficient Communication
2. Separation of Identity and Address
3. Location Awareness
4. Explicit Support for Client-Server Traffic and Distributed Services
5. Person-to-Person Communication
6. Security
7. Control, Management, and Data Plane separation
8. Isolation
9. Symmetric/Asymmetric Protocols
10. Quality of Service

Nice to have:
- Global Routing with Local Control of Naming and Addressing
- Real Time Services
- Cross-Layer Communication
- Manycast
- Receiver Control
- Support for Data Aggregation and Transformation
- Support for Streaming Data
- Virtualization

TimeLine

- GreenIT&Nets
- Sustainable Internet
- SF for Clouds
- Cognitive Nets and clouds
- NDL SF for complex nets
- Programmable Networks
- NetApp’s
- CineGrid
- SF for CineGrid

- Machine Learning +
- Virtualized Internet
- "I Want" Internet 3.0

- Good Old Trucking

Technologies:
- TCP
- RDUDP, SCTCP, ...
- ATM (G)MPLS
- SONET/SDH
- OpenFlow
- NDL SF
- SF for Clouds
- SF for CineGrid
- NM, OCCI, NSI
- NM - GLIF
- Hybrid Nets
- TBN
- Policy
- (G)MPLS, PBT/PLSB
- NetApp’s NM OCCI NSI
- AAA TBN Policy
- GreenIT&Nets
- Sustainable Internet
- Cognitive Nets and clouds
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Time:
- 1980
- 2000
- 2005
- 2011
- 2020
TimeLine

- Sustainable Internet
- Cognitive Nets and clouds
- Virtualized Internet
- Good Old Trucking

“I Want” Internet 3.0

2020

I retire

2040
I Want

Graph Theory

RDF Semantic descriptions

Context information

Logging History

Policy

APP Feedback

Monitoring

Sustainability

Machine Learning

Cloud Computing

Graph Theory

Machine Learning

Sustainability

Cloud Computing

Graph Theory

Machine Learning

Sustainability

Cloud Computing

Graph Theory

Machine Learning

Sustainability

Cloud Computing
Hybrid Networking <-> Computing

Routers ↔ Supercomputers

Ethernet switches ↔ Grid & Cloud

Photonic transport ↔ GPU’s

What matters:
Energy consumption/multiplication
Energy consumption/bit transported
Challenges

• Data – Data – Data
  – Archiving, publication, searchable, transport, self-describing, DB innovations needed, multi disciplinary use

• Virtualisation
  – Another layer of indeterminism

• Greening the Infrastructure
  – e.g. Department Of Less Energy: [http://www.ecrinitiative.org/pdfs/ECR_3_0_1.pdf](http://www.ecrinitiative.org/pdfs/ECR_3_0_1.pdf)

• Disruptive developments
  – BufferBloath, Revisiting TCP, influence of SSD’s & GPU’s
  – Multi layer Glif Open Exchange model
  – Invariants in LightPaths (been there done that 😊)
    - X25, ATM, SONET/SDH, Lambda’s, MPLS-TE, VLAN’s, PBT, OpenFlow, ….
  – Authorization & Trust & Security and Privacy
Data Centers
The Way Forward!

- Nowadays scientific computing and data is dwarfed by commercial & cloud, there is also no scientific water, scientific power.
  - Understand how to work with elastic clouds
  - Trust & Policy & Firewalling on VM/Cloud level
- Technology cycles are 3 – 5 year
  - Do not try to unify but prepare for diversity
  - Hybrid computing & networking
  - Compete on implementation & agree on interfaces and protocols
- Limitation on natural resources and disruptive events
  - Energy becomes big issue
  - Follow the sun
  - Avoid single points of failure (aka Amazon, Blackberry, …)
  - Better very loosely coupled than totally unified integrated…
ECO-Scheduling
Q & A

Slides thanks to:

- Paola Grosso
- Sponsors see slide 1. 😊
- SNE Team & friends, see below