Managing e-Infrastructures

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Complex (network) infrastructures
Optical transmission

Virtualization

…with more possibilities
The Big Data Challenge

6 Vs of Big Data

Volume
- Terabytes
- Records/Arch
- Tables, Files
- Distributed

Velocity
- Batch
- Real/near-time
- Processes
- Streams

Variety
- Structured
- Unstructured
- Multi-factor
- Probabilistic
- Linked
- Dynamic

Variability
- Changing data
- Changing model
- Linkage

Veracity
- Trustworthiness
- Authenticity
- Origin, Reputation
- Availability
- Accountability

Acquired Properties

Native Properties
The **ExoGENI Rack**

- VPN Gateway - Juniper SRX100
- Management Switch - Dell Force10 S55
- OpenFlow Switch - Dell Force10 S4810P
- Head Node - Dell R620
- Compute Nodes - 8 x Dell R620
- Storage Node - Dell R720

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The OpenLab in Amsterdam
<table>
<thead>
<tr>
<th>DEMO</th>
<th>TITLE</th>
<th>OWNER</th>
<th>AFFILIATION</th>
<th>E-MAIL</th>
<th>A-SIDE</th>
<th>Z-SIDE</th>
<th>PORTS(S) MAN-LAN</th>
<th>PORTS(S) TNC2013</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Big data transfers with multipathing, OpenFlow and MPTCP</td>
<td>Ronald van der Pol</td>
<td>SURFnet</td>
<td><a href="mailto:ronald.vanderpol@surfnet.nl">ronald.vanderpol@surfnet.nl</a></td>
<td>TNC/MECC, Maastricht NL</td>
<td>Chicago, IL</td>
<td>Existing 100G link between Internet2 and ESnet</td>
<td>2x40GE (juniper)- 2x 10GE (OME6500)</td>
<td>In this demonstration we show how multipathing, OpenFlow and Multipath TCP (MPTCP) can help in large file transfers between data centers (Miami-Madrid/Chicago). An OpenFlow application provides multiple paths between the servers and MPTCP will be used on the servers to simultaneously send traffic over all three paths. This demo uses 2x40GE on the traffic path. WOMNet, ESnet provides 2x40GE between MAN-LAN and Starlight. UNL and USHDA provide additional 100Gs.</td>
</tr>
<tr>
<td>2</td>
<td>Visualize 100G traffic</td>
<td>Inder Monga</td>
<td>ESnet</td>
<td><a href="mailto:imonga@es.net">imonga@es.net</a></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Using an STMP link from the Juniper switch at TNC2013, and via Brocade AL2S node in MAN-LAN, this demo would visualize the total traffic on the link of all data in aggregate. The network diagram will show the transatlantic topology and some of the topologies.</td>
</tr>
<tr>
<td>3</td>
<td>How many modern servers can fill a 100Gbps Transatlantic Circuit?</td>
<td>Inder Monga</td>
<td>ESnet</td>
<td><a href="mailto:imonga@es.net">imonga@es.net</a></td>
<td>Chicago, IL</td>
<td>TNC showfloor</td>
<td>1x 100GE</td>
<td>8x 10GE</td>
<td>In this demonstration, we show how the proper testing tool, only 2 hosts on each continent can generate almost 60Gbps of traffic. Each instance of 4 10G NICs connected to 40GE switch, and key ports running to generate traffic. ESnet’s new “porter” throughput measurement tool, will be used. This tool features from other tools such as nload, netflow, and netem. See <a href="https://www.esnet.org/demos/tnc2013/100g/">https://www.esnet.org/demos/tnc2013/100g/</a></td>
</tr>
<tr>
<td>4</td>
<td>First European ExoGENI at Work</td>
<td>Jeroen van der Ham</td>
<td>UvA</td>
<td><a href="mailto:vdham@uva.nl">vdham@uva.nl</a></td>
<td>RENCI, NC</td>
<td>UvA, Amsterdam, NL</td>
<td>1x 10GE</td>
<td>1x 10GE</td>
<td>The ExoGENI nodes at RENCI and UvA will be interconnected over a 10G pipe and be set on continuous networking. The GENI connectivity between Amsterdam and the rest of the GENI nodes in the USA.</td>
</tr>
<tr>
<td>5</td>
<td>Up and down North Atlantic at 100G</td>
<td>Michael Enrico</td>
<td>DANTE</td>
<td><a href="mailto:michael.enrico@dante.net">michael.enrico@dante.net</a></td>
<td>TNC showfloor</td>
<td>TNC showfloor</td>
<td>1x 100GE</td>
<td>1x 100GE</td>
<td>The DANTE 100GE test set will be placed at the TNC2013 showfloor and connected to the Juniper at 100G. When the demo is running, all 8 MAN-LANs will ensure that the traffic sent to UvA LAN returns to the showfloor. On display is the throughput and RTT to show the traffic crossed the Atlantic next.</td>
</tr>
</tbody>
</table>
This brings new fundamental questions with regard to scalability, robustness and sustainability.

A new model for the Internet

Can we build an Internet that is smart and sustainable?

With:

• Determinist and federative behaviors
• Flexible and dynamic communication
• More intelligence in the network
Towards smart and sustainable e-infrastructures

Three focus areas

Semantic models

(Network) services

Greenness and sustainability
• How can we represent complex e-Infrastructure?

- Semantic models

(Network) services

- How can compose end-to-end services that fully exploit virtualized programmable infrastructures?

Greenness and sustainability

- Can we use networks to provide support for applications that run in a more sustainable manner?

COMMIT/
Semantic models

“One of the main ingredients in the design, implementation and operation of computing infrastructures is the information model. This information model must describe both the physical infrastructure and its virtualization aspects.”
How the customer explained it
How the Project Leader understood it
How the Analyst designed it
How the Programmer wrote it
How the Business Consultant described it
How the project was documented
What operations installed
How the customer was billed
How it was supported
What the customer really needed
An effort started in 2010 (in parallel with our involvement in the FP7 projects Geysers and NOVI).

The goal was to capture the concept of virtualization in computing infrastructures and to describe the storage and computing capabilities of the resources.

A key feature is the decoupling of virtualization, connectivity and functionalities.

It is built upon the NML ontology.
It uses the nml:node concept as basic entity to describe resources in computing infrastructures.

It can be used as:
• a stand-alone model (i.e. without any network descriptions),
• in combination with NML by importing the NML ontology into the INDL definition.
Node components

- Node Component
  - partOf
  - rdfs:subClassOf Storage Component
  - rdfs:subClassOf Processor Component
  - rdfs:subClassOf Memory Component

- Storage Component
- Processor Component
- Memory Component

- hasComponent
- component
- partOf
- rdfs:subClassOf
- size
- speed
- cores
- architecture
- size
- Integer
- Integer
- Integer
- Integer
- String
Our connecting models

- geysers.owl
- novi.owl
- cdl.owl
- indl.owl
- qosawf.owl
- qosawf_map
- nml.owl
- edl.owl

full import
selective import
NOVI Federation

Our model is used for:
- Resource discovery
- Embedding algorithms
INDL use in NOVI

- Two nodes in the NOVI federation:
INDL in Geysers

- The virtualization model:
The OIntEd editor

http://indl-gui.appspot.com/

A methodology for separation of concerns between domain experts and knowledge engineers

NML and NSI

NML - Network Markup Language and NSI – Network Service Interface within the OGF.

- See: “Network Markup Language Base Schema version 1“

The Network Markup Language purpose is to create a functional description of multi-layer and multi-domain networks. It can be used for aggregated or abstracted topologies.

Under development: the Network Service Interface Topology Extensions
(Draft OGF Standard)
Publications (I)

- **Resource discovery and allocation for federated virtualized infrastructures**
  C. Pittaras, C. Papagianni, A. Leivadeas, P. Grosso, J. van der Ham, S. Papavassiliou

- **A Semantic-Web Approach for Modeling Computing Infrastructures**
  M. Ghijsen, J. van der Ham, P. Grosso, C. Dumitru, H. Zhu, Z. Zhao and C. de Laat

- **Addressing Big Data Issues in Scientific Data Infrastructure**
  Y. Demchenko, P. Membrey, P. Grosso and C. de Laat
  In: First International Symposium on Big Data and Data Analytics in Collaboration (BDDAC 2013). Part of
  The 2013 International Conference on Collaboration Technologies and Systems (CTS 2013), 2013

- **Semantic Distributed Resource Discovery for Multiple Resource Providers**
  C. Pittaras, M. Ghijsen, W. Adianto, P. Grosso, J. van der Ham and C. de Laat,
  In: Proceedings of the 8th International Conference on Semantics, Knowledge and Grids (SKG) 2012

- **OIntEd: online ontology instance editor enabling a new approach to ontology development**
  W. Adianto, R. Koning, P. Grosso, A. Belloum, M. Bubak and C. de Laat,
  In: Journal of "Software: Practice and Experience" 2012
“Automated advanced capabilities to users [...]: 
intelligent resource mapping, policy-driven 
access and resource allocation, context aware 
resource discovery, transparent data plane 
connectivity and monitoring of combined user 
slices and substrate resources across domains”
NewQoSPlanner

The NSI – Network Service Interface – creates on the fly connections between domains.

Z. Zhao, J. v/d Ham, A. Taal, R. Koning, P. Grosso and C. de Laat
Planning data intensive workflows on inter-domain resources using the Network Service Interface (NSI)
In: WORKS 2012
HyperFlow

Encoding times improve as the end nodes are connected via dynamic lightpaths

C. Dumitru, Z. Zhao, P. Grosso and C. de Laat
HybridFlow: Towards Intelligent Video Delivery and Processing Over Hybrid Infrastructures (In CTS 2013)
Ralph Koning, Paola Grosso and Cees de Laat.  
*Using ontologies for resource description in the CineGrid Exchange,*  
A queueing model approach
Publications (II)

- **A Queueing Theory Approach to Pareto Optimal Bags-of-Tasks Scheduling on Clouds**
  C. Dumitru, A. Oprescu, M. Zivkovic, R. v/d Mei, P. Grosso and C.de Laat
  Submitted to Europar2014

- **HybridFlow: Towards intelligent video delivery and processing over hybrid infrastructures**
  C.Dumitru, Z. Zhao, P. Grosso and C.de Laat
  In: 2013 International Conference on Collaboration Technologies and Systems (CTS), 2013

- **An agent based network resource planner for workflow applications**
  Z. Zhao, P. Grosso, J. van der Ham, R. Koning and C.de Laat.

- **Using ontologies for resource description in the CineGrid Exchange**
“….the cloud model provides also benefits from the environmental perspective….“
Green scheduling

Network infrastructures

CO₂ footprint; Energy needed and lost

Energy transport

Bits to energy

Green energy sources

CO₂ footprint; Energy needed and lost

Energy transport

Energy to bits
Energy saving in clouds

Quantifying the energy performance of VMs is the first step toward energy-aware job scheduling.

*Profiling energy consumption of VMs for green cloud computing*
In: International Conference on Cloud and Green Computing (CGC2011), Sydney December 2011
Energy Efficient Ethernet (802.3az)

Power savings techniques in hardware can be leveraged in architecting communication patterns in data centres.

D. Pavlov and J. Soert and P. Grosso and Z. Zhao and K. van der Veldt and H. Zhu and C.de Laat
Towards energy efficient data intensive computing using IEEE 802.3az
In: DISCS 2012 workshop - Nov 2012
Networks and CO2

- Take a network (Esnet, working on using SURFnet data)
- Define the traffic model running on it
- Use the energy monitoring information and energy costs data
- Compare path selection strategies: shortest, cheapest and greenest
Results

In region 1 the task should be performed locally, independently of the type of transport network.

In region 2 the task can be performed remotely provided that the connection is a light path.

In region 3 the task should be done remotely for both types of transport networks.

Given different network paths we can identify decision boundaries as function of the task complexity.
Publications (III)

• Storage to Energy: modeling the carbon emission of storage task offloading between data centers
  A. Taal, D. Drupsteen, M. Makkes and P. Grosso
  In: CCNC conference (Las Vegas Jan. 2014)

• A decision framework for placement of applications in clouds that minimizes their carbon footprint
  M. Makkes, A. Taal, A. Osseyran and P. Grosso

• EKB: semantic information system for energy-aware monitoring in distributed infrastructures
  H. Zhu, K. v/d Veldt, P. Grosso, X. Liao and C. de Laat
  In: IEEE International Conference on Cloud and Green Computing (CGC 2013) - Sep. 2013

• Towards energy efficient data intensive computing using IEEE 802.3az
  In: DISCS 2012 workshop - Nov 2012
Conclusions

• There is a clear need for a common information model that allows intelligent information exchange.

INDL, NML

• Such models support novel scenarios that will empower BigData transport and processing.

BaTS, CineGrid, NetQoSPlanner

• BigData can be ‘green’.