Science Faculty @ UvA

Informatics Institute

- AMLAB: Machine Learning (Prof. dr. M. Welling)
- FCN: Federated Collaborative Networks (Prof. dr. H. Afsarmanesh)
- ILPS: Information and Language Processing Systems (Prof. dr. M. de Rijke)
- ISIS: Intelligent Sensory Information Systems (Prof. dr. ir. A.W.M. Smeulders)
- CSL: Computational Science Laboratory (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)
SNE - Mission

Can we create smart and safe data processing infrastructures that can be tailored to diverse application needs?

• **Capacity**
  – Bandwidth on demand, QoS, architectures, photonics, performance

• **Capability**
  – Programmability, virtualization, complexity, semantics, workflows

• **Security**
  – Policy, Trust, Anonymity, Privacy, Integrity

• **Sustainability**
  – Greening infrastructure, Awareness

• **Resilience**
  – Failures, Disasters, Systems under attack
SNE - Mission

Can we create smart and safe data processing infrastructures that can be tailored to diverse application needs?

- **Capacity**
  - Bandwidth on demand, QoS, architectures, photonics, performance

- **Capability**
  - Programmability, virtualization, complexity, semantics, workflows

- **Security**
  - Policy, Trust, Anonymity, Privacy, Integrity

- **Sustainability**
  - Greening infrastructure, Awareness

- **Resilience**
  - Failures, Disasters, Systems under attack
What Happens in an *Internet* Minute?

- 639,800 GB of global IP data transferred
- 20 New victims of identity theft
- 204 million Emails sent
- 135 Botnet infections
- 100+ New LinkedIn accounts
- 1,300 New mobile users
- 204 million App downloads
- 47,000 App downloads
- $83,000 In sales
- 47,000 In sales
- 61,141 Hours of music
- 320+ New Twitter accounts
- 20 million Photo views
- 20 million Photo views
- 3,000 Photo uploads
- 100,000 New tweets
- 6 New Wikipedia articles published
- 6 New Wikipedia articles published

And Future Growth is Staggering:

- 277,000 Logins
- 6 million Facebook views
- 1.3 million Video views
- 2+ million Search queries
- 30 Hours of video uploaded
- In 2015, it would take you 5 years to view all video crossing IP networks each second
There is always a bigger fish.
Internet developments

... more data!

... more realtime!

... more users!
Multiple colors / Fiber

Per fiber: ~ 80-100 colors * 50 GHz
Per color: 10 – 40 – 100 Gbit/s
BW * Distance ~ 2*10^{17} bm/s

Wavelength Selective Switch

New: Hollow Fiber!
⇒ less RTT!
GPU cards are disruptive!

- Top 500: 20,000,000$ in 7 years
- #1 and #500: 500$
Reliable and Safe!

This omnipresence of IT makes us not only strong but also vulnerable.

• A virus, a hacker, or a system failure can instantly send digital shockwaves around the world.

The hardware and software that allow all our systems to operate is becoming bigger and more complex all the time, and the capacity of networks and data storage is increasing by leaps and bounds.

We will soon reach the limits of what is currently feasible and controllable.
ExoGeni @ OpenLab - UvA

Installed and up June 3th 2013

TNC2013 DEMOS JUNE, 2013

1. Rig tests transfers with mulequing, OpenFlow and MPTCP
   - Owner: Morlan van der Mei
   - Affiliation: SURFnet
   - Details: Existing 100G link between Internet2 and ExoNet

2. Visualization 100G Traffic
   - Owner: Monge
   - Details: Chicago, IL

3. How mostly modern servers can the ExoGENI Transatlantic
   - Owner: Monge
   - Details: Chicago, IL

4. First download ExoGENI at 100G
   - Owner: van der Mei
   - Details: UNC, NC

5. 10G and 100G North Atlantic 100G Pilot
   - Owner: Michael Rizzo
   - Details: TNC showfloor

Connected via the new 100 Gb/s transatlantic To US-GENI
Amsterdam is a major hub in The GLIF

Can we create smart and safe data processing infrastructures that can be tailored to diverse application needs?

- **Capacity**
  - Bandwidth on demand, QoS, architectures, photonics, performance
- **Capability**
  - Programmability, virtualization, complexity, semantics, workflows
- **Security**
  - Policy, Trust, Anonymity, Privacy, Integrity
- **Sustainability**
  - Greening infrastructure, Awareness
- **Resilience**
  - Failures, Disasters, Systems under attack
SARNET: Security Autonomous Response with programmable NETworks

Cees de Laat
Leon Gommans, Rodney Wilson, Rob Meijer
Tom van Engers, Marc Lyonais, Paola Grosso, Frans Franken, Ameneh Deljoo, Ralph Koning, Ben de Graaff, Stojan Trajanovski
Cyber security program

• Research goal is to obtain the knowledge to create ICT systems that:
  – model their state (situation)
  – discover by observations and reasoning if and how an attack is developing and calculate the associated risks
  – have the knowledge to calculate the effect of counter measures on states and their risks
  – choose and execute one.

In short, we research the concept of networked computer infrastructures exhibiting SAR: Security Autonomous Response.
Network virtualizations and SDN

Reasoning

Risk evaluation

Trust groups

Execute response & adaptation

SARNET
Security Autonomous Response with programmable NETworks

Cyber Security program

Pi: CdL
Co-Pi’s: LG, RW, RM
Co-Sci: PG, TvE, FF, ML

400 + 285 + 300 kEuro
2 PhD’s (AD, RK), 1 PD (ST)
Prog & Eng manpower (BG)

delaat.net/sarnet

• Network virtualizations and SDN
• Reasoning
• Risk evaluation
• Trust groups
• Execute response & adaptation
Ciena’s CENI topology

- Ottawa - Chicago Infrastructure
- Canarie MANLAN link
- ESnet alt route segment
- Link to Ciena Station Ridge HQ
Context & Goal

Security Autonomous Response NETwork Research

Ameneh Deljoo (PhD):
Why create SARNET Alliances? Model autonomous SARNET behaviors to identify risk and benefits for SARNET stakeholders.

Stojan Trajanovski (PD):
Determine best defense scenario against cyberattacks deploying SARNET functions (1) based on security state and KPI information (2).

Ralph Koning (PhD) Ben de Graaff (SP):
1. Design functionalities needed to operate a SARNET using SDN/NFV
2: deliver security state and KPI information (e.g. cost)
National Science Foundations ExoGENI racks, installed at UvA (Amsterdam), Northwestern University (Chicago) and Ciena’s labs (Ottawa), are connected via a high performance 100G research network and trans-Atlantic network facilities using the Ciena 8700 Packetwave platform. This equipment configuration is used to create a computational and storage test bed used in collaborative demonstrations.
Position of demo @ SC15

Objective

• To get a better understanding for cyber attack complexity by visually defend a network suffering from basic volumetric attacks.
• To find a way to visualize future research in automated response.

Demo highlights

• Pre-programmed attack scenarios that are able to show defense functions.
• Virtual sales + income from web services
• Defense cost

DDoS Defence functions.

• Filtering
• Blocking
• Resource Scaling
Demo stack

- Multitouch Table + Browser
- VNET-ui (skynet.lab.uvalight.net)
- UI controller
- VNET-core
- Topology orchestrator
- Monitoring
- VNET-tools
- VNET-agent
- Agent scripts
- Virtual machines
- Network Functions
- ExoGENI ORCA Framework
- NSI Driver
- 8700 Driver

Developed by UvA
Developed by RENCI
Service Provider Group framework

A Service Provider Group (SPG) is an organisation structure providing a defined service only available if its members collaborate.

Examples:
Service Provider Group Characteristics

• Autonomous members acting together on a decision to provide a service none could provide on its own
• Appears as a single provider to a customer
• Appears as a collaborative group to members with standards, rules and policies that are defined, administered, enforced and judged by the group.
• Autonomy in the group: every member signs an agreement declaring compliance with common rules, unless local law determines otherwise.
• Membership rules organizes trust amongst members and manage group reputation and viability.
Envisioned role of the SPG: define slice archetypes?

Slice Creation level

Service Provider Group level

Aggregate Manager

Service Provider Infrastructure Level

Privacy
Big Science
DRP
Cyber defense

SPG - A
SPG - B

AM
AM
AM
AM
AM
In our model, we refer to four layers of components:

- the signal layer—describes acts, side-effects and failures showing outcomes of actions in a topology.
- the action layer—actions: performances that bring a certain result,
- the intentional layer—intentions: commitments to actions, or to build up intentions,
- the motivational layer—motives: events triggering the creation of intentions.
Simplified Eduroam case at signalling layer

Petri net of EduRoam Case (first step)
Describing Intentions, Motivations and Actions

Petri net of EduRoam Case

EduRoam Case
Can we create *smart* and safe data processing infrastructures that can be tailored to diverse application needs?

- **Capacity**
  - Bandwidth on demand, QoS, architectures, photonics, performance
- **Capability**
  - Programmability, virtualization, complexity, semantics, workflows
- **Security**
  - Policy, Trust, Anonymity, Privacy, Integrity
- **Sustainability**
  - Greening infrastructure, Awareness
- **Resilience**
  - Failures, Disasters, Systems under attack
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 Big Data Challenge

Doing Science

Wisdom

Knowledge to act

Information

Data a.o. from ESFRI’s

ICT to enable Science

e-IRG

Workflows Schedulers to act

OWL

XML, RDF, rSpec, SNMP, Java based, etc.

GRID/CLOUD
The Big Data Challenge

Doing Science

Wisdom

Knowledge

Information

Data
a.o. from ESFRI’s

ICT to enable Science

e-IRG
Workflows
Schedulers

OWL

XML, RDF, rSpec,
SNMP, Java based, etc.

MAGIC DATA CARPET

curation - description - trust - security - policy – integrity
The Big Data Challenge

Doing Science

ICT to enable Science

Wisdom

Knowledge

XML, RDF, rSpec, SNMP, Java based, etc.

OWL

Science App Store?

MAGIC DATA CARPET

curation - description - trust - security - policy – integrity

Information

Data

a.o. from ESFRI’s

Scientists live here!

GRID/CLOUD
Can we create smart and safe data processing infrastructures that can be tailored to diverse application needs?

- **Capacity**
  - Bandwidth on demand, QoS, architectures, photonics, performance

- **Capability**
  - Programmability, virtualization, complexity, semantics, workflows

- **Security**
  - Policy, Trust, Anonymity, Privacy, Integrity

- **Sustainability**
  - Greening infrastructure, Awareness

- **Resilience**
  - Failures, Disasters, Systems under attack
The smart network, the smart infrastructure

Dr. Paola Grosso
System and Network Engineering (SNE) research group
UvA
Email: p.grosso@uva.nl
Why do we need a smart network/infrastructure?

What is a smart network/infrastructure?
We exploit *richer network and infrastructure descriptions* to deliver *federated network and clouds services*.

We leverage the *SDN paradigm* to align network behavior closer and applications needs.

We get:

- more energy-efficient,
- more secure,
- more adaptable networks
Ontology families

M. Ghijsen, J. v/d Ham, P. Grosso, C. Dumitru, H. Zhu, Z. Zhao, C. De Laat
OMN – Open Multinet

https://github.com/open-multinet
https://github.com/open-multinet/playground-rspecs-ontology/tree/master/omnlib/ontologies

A. Willner, C. Papagianni, M. Giatili, P. Grosso, M. Morsey, Al-Hazmi Y., I. Baldin
The Open-Multinet Upper Ontology - Towards the Semantic-based Management of Federated Infrastructures
The 10th International Conference on Testbeds and Research Infrastructures for the Development of Networks & Communities (TRIDENTCOM2015)
Transitioning from OpenNaas to SemNaaS

Developed a semantic enabled Network-as-a-Service (NaaS) system

Applied NML2/OMN on that system.

SemNaaS: Add Semantic Dimension to the Network as a Service
Mohamed Morsey, Hao Zhu, Iasiar Canyameres, Paola Grosso
Informatics Institute, University of Amsterdam
i2CAT Foundation, Barcelona

M Morsey, H Zhu, I Canyameres, P Grosso
SemNaaS: Add Semantic Dimension to the Network as a Service
The Semantic Web: ESWC 2015 conference

SemNaaS Components
- Request Generation and Validation Component:
  - SemNaas performs two levels of validation, namely request validation and connectivity check.
  - It uses SPARQL to detect unreachability among various nodes.
- Monitoring Component:
  - A network resource may experience failure conditions as well, e.g., network connectivity failure.
  - Whenever a change occurs in the resource status, SemNaas tracks that change.
- Report Generation Component:
  - SemNaas supports generating reports about the whole resource reservation process.
  - Reports enable system administrators to identify the problematic resources of OpenNaas.

Interconnection of Distributed Naas Instances
- OpenNaas faces the problem of maintaining the connections of the IDs assigned to the various network components.

Use Case
- The Virtual Routing Function use case aims to implement inter-domain routing through OpenNaas over an OpenFlow infrastructure.

Network Markup Language
- The underlying network connecting data centers or within a single site is still too unmanageable and unrepeatable than the other parts of the infrastructure.
- New frameworks are emerging to define and create such dynamic network services, these frameworks in essence support as a Service (NaaS) operations.
- The emerging Naas software systems require powerful and rich vocabularies, such as the ones that can be provided by Semantic Web technologies.
- DML ontologies have several advantages as models for Naas i.e. they are easy to extend, they allow for automatic validation of both requests and provisioned services, and they enhance network resource discovery.

Conclusion and Future Work
- SemNaas leverages Semantic Web with Naas to develop an intelligent Naas system.
- SemNaas resources can be interconnected to SDN cloud.

Contact Information
- Web: https://towards.ai
- Email: morsey@ivi.fswi.uva.nl
- Phone: +31 20 925 3989

SemNaas Architecture
- SemNaas consists of four components:
  1. request validation and connectivity checking component.
  2. OpenNaas component, which is a plugable component, that supports the network resources provisioning.
  3. monitoring component.
  4. report generation component.

Objectives
- Applying Semantic Web as Network as a Service (Naas).
- Utilizing Network Markup Language (NML) entities to support Naas operations.
- Developing a Semantic Web based system called SemNaas, which applies Semantic Web technologies on Naas.

Diagram: SemNaas system architecture.

Diagram: Sequence diagram for Virtual Routing Function (VRF).
SWSDI 2016 Workshop


Contents

  1.1 Workshop Objectives
  1.2 Topics of Interest
  1.3 Workshop Organizers
  1.4 Program Committee
  1.5 Submission Guidelines
  1.6 Important Dates

Workshop Objectives

The main objective of SWSDI 2016 is to study the applicability and maturity of Semantic Web based methodologies for modelling the newly emerging software-defined (computing and networking) infrastructures, particularly federated infrastructures and federated Clouds. Furthermore, SWSDI 2016 aims to identify how the Semantic Web surpasses other approaches, such as the exchange of simple XML or JSON serialized tree data structures.

Workshop organizers
Jorge Cardoso, University of Coimbra, Portugal
Paola Grosso, University of Amsterdam, The Netherlands
Mohamed Morsey, University of Amsterdam, The Netherlands
Alexander Willner, TU Berlin, Germany

Deadlines
Notification of acceptance: Friday April 1st, 2016.
Emerging interest in SDN for energy efficiency

- Emerging studies improve on the energy consumption of servers by the VM migration.
- Some change the OpenFlow protocol to be energy-aware.
- All of them are implemented in intra-data center scale.
- All have a fixed initial traffic matrix.

Yearly distribution of the OpenFlow technique adoption by decision frameworks from December 2008 to November 2013

Green routing with SDN

Make a routing decision to aggregate traffic over a subset of links and devices in over-provision networks and switch off unused network components

How much savings?

We adopt linear programming to determine how to program flows in the network.

We show that in FatTree networks, where switches can save up to 60% of power in sleeping mode, we can achieve 15% minimum improvement assuming a one-to-one traffic scenario. Two of our algorithm variations privilege performance over power saving and still provide around 45% of the maximum achievable savings.

General chair
Anwar Osseyran, SURFsara & University of Amsterdam, The Netherlands

Program chairs
Paola Grosso, University of Amsterdam, The Netherlands
Patricia Lago, VU University Amsterdam, The Netherlands

Deadlines
SARNET

Secure Autonomous Response Networks
Ralph Koning (UvA), Ameneh Deljoo (UvA), Robert Meijer (TNO), Leon Gommans (KLM),
Tom van Engers (UvA), Rodney Wilson (Ciena), Cees de Laat (UvA)

SARNET
SARNET, Secure Autonomous Response NETworks, is a project funded by the Dutch Research
Foundation. The University of Amsterdam, TNO, KLM, and Ciena conduct research on automated
methods against attacks on computer network infrastructure.
The research goal of SARNET is to obtain the knowledge to create ICT systems that
• model the system’s state based on the emerging behaviour of its components,
• discover by observations and reasoning if and how an attack is developing
  and calculate the associated risks,
• have the knowledge to calculate the effect of countermeasures on states and
  their risks, and
• choose and execute the most effective countermeasure.
We benchmarked three kernel modules: `veth`, `macvlan` and `ipvlan`, to quantify their respective raw TCP and UDP performance and scalability.

Our results show that the `macvlan` kernel module outperforms all other solutions in raw performance. All kernel modules seem to provide sufficient scalability to be deployed effectively in multi-container environments.

*J. Claassen, R. Koning and P. Grosso. (2016)*

*Linux containers networking: performance and scalability of kernel modules*  
*Accepted at NOMS 2016*
Open research directions

• Can we create Semantic NaaS in federated environments?

• How can software services exploit SDN for energy efficiency of the applications?

• Are containers and (SDN) overlays the solution for secure networks?
Dr. Zhiming Zhao

Senior Researcher
System and Network Engineering
University of Amsterdam

EU H2020 SWITCH (Scientific Coordinator)
EU H2020 ENVRIPLUS (Theme Leader)
EU H2020 VRE4EIC (Task Leader)

Email: z.zhao@uva.nl
Web: http://staff.fnwi.uva.nl/z.zhao/

Modeling, Developing and Controlling Quality Critical Distributed Systems on Programmable Infrastructures.
Research topics

• Programming, provisioning and controlling models for time critical applications on programmable infrastructure
• Interoperable research infrastructures for system level of big data sciences
• Virtual research environments for large scale research communities
Time critical applications

- have **very high** business potential or social impacts, e.g.,
  - live event broadcasting,
  - disaster early warning, and
  - real-time business collaboration;
- have **very critical** quality requirements for services, e.g.,
  - video quality, system interaction, or data delivery;
- But are **very expensive in** implementation and operation.
Challenges and difficulties

• Development challenges
  – QoS/QoE between different levels
  – Verification
  – Optimization

• Provisioning challenges
  – Infrastructure customization
  – Fast provisioning

• Operation challenges
  – Run-time monitoring adaptation
  – Autonomous/human-in-the-loop control
SWITCH addresses the entire life-cycle of time-critical, self-adaptive Cloud applications by developing new middleware and front-end tools to enable users to specify their time-critical requirements for an application interactively using a direct manipulation user interface, deploy their applications and adapt the infrastructure to changing requirements at runtime either automatically (using the specified requirements) or by human intervention if desired.
Software Workbench for Interactive, Time Critical and Highly self-adaptive Cloud applications

- EU H2020 ICT RIA project
- Funding 3M, 6 partners
- Coordinator: University of Amsterdam (Zhiming Zhao, Cees de Laat)
- Duration: 3 years
Motivation: societal challenges - system level of environmental sciences

- Earthquake
- Climate changing
- Volcano
- Water
- Species disappear
- Food security
- Pollution

Interoperable ICT services
Interoperable infrastructures for environmental sciences
Research Infrastructures, I3, and ESFRIs in environmental Sciences

Sensor technology innovation → Common data services

Exploitation

Knowledge transfer

Trans-Disciplinary Access

Societal Economical impacts
Common data services

- Curation
- Identification
- Cataloguing
- Processing
- Optimization
- Provenance
Reference RI model

Ontological framework

- Use cases workflows
- Common challenges
- Prioritized services
- Technologies
- Accessing policies
- Community
- Current status
- Architectures
- Metadata
- Requirements

SIOs
Metadata
Prioritized services
Community

RI model

Standards
• ENVRIPLUS: [www.envriplus.eu](http://www.envriplus.eu), 15M Euro, 4 years
• The data for science theme: 5M Euro
• Partners: 37
• Theme leader: University of Amsterdam (Zhiming Zhao)
• Key members in the *Data for Science* theme

Zhiming Zhao (UvA)  
Paola Grosso (UvA)  
Alex Vermeulen (LU/ICOS)  
Leonardo Candela (CNR)  
Keith Jeffery (EPOS)  
Yannick Legre (EGI)

Malcolm Atkinson (UEDIN)  
Alex Hardisty (CU)  
Paul Martin (UvA)  
Daniele Bailo (INGV/EPOS)  
Thomas Loubrieu (INFERMERE/EMSO)  
Barbara Magagna (EEA/LTER)
VRE4EIC

- EU H2020: VRE4EIC project
- Virtual Research Environment (VRE)
- Our contribution: lead the task of research sustainability, exploitation of VRE development to the ENVRI$^{\text{PLUS}}$ community.
The basic idea of VRE4EIC

1. Requirement analysis, Gap identification
2. Co-design and development model for prioritized services
3. User customisable abstract virtual research environment
4. Community support and training, Competence centres.

VRE to Empower multidisciplinary research communities and accelerate Innovation and Collaboration

Domain scientists
VRE operators
Metadata specialists, Developer
Education, trainers

User communities

Existing VREs, RIs, technologies etc.

Relevant projects, initiatives

Cloud/Grid infrastructure deployment

Policy
Service
Metadata
Workflow
...
Summary

• Exchange of research experiences, ideas etc.
  – Time critical cloud computing
  – Environmental sciences and big data infrastructures
  – Virtual research environments

• Joint proposals
  – EU-China
  – NWO-NSFC
Questions?

http://delaat.net
http://delaat.net/sarnet


Contact us:

delaat@uva.nl
p.grosso@uva.nl
z.zhao@uva.nl