Invited Talk at the University of Sydney

NorNet at the University of Sydney
An Introduction to the NorNet Core Testbed

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Simula Research Laboratory

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- Motivation
- The NorNet Core Testbed
- Conclusion
Overview:
About Norway and the Simula Research Laboratory

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Where is Norway?

Facts about Norway
- Capital: Oslo
- Size: ca. 385,000 km²
- Population: ca. 5,165,800
- Internet TLD: .no
The Kingdom of Norway (Kongeriket Norge)
The Simula Research Laboratory

- Located in Fornebu
  - Just outside of Oslo
  - In the IT Fornebu complex
- Public limited company
  - Non-profit research organisation
  - Ca. 160 people from all over the world
- Research groups
  - Scientific Computing
  - Software Engineering
  - Resilient Networks and Applications
- Norway's leading place for computer science research

Visit https://www.simula.no for further information!
Overview:
Motivation

- About Norway and the Simula Research Laboratory
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- The NorNet Core Testbed
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Motivation: Robust Networks

- More and more applications rely on ubiquitous Internet access!
- However, our current networks are not as robust as they should be ...

How to make networks more robust?
Resilience by Redundancy

Multi-Homing

- Connections to multiple Internet Service Providers (ISP)
- Idea: if one ISP has problems, another connection still works

Is resilience really improved? What about multi-path transport?
Idea: A Testbed for Multi-Homed Systems

Research in realistic setups is necessary!

• A multi-homed Internet testbed would be useful
  - Something like PlanetLab?
  - Perhaps with better node availability?
  - Support for mobile access (e.g. 2G/3G/4G/CDMA) as well as wired?

• NorNet – A research testbed for multi-homed systems!
  - Lead by the Simula Research Laboratory in Fornebu, Norway
  - Supported by Forskningsrådet

NorNet – A research testbed for multi-homed systems!

NorNet!

https://www.nntb.no
Overview:
The NorNet Project

- About Norway and the Simula Research Laboratory
- Motivation
- The NorNet Core Testbed
- Conclusion
Goals of the NorNet Project

- Building up a **realistic** multi-homing testbed
- Wired and wireless
  - Wired → “NorNet Core”
  - Wireless → “NorNet Edge”
- Perform research with the testbed!

**How to get a realistic testbed?**
Idea: Distribution of NorNet over whole Norway

- **Challenging topology:**
  - Large distances
  - A few “big” cities, many large rural areas
  - Svalbard:
    - Interesting location
    - Many polar research institutions

- **Deployment:**
  - Core: 11 sites in Norway + CN, DE (4x), SE, US, KR, AU
  - Edge: hundreds of nodes in Norway
Overview:
NorNet Core

- About Norway and the Simula Research Laboratory
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- The NorNet Core Testbed
- Conclusion
Idea for NorNet Core: Tunnelling

- Researchers require control over used ISP interfaces
  - Which outgoing (local site) interface
  - Which incoming (remote site) interface

- Idea: Tunnels among sites
  - Router at site A: IPs $A_1$, $A_2$, $A_3$
  - Router at site B: IPs $B_1$, $B_2$
  - IP tunnel for each combination: $A_1 \leftrightarrow B_1$, $A_1 \leftrightarrow B_2$, $A_2 \leftrightarrow B_1$, $A_2 \leftrightarrow B_2$, $A_3 \leftrightarrow B_1$, $A_3 \leftrightarrow B_2$
  - Fully-connected tunnel mesh among NorNet Core sites
  - Each site's router (called **tunnelbox**) maintains the tunnels
    - Static tunnels
    - NorNet-internal addressing and routing over tunnels
Address Assignment

- NorNet-internal address spaces:
  - Private NorNet-internal IPv4 “/8” address space (NAT to outside)
  - Public NorNet-internal IPv6 “/48” address space
- Systematic address assignment:
  - IPv6: 2001:700:4100:<PP><SS>::<NN>/64
    (PP=Provider ID; SS=Site ID; NN=Node ID)
- NorNet-internal DNS setup including reverse lookup

Make it as easy as possible to keep the overview!
A usual NorNet Core site:

- 1x switch
- 4x server
  - 1x tunnelbox
  - 3x research systems
- At least two ISP connections
  - Research network provider
  - Other providers
- IPv4 and IPv6 (if available)

Additional researcher-provided sites:

- Varying configurations
- VM setups, powerful servers, “retro-style” PCs ...
## NorNet Core Site Deployment Status (December 2016)

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<tr>
<th>No.</th>
<th>Site</th>
<th>ISP 1</th>
<th>ISP 2</th>
<th>ISP 3</th>
<th>ISP 4</th>
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- **IPv4 and IPv6**
- **IPv4 only (ISP without IPv6 support)**
- **IPv4 only (site's network without IPv6 support)**
- **ISP negotiation in progress**

[https://www.nntb.no/pub/nornet-configuration/NorNetCore-Sites.html](https://www.nntb.no/pub/nornet-configuration/NorNetCore-Sites.html)
Some Site Statistics
(January 2017)

Active Sites: 23
Distinct ISPs of Active Sites: 18
Distinct Countries of Active Sites: 8
Total IPv4 Interfaces: 42
Total IPv4 Tunnels: 861
Total IPv6 Interfaces: 26
Total IPv6 Tunnels: 325

https://www.nntb.no/pub/nornet-configuration/NorNetCore-Sites.html
Remote Systems

Our servers may be really remote!

The “road” to Longyearbyen på Svalbard, 78.2°N
Virtualisation

“Anything that can go wrong, will go wrong.”
[Murphy's law]

• Experimentation software is experimental
• How to avoid software issues making a remote machine unusable?
• Idea: virtualisation
  – Lightweight, stable software setup: Ubuntu Server 14.04 LTS
  – KVM (Kernel-based Virtual Machine)
  – Other software runs in VMs:
    • Tunnelbox VM on physical server #1
    • 2 LXC-based research node VMs on physical servers #2 to #4
  – In case of problem: manual/automatic restart or reinstall of VM
You may use NorNet Core, too!

Join the tutorial session today! Here at the University of Sydney!

- Contents:
  - Get access to NorNet Core
  - User and slice management
  - Access to slices
  - Using and configuring slivers with own software
  - How to make use of multi-homing?
Overview:

Conclusion

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Conclusion and Future Work

“*The road to hell is paved with unused testbeds.*”

[James P. G. Sterbenz]

- The NorNet Core testbed is ready for experiments!
  - Do you have experiment ideas? → Talk to us!
- Future work:
  - NorNet Core
    - More multi-homing, i.e. further ISPs, IPv6
    - Additional sites
  - Improve and refine management software
  - Get more users, may be you?

Visit [https://www.nntb.no](https://www.nntb.no) for further information!
“NorNet wants to be a building block of the railroad to heaven” ...

... and not be another unused testbed that paves the road to hell!

https://www.nntb.no