Invited Talk at Qiongzhou University

The NorNet Testbed at Qiongzhou University

A Large-Scale Experiment Platform for Real-World Experiments with Multi-Homed Systems

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Simula Research Laboratory

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Overview:
About Norway and the Simula Research Laboratory

- About Norway and the Simula Research Laboratory
- Motivation
- The NorNet Testbed
  - NorNet Core
  - NorNet Edge
- Users and Research
- Conclusion
Where is Norway?

Facts about Norway
Capital: Oslo
Size: ca. 385,000 km²
Population: ca. 5,150,000
Internet TLD: .no
The Simula Research Laboratory

- Located in Fornebu
  - Just outside of Oslo
  - In the IT Fornebu complex
- Public limited company
  - 100% owned by Norwegian government
  - Strong connection to Universitetet i Oslo
  - Ca. 160 people from all over the world
- Research groups
  - Scientific Computing
  - Software Engineering
  - Network and Distributed Systems
- Norway's leading place for computer science research

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

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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?
New Technology: Multi-Homed Systems

1. Multi-homed systems are a new technology that can make use of existing Internet infrastructure without new investment

2. Evolve from traditional TCP protocol to
   → Multi-Path TCP (MPTCP) and
   → Concurrent Multipath Transfer for SCTP (CMT-SCTP)

3. Single-path transport evolving to
   → multi-path transmission and
   → concurrent transmission

4. Multi-path transport brings the following benefits:
   → Users can combine bandwidth of multiple ISPs
   → **Increased throughput** for users
   → **Improved robustness** for resilience-critical and time-critical applications
   → Increased subscription sales for ISPs
Overview:
The NorNet Project

- Motivation
- The NorNet Testbed
  - NorNet Core
  - NorNet Edge
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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?
Overview:
NorNet Core

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A usual NorNet Core site:

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

Additional researcher-provided sites:

- Varying configurations
- VM setups, powerful servers, “retro-style” PCs ...
# Site Deployment Status

(October 2014)

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<tr>
<th>No.</th>
<th>Site</th>
<th>ISP 1</th>
<th>ISP 2</th>
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<th>ISP 4</th>
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</table>

- **IPv4 and IPv6**
- **IPv4 only (ISP without IPv6 support 😞)**
- **ISP negotiation in progress**
- **IPv4 only (site’s network without IPv6 support)**

[https://www.nntb.no/pub/nornet-configuration/NorNetCore-Sites.html](https://www.nntb.no/pub/nornet-configuration/NorNetCore-Sites.html)
Some Site Statistics
(October 2014)

<table>
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<th>Category</th>
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<td>Distinct ISPs of Active Sites</td>
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<td>Distinct Countries of Active Sites</td>
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<tr>
<td>Total IPv4 Interfaces</td>
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<td>Total IPv4 Tunnels</td>
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<td>Total IPv6 Interfaces</td>
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<td>Total IPv6 Tunnels</td>
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<td>Inactive Sites</td>
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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 12.04 LTS
  - VirtualBox 4.3
  - Other software runs in VirtualBox 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
PlanetLab-based Software for Experiments

- **Key idea:**
  - Researchers should get virtual machines for their experiments
  - Like *PlanetLab* …
  - … but with multi-homing and IPv6, of course

- **PlanetLab software:**
  - Different “stable” distributions: *PlanetLab*, *OneLab*, etc.
  - Current implementation: based on *Linux V Servers*
    - Not in mainline kernel
    - Patched kernel, makes upgrades difficult
  - The future: **Linux Containers** (LXC)
    - Active development by *PlanetLab/OneLab*
    - We are involved in developing and testing the LXC software
Experiments with Special Requirements

- NorNet Core can satisfy special setup requirements for experiments!

- Example: VMs with custom operating system
  - For example: custom Linux, FreeBSD, AROS, ...
  - Currently still requires manual setup, automation as future work

- Other example: VoIP SIP honeypot
  - Security project at University of Duisburg-Essen (UDE)
  - Tunnelboxes tunnel SIP traffic to a central honeypot server at UDE site
  - Analysis of SIP attacks tried on the tunnelbox addresses at different sites

Special requirements for your experiment? Ask!
Overview: NorNet Edge

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NorNet Edge needs to cover many locations!
NorNet Edge Nodes

Ufoboard:

- Custom-made for NorNet
- Based on off-the-shelf smartphone board (Samsung Galaxy S)
- 1 GHz ARM Cortex-A8 CPU
- 512 MiB RAM
- 16-32 GB disk (SD card)
- 7 USB ports + Ethernet port
- Debian Linux 7.6 ("Wheezy")
Live Visualisation of NorNet Edge

See http://robustenett.no/map!
Overview: Users and Research

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Users and Research

- We already got some users!
- Examples:
  - Shared Bottleneck Detection (UiO+Simula)
  - VoIP Misuse Detection (UDE)
  - Multi-Path Transport (Simula, UDE, UiO, HU, etc.)
  - Balia Congestion Control (Bell Labs in South Korea)
  - IPv4/IPv6 Performance Comparison (Simula)
  - ...

"The road to hell is paved with unused testbeds."
[James P. G. Sterbenz]

See https://www.nntb.no/projects/ for further projects using NorNet!

Next step: get even more users!
Collaborations

- PlanetLab/OneLab
  - Development and testing of the research software
  - URLs: https://www.planet-lab.org, https://www.onelab.eu

- RIPE Atlas
  - Connectivity and reachability measurements
  - URL: https://atlas.ripe.net
  - Node deployed at site in Longyearbyen

- Seattle
  - Open Peer-to-Peer Computing, project at NYU
  - URL: https://seattle.poly.edu
  - Running inside NorNet Core slice

- ToMaTo
  - Topology Management Tool
  - URL: http://tomato-lab.org
  - Part of the G-Lab testbed
Important Points for Today

- How to use NorNet Core?
- How to set up the NorNet Core site at Qiongzhou University?
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Conclusion and Future Work

- The NorNet testbed is ready for experiments!
  - Do you have experiment ideas? → Talk to us!

- Future work:
  - Extend NorNet Core
    - More multi-homing, i.e. further ISPs, IPv6
    - Additional sites
  - Extend NorNet Edge
    - Cover additional countries: Funding granted for Sweden, Spain and Italy!
    - Node upgrades (UMTS → LTE, WLAN, subscriptions, …)
  - Improve and refine management software
  - Get more users, may be you?

And, of course, do more research!
“NorNet wants to be a building block of the railroad to heaven” ... 

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

Visit https://www.nntb.no for further information!