

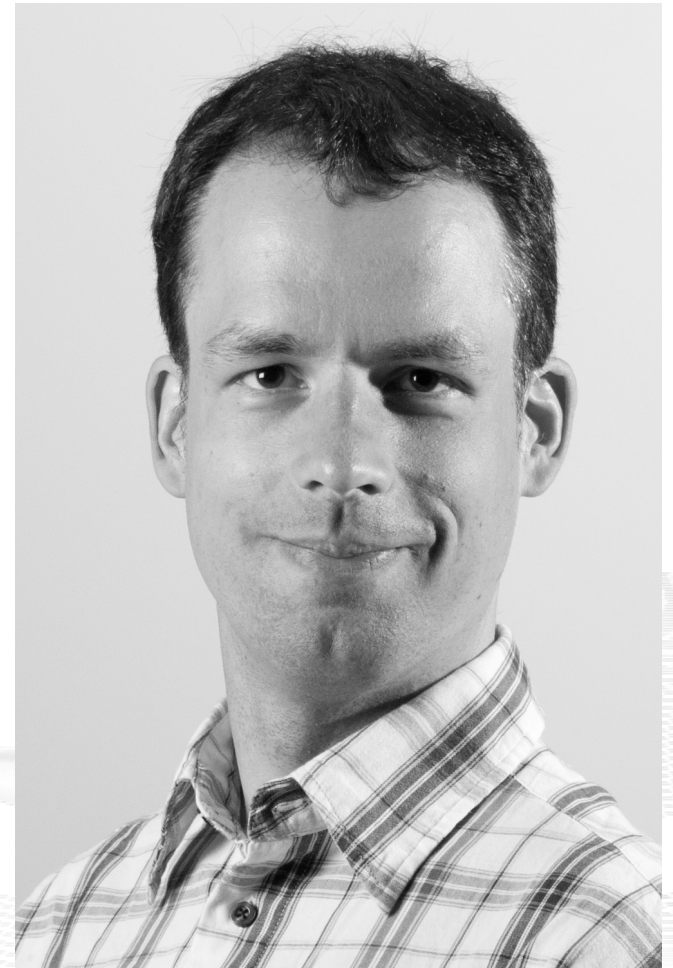
The NorNet Project

An Introduction to NorNet for the Site Deployment at Høgskolen i Narvik

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Overview: Motivation

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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 ...



Resilience by Redundancy

Multi-Homing

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



Do multiple ISP connections really improve robustness?

Load Sharing with Multi-Path Transfer

Multi-Path Transfer

- Having (and paying for!) multiple ISPs
- Utilise all connections simultaneously \Rightarrow increased bandwidth

A very hot research topic in the IETF:

- Concurrent Multipath Transfer for SCTP (CMT-SCTP)
- Multi-Path TCP (MPTCP)
- Congestion control challenges for 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. 3G) 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

<http://www.nntb.no>

Overview: The NorNet Project

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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?

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
- **NorNet Core:**
 - Ca. 10 sites planned
- **NorNet Edge:**
 - Ca. 500 nodes planned



Overview: NorNet Core

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Idea: 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:

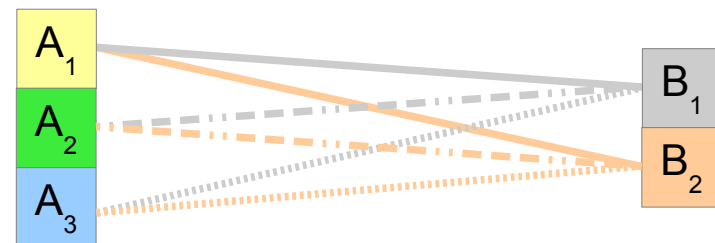
$A_1 \leftrightarrow B_1, A_1 \leftrightarrow B_2, A_2 \leftrightarrow B_1, A_2 \leftrightarrow B_2, A_3 \leftrightarrow B_1, A_3 \leftrightarrow B_2$

- Fully-connected tunnel mesh among NorNet Core sites (ca. 10)

- 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:
 - IPv4: 10.<Provider ID>.<Site ID>.<Node ID>/24 per site
 - Similar for IPv6, with “/64” network per site


Make it as easy as possible to keep the overview!

Idea: PlanetLab-based Software for Experiments

- Key idea:
 - Researchers should get virtual machines for their experiments
 - Like **PlanetLab** ...
 - ... but with multi-homing, of course
- PlanetLab software:
 - Different “stable” distributions: PlanetLab, OneLab, etc.
 - Current implementation: based on Linux VServers
 - Not in mainline kernel
 - Patched kernel, makes upgrades difficult
 - The future: **Linux Containers (LXC)**
 - Active development by PlanetLab/OneLab
 - We are involved in testing experimental LXC software

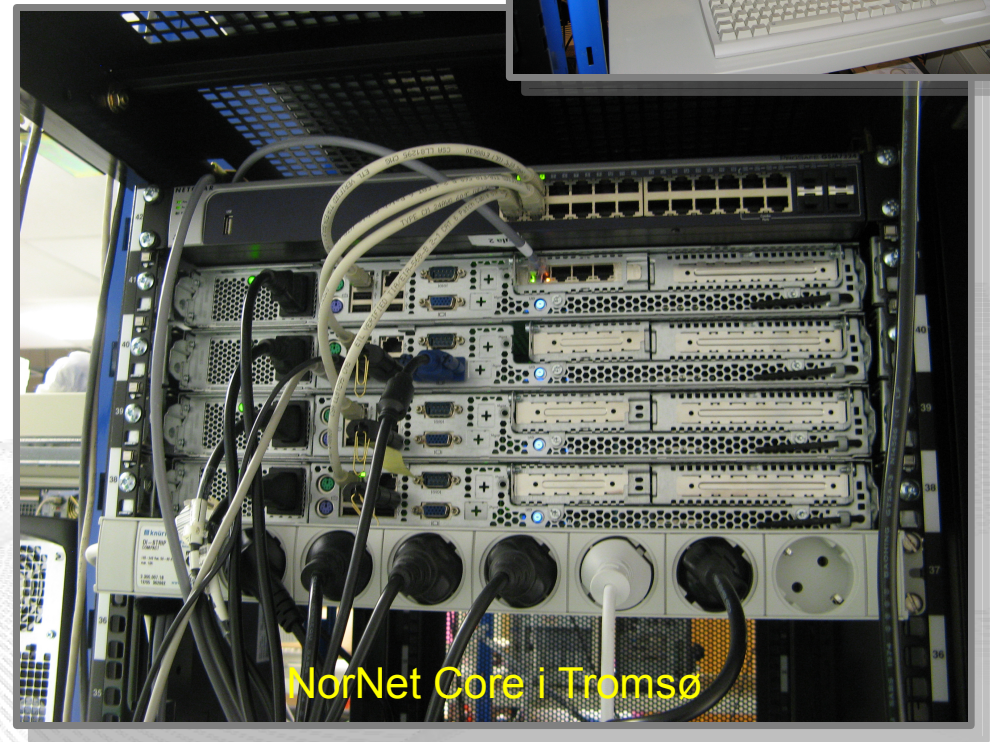
NorNet Core Site Deployment

A NorNet Core site:

- 1x switch
- 4x server
 - 1x tunnelbox
 - 3x research systems
- At least two ISP connections
 - Uninett 
 - Other providers

Status:

- 8 sites deployed
- 3 more during the next weeks



Monitoring

- PlanetLab:
 - 367 nodes of 1035 nodes alive (June 28, 2012)
⇒ availability < 36% ☹
 - NorNet should do much better!
- Direct contact to technical staff/researchers at sites
- Monitoring using Nagios
 - Flexible
 - Extendable by service-specific plug-ins

Nagios[®]

How to visualise NorNet?

“Kontrollsentret”

Velkommen til NorNet-Kontrollsentret på Simula Research Laboratory, Fornebu

The interface displays a map of Europe with various weather stations marked. A green line connects several stations in Norway. The map includes labels for countries like Norge (Norway), Sverige (Sweden), Suomi (Finland), Danmark (Denmark), and others. A legend on the right lists overlays such as Sites, Connections, Clouds forecasts, Precipitation forecasts, and Weather. Below the map, there is a clock showing 9:25:56 on Monday, 4. mars 2013. A section titled 'Lofasjon' (Location) lists participating institutions with their respective flags. A section titled 'Problemer:' (Problems) shows a green smiley face and the text 'Ingen problem!' (No problems!). A section titled 'I jorden:' (On the ground) lists more institutions. At the bottom, a red banner contains the text: 'For mer informasjon om NorNet-prosjektet, se <http://www.norib.no/>!'

Overlays

- Sites
- Connections
- Clouds forecasts
- Precipitation forecasts
- Weather

Base Layer

- Bing Aerial
- Bing Road
- Google Terrain
- Google Satellite
- Mapnik

Lofasjon

Problemer:

😊 Ingen problem! 😊

I jorden:

- Høgskolen i Gjøvik
- Simula Research Laboratory
- Universitetet i Bergen
- Universitetet i Stavanger
- Universitetet i Tromsø
- Høgskolen i Narvik
- Universitetet i Agder
- Universitetet i Oslo
- Universitetet i Trondheim
- Universitetet på Svalbard
- Universität Duisburg-Essen

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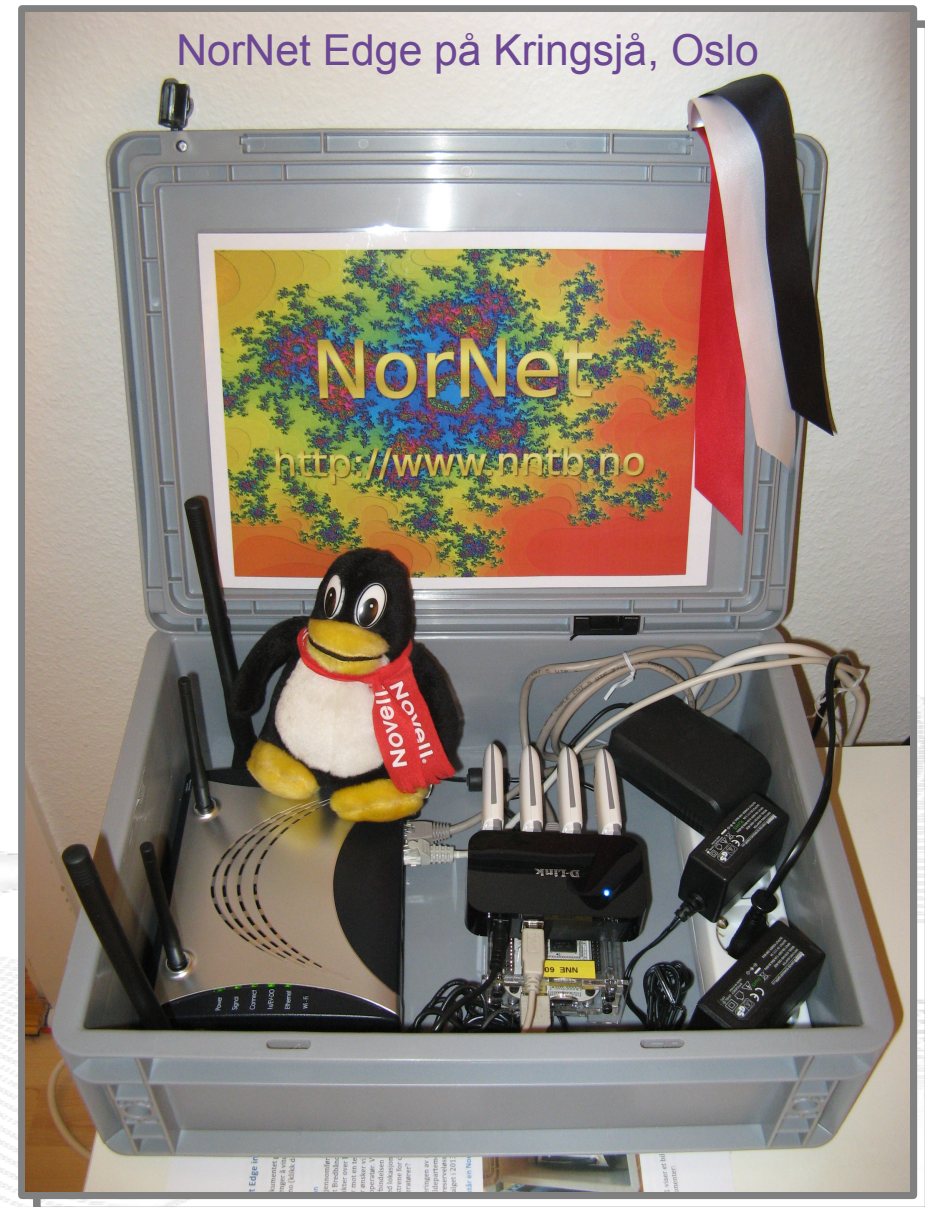
The NorNet Edge Box: Ready for Deployment

Box contents:

- Beagle Bone embedded Linux system
- 4x USB UMTS (at USB hub):
 - Telenor, NetCom,
 - Network Norway, Tele2
- 1x ICE CDMA mobile broadband
- 1x Ethernet
- Power supplies
- Handbook

Status:

- Ca. 300 nodes distributed already
- Initial measurements



Overview: Research

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Resilience

- Network resilience
 - Are there hidden dependencies among ISPs?
 - Are there dependencies between mobile and wired ISPs?
 - ...
- Mobility and handovers
- Applications
 - Emergency call handling (e.g. healthcare)
 - ...
- ...

Load Sharing

- Multi-Path Transfer
 - Network Layer
 - Routing ...
 - Transport Layer
 - CMT-SCTP
 - MPTCP
 - ...
 - Higher Layers
- Applications
 - Multimedia (e.g. IPTV), ...
 - WEBRTC, ...
- ...

Users

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

[James P. G. Sterbenz]

- Of course, NorNet does **not** intend to be another unused testbed!
- NorNet will be open for all interested users!
 - Similar to PlanetLab ...
 - ... but with higher node availability and tighter monitoring
 - ... and, of course, multi-homing
- **Particularly, it can also be used by Høgskolen i Narvik!**

More details to be announced soon!

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Conclusion and Future Work

- NorNet is progressing!
 - Management software under development
 - First site deployments have been made
- Future work:
 - Finish the initial deployment
 - Make sites multi-homed
 - Improve/refine management software

And, of course, do some research!

Any Questions?

N  R N E T

Visit <http://www.nntb.no> for further information!