

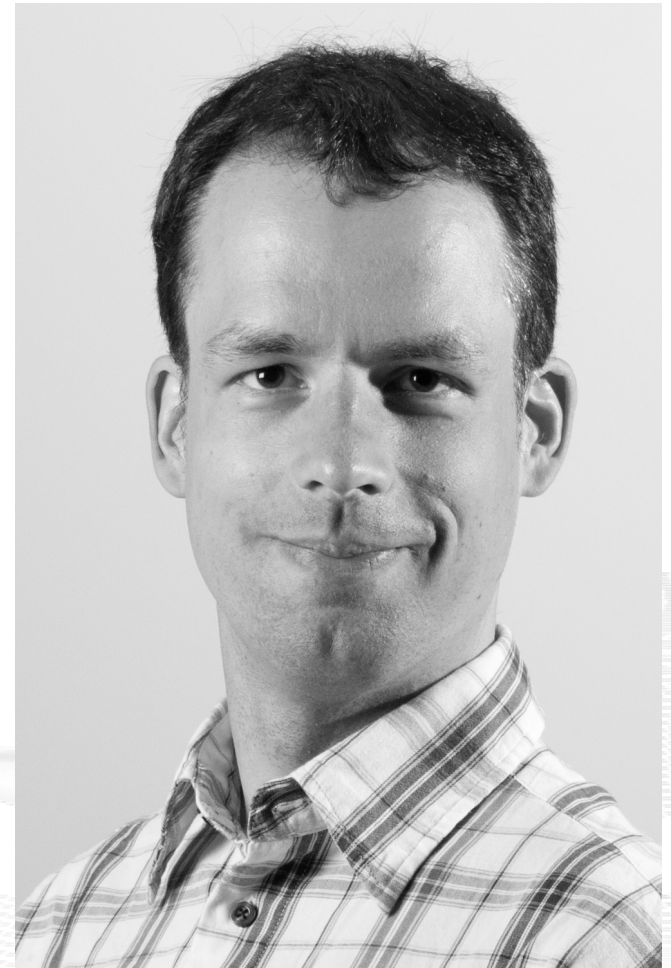
Invited Talk at Technische Universität Berlin

The NorNet Project – A Research Testbed for Multi-Path Transport

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Contents

- Motivation
- The NorNet Project
 - NorNet Core
 - NorNet Edge
- Research and Users
- Conclusion

Overview: Motivation

- **Motivation**
- The NorNet Project
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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 ...

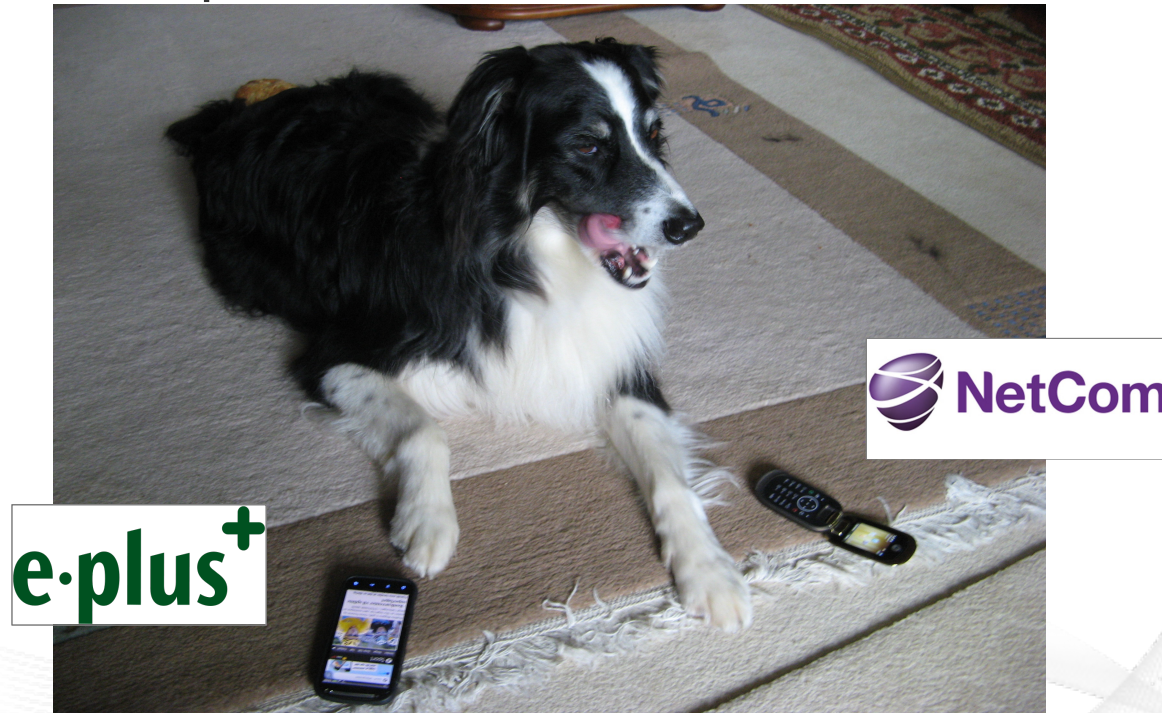


How to make networks more robust?

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. 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:**
 - Currently 10+1 sites
- **NorNet Edge:**
 - Currently ca. 400 nodes



Overview: NorNet Core

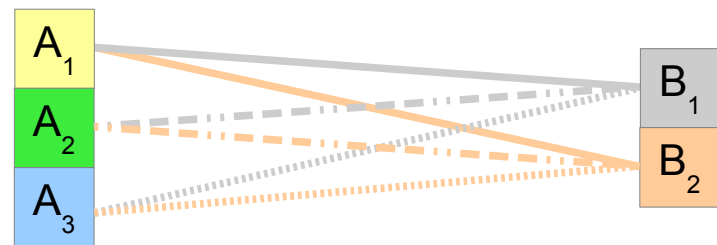
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Idea: Tunnelling

- 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
 - IPv6: 2001:700:4100:<PP><SS>::/64 (*PP*=Provider ID; *SS*=Site ID)


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

A 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
- IPv4 and IPv6 (if available)



UNIS

Longyearbyen 78.2°N,15.6°E



NorNet Core på Svalbard

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

The Nagios logo is displayed in a bold, black, sans-serif font. The letter 'N' is significantly larger than the other letters and has a horizontal line extending from its base to the left. A registered trademark symbol (®) is located at the top right of the 's'. The logo is positioned on the right side of the slide, partially overlapping a decorative background of white, wavy, grid-like lines.

How to visualise NorNet?

“Kontrollsenteret”

Velkommen til NorNet-Kontrollsenter på Simula Research Laboratory, Fornebu

Overlays

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

Base Layer

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

Uofasjon

Problemer:

😊 Ingen problem! 😊

J orden:

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

For mer informasjon om NorNet-prosjektet, se <http://www.nnib.no/>!

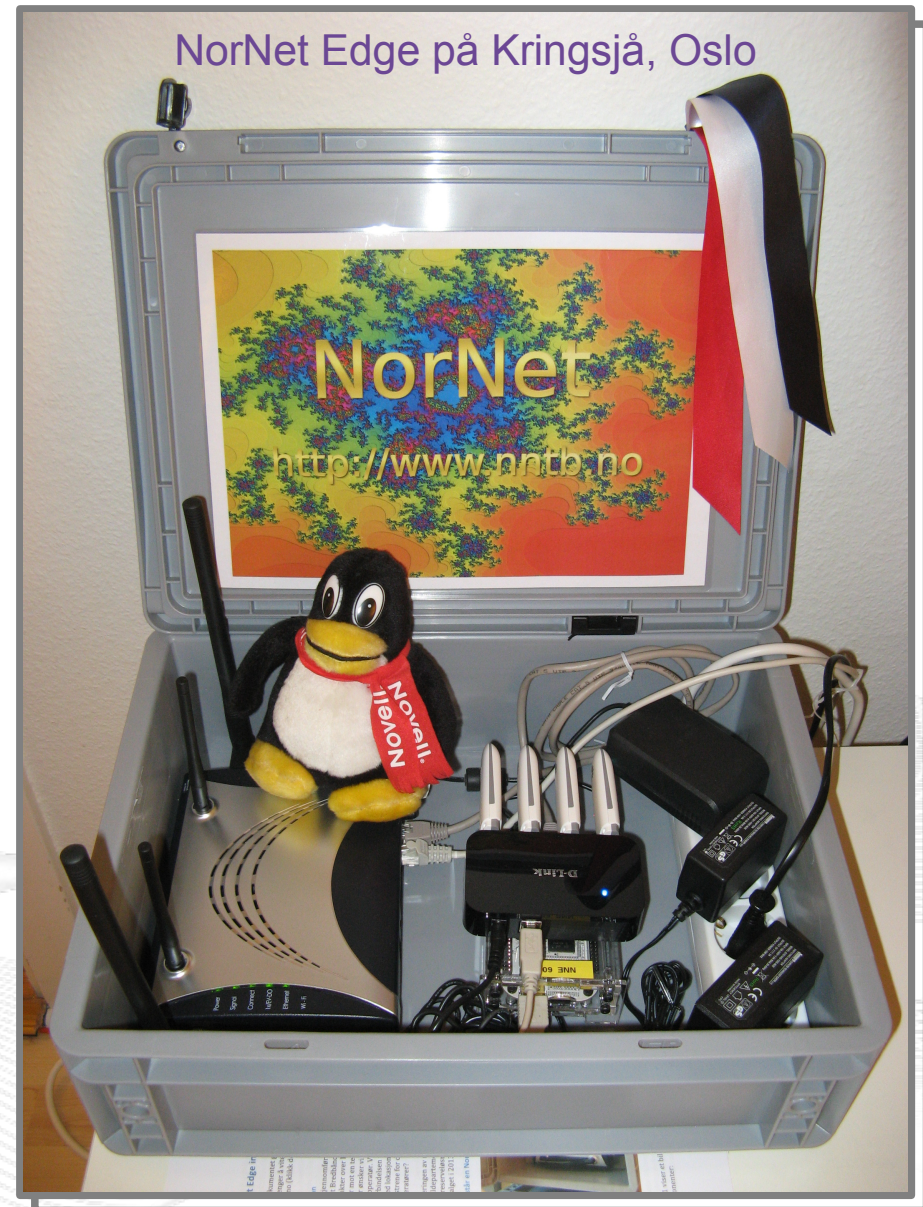
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The NorNet Edge Box: Ready for Deployment (1)

Box contents:

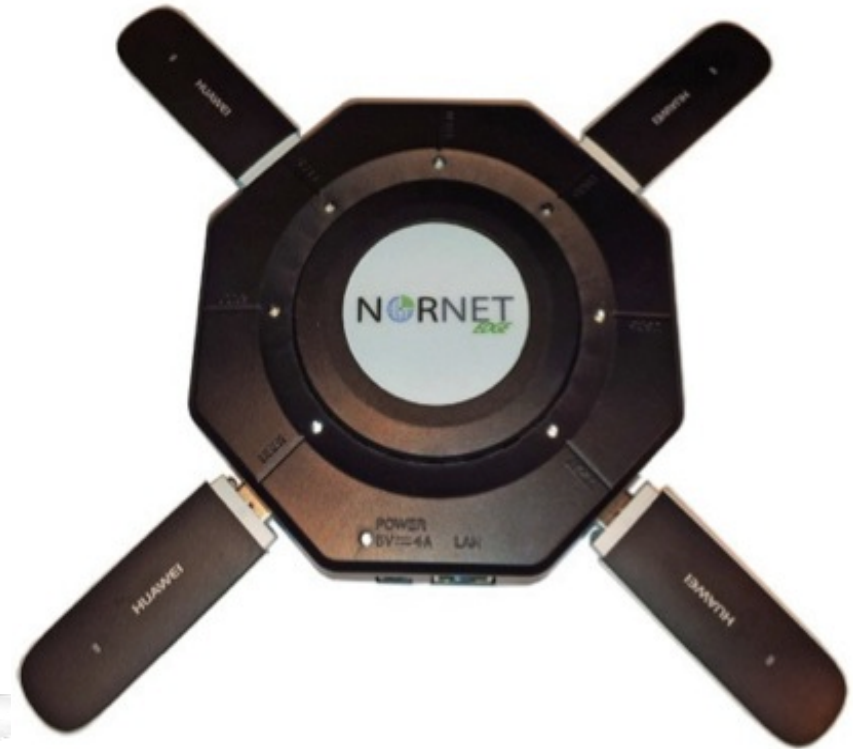
- Beagle Bone or Ufoboard embedded Linux system
- 4x USB UMTS:
 - Telenor, NetCom,
 - Network Norway, Tele2
- 1x ICE CDMA mobile broadband
- 1x Ethernet
- Power supplies
- Handbook



The NorNet Edge Box: Ready for Deployment (2)

Box contents:

- Ufoboard embedded Linux system (3.8.x)
- **MPTCP (0.87) (3.10)**
- 4x USB UMTS:
 - Telenor, NetCom,
 - Network Norway, Tele2



NorNet Edge Visualisation

NorNet Edge Visualization

Dashboard Comparative view 2013/7/26 13:54:32

OPERATOR: All

COLOR CODE

- All networks available
- Some networks available
- No networks available
- Node unreachable

UP RATE, %: 83

Search by location or node id

LOCATION	NODE ID	STATUS
Åmot	nne255	●
Asker	nne379	●
Aurskog-Høland	nne365	●
Aurskog-Høland	nne367	●
Aurskog-Høland	nne376	●
Aurskog-Høland	nne377	●
Aurskog-Høland	nne411	●
Austrheim	nne554	●
Bardu	nne272	●
Berg	nne262	●
Bergen	nne202	●
Bergen	nne236	●
Bergen	nne238	●
Bergen	nne283	●
Bergen	nne284	●
Bergen	nne285	●
Bergen	nne286	●
Bergen	nne291	●
Bergen	nne292	●
Bergen	nne293	●

See <http://demo.robustenett.no>

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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 at the TU Berlin!**

More details to be announced soon!

The 1st NorNet Users Workshop (NNUW-1)

The 1st International NorNet Users Workshop

NNUW-1

Fornebu, Akershus/Norway

September 18-19, 2013

See <http://www.nntb.no/>

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Conclusion and Future Work

- NorNet is progressing!
 - Management software under development
 - Site deployments have been made
- Future work:
 - Initial tests with first users
 - 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!