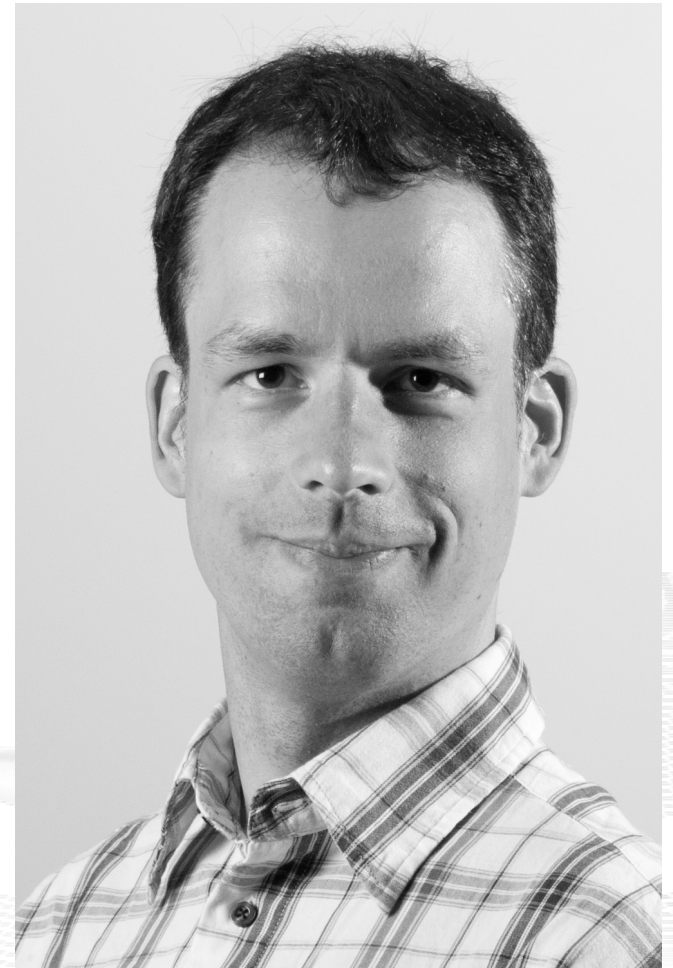# Invited Talk at Høgskolen i Oslo og Akershus

An Overview of the NorNet Testbed for Multi-Homed Systems

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18 April 2013

Contents

- Motivation

- The NorNet Project

  - NorNet Core

  - NorNet Edge

- Research and Users

- Conclusion

Overview:
Motivation

[simula . research laboratory]   - by thinking constantly about it

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

Do multiple ISP connections really improve robustness?

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

- **Motivation**

- **The NorNet Project**

  - NorNet Core

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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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  - **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
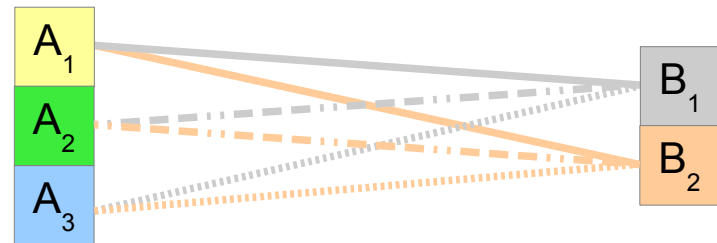
  – IP tunnel for each combination:
    $A_1 \leftrightarrow B_1$, $A_1 \leftrightarrow B_2$, $A_2 \leftrightarrow B_1$, $A_2 \leftrightarrow B_2$, $A_3 \leftrightarrow B_1$, $A_3 \leftrightarrow B_2$

  – 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

NorNet Core Site Deployment

A NorNet Core site:

- 1x switch

- 4x server

  - 1x tunnelbox

  - 3x research systems

- At least two ISP connections

  - Uninett **UNINETT**

  - Other providers

Status:

- 10+1 sites deployed

- Some more in the future

UNIS

Longyearbyen 78.2°N,15.6°E

NorNet Core på Svalbard

Monitoring

- PlanetLab:

  - 367 nodes of 1035 nodes alive (June 28, 2012)
    $\Rightarrow$ availability < 36% ☹

  - NorNet should do <u>much</u> better!

- Direct contact to technical staff/researchers at sites

- Monitoring using Nagios

  - Flexible

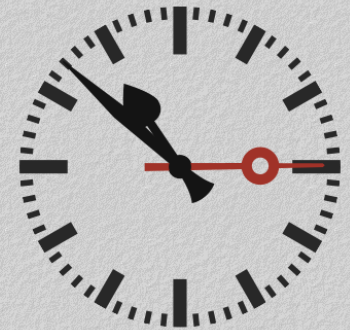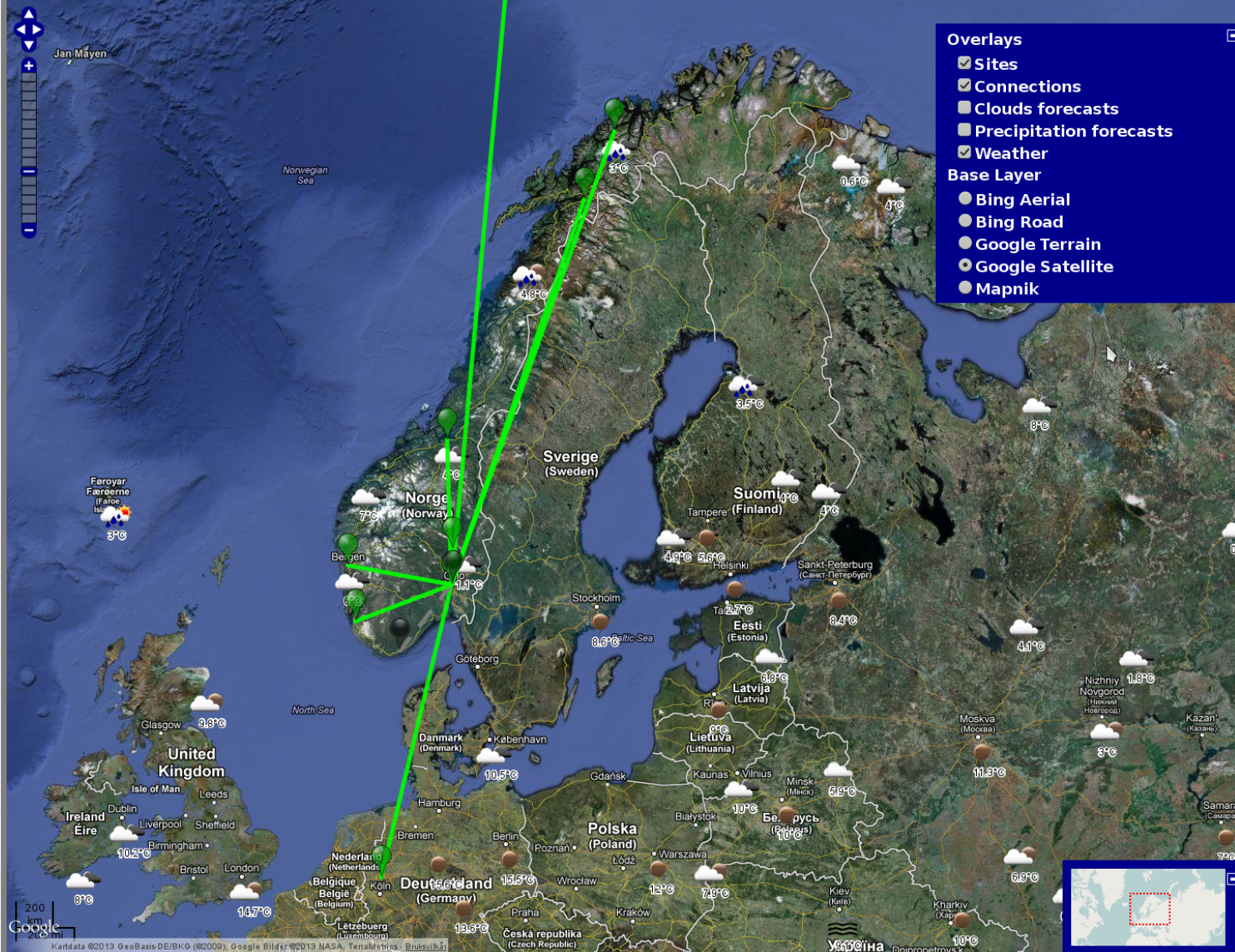 - Extendable by service-specific plug-ins

Nagios®

How to visualise NorNet?

"Kontrollsenteret"

Overview:
NorNet Edge

- **Motivation**

- **The NorNet Project**

  - NorNet Core

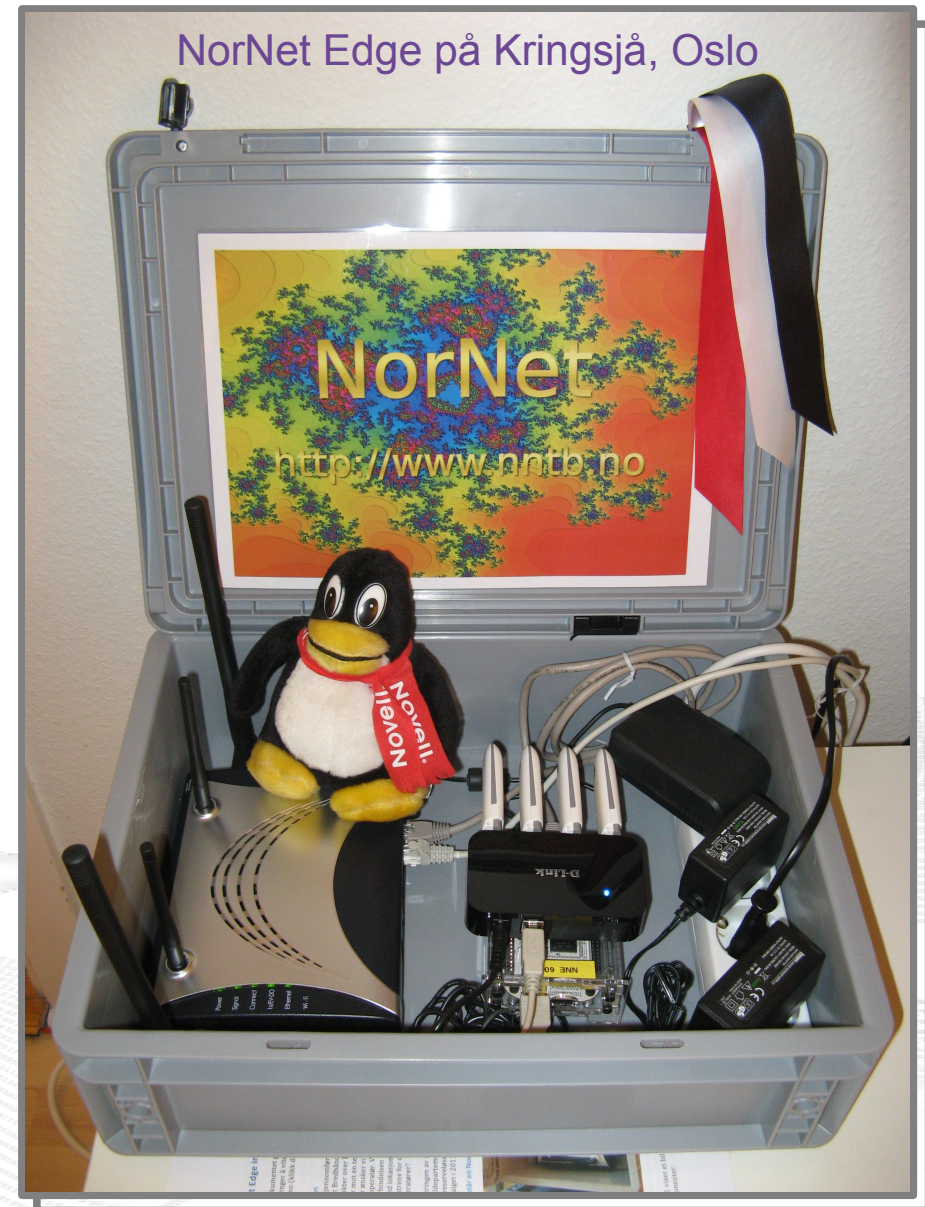 - NorNet Edge

- Research and Users

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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

NorNet Edge på Kringsjå, Oslo

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)
    - ...

- Security

Load Sharing

- Multi-Path Transfer

    - Network Layer

        - Routing ...

    - Transport Layer

        - Concurrent Multipath Transfer for SCTP (CMT-SCTP)

        - Multi-Path TCP (MPTCP)

        - …

    - Higher Layers

- Applications

    - Multimedia (e.g. IPTV, Video on Demand), ...

    - Web Real-Time Communication (WebRTC)

- ...

I E T F

WebRTC
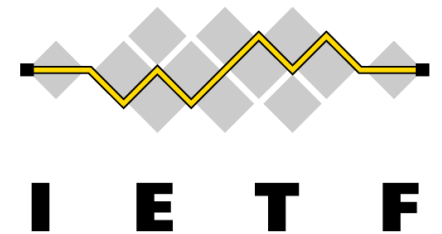
Users

> **"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 at Høgskolen i Oslo og Akershus!**

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 <u>research</u>!

Any Questions?

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