NorNet

An Open, Large-Scale Testbed for Multi-Homed Systems

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- Motivation

- The NorNet Testbed

  - NorNet Core

  - NorNet Edge

- Research and Users

- Conclusion

Overview:
Motivation

Motivation: Robust Networks

- More and more applications rely on ubiquitous Internet access!

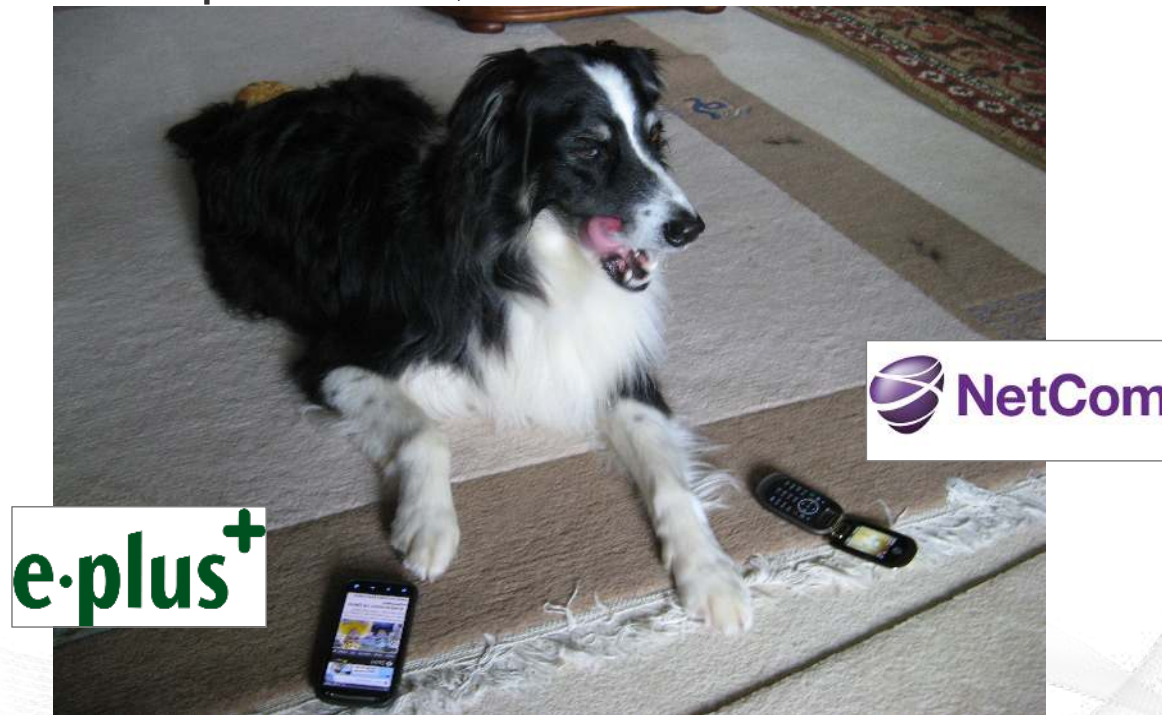- However, our current networks are not as robust as they should be ...

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

- **Motivation**

- **The NorNet Testbed**

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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!**

NORNET

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+3 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 (< 20)
    - Each site's router (called **tunnelbox**) maintains the tunnels
        - Static tunnels
        - NorNet-internal addressing and routing over tunnels
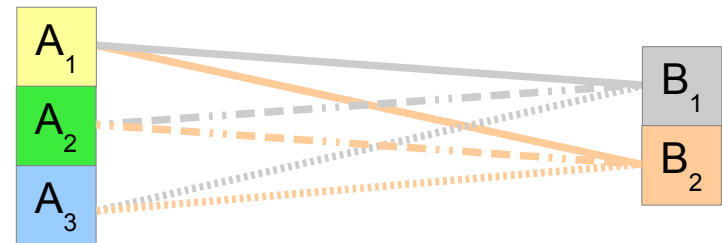
Address Assignment

- 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!

A NorNet Core Site Deployment

A usual NorNet Core site:

- 1x switch

- 4x server

  – 1x tunnelbox

  – 3x research systems

- At least two ISP connections

  – Uninett **UNINETT**

  – Other providers

- IPv4 and IPv6 (if available)

UNIS

Longyearbyen 78.2°N,15.6°E

NorNet Core på Svalbard

Site Deployment Status
(January 2014)

Site	Location	Primary ISP	Second ISP
Simula Research Laboratory	Fornebu, Akershus	UNINETT	Kvantel (Hafslund)
Universitetet i Oslo	Blindern, Oslo	UNINETT	PowerTech
Høgskolen i Gjøvik	Gjøvik, Oppland	UNINETT	PowerTech
Universitetet i Tromsø	Tromsø, Troms	UNINETT [1]	PowerTech
Universitetet i Stavanger	Stavanger, Rogaland	UNINETT [1]	BKK
Universitetet i Bergen	Bergen, Hordaland	UNINETT	BKK
Universitetet i Agder	Kristiansand, Vest-Agder	UNINETT	PowerTech
Universitetet på Svalbard	Longyearbyen, Svalbard	UNINETT [1]	Telenor [4]
NTNU Trondheim	Trondheim, Sør-Trøndelag	UNINETT	PowerTech
Høgskolen i Narvik	Narvik, Norland	UNINETT	PowerTech
University of Duisburg-Essen	Essen/Germany	DFN	Versatel [2,3]
Hainan University	Haikou, Hainan/China	CERNET [1]	China Unicom [1]
Karlstads Universitet	Karlstad, Värmland/Sweden	SUNET	– [4]

1) IPv6 available from ISP, but not deployed to NorNet Core site
2) IPv6 not available from ISP ☹
3) Consumer-grade ADSL connection
4) Negotiations in progress

What about a site at CAIA/Swinburne University?

Idea: *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 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 the LXC software

The LXC-based *PlanetLab*/*OneLab* Software

- Researchers get container (sliver) inside a Linux environment

- Same kernel, but slivers are separated from each other

- LXC uses *Open vSwitch*:

    - Slivers are connected to a virtual switch

    - Switch is bridged into real network

    - **Own IPv4/IPv6 addresses** for each sliver!

- Fedora Core 18 Linux environment inside the slivers

**A full-featured, multi-homed Linux system!**

Remote Systems

Our servers may be really <u>remote</u>!

The "road" to Longyearbyen på Svalbard, 78.2°N

Virtualisation

- 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
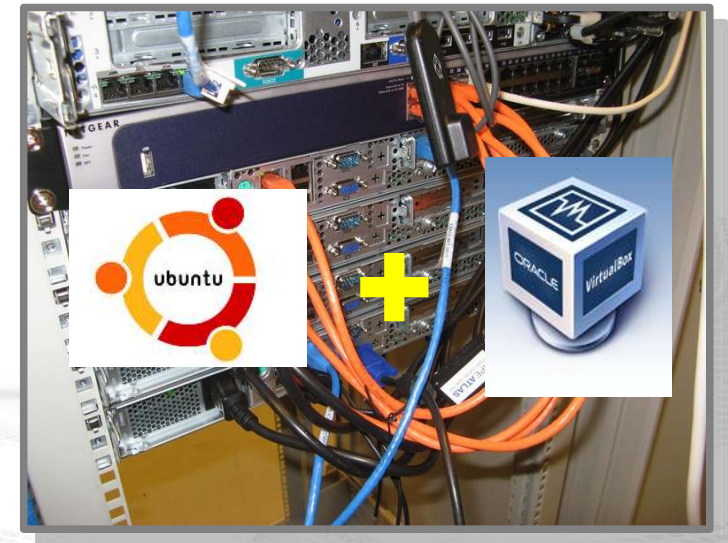
Experiments with Special Requirements

> ## Special requirements for your experiment? Ask!

- **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

Monitoring

- PlanetLab:

  – 575 nodes of 1042 nodes alive (September 9, 2013)
    ⇒ availability ca. 55% ☹

  – 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"
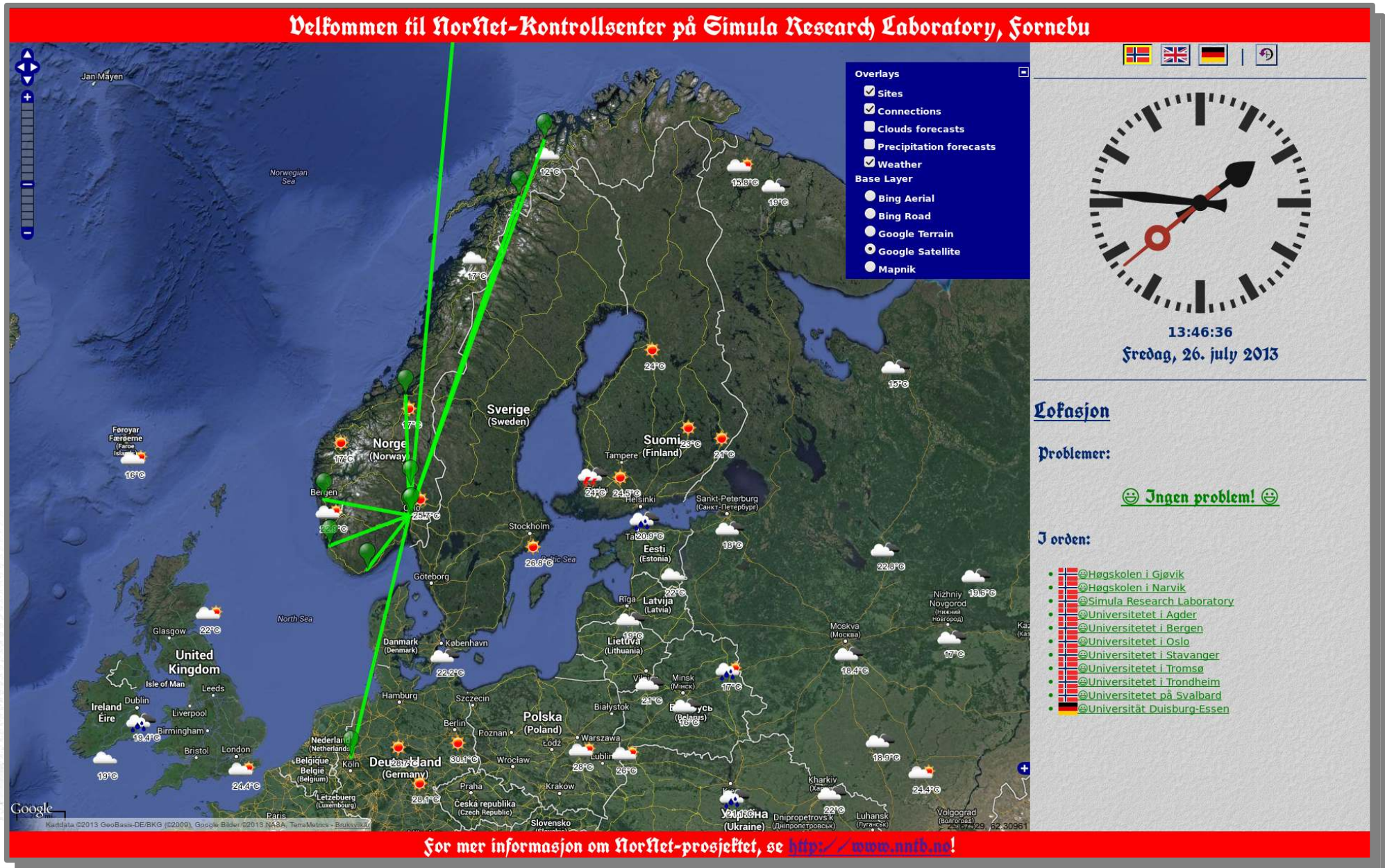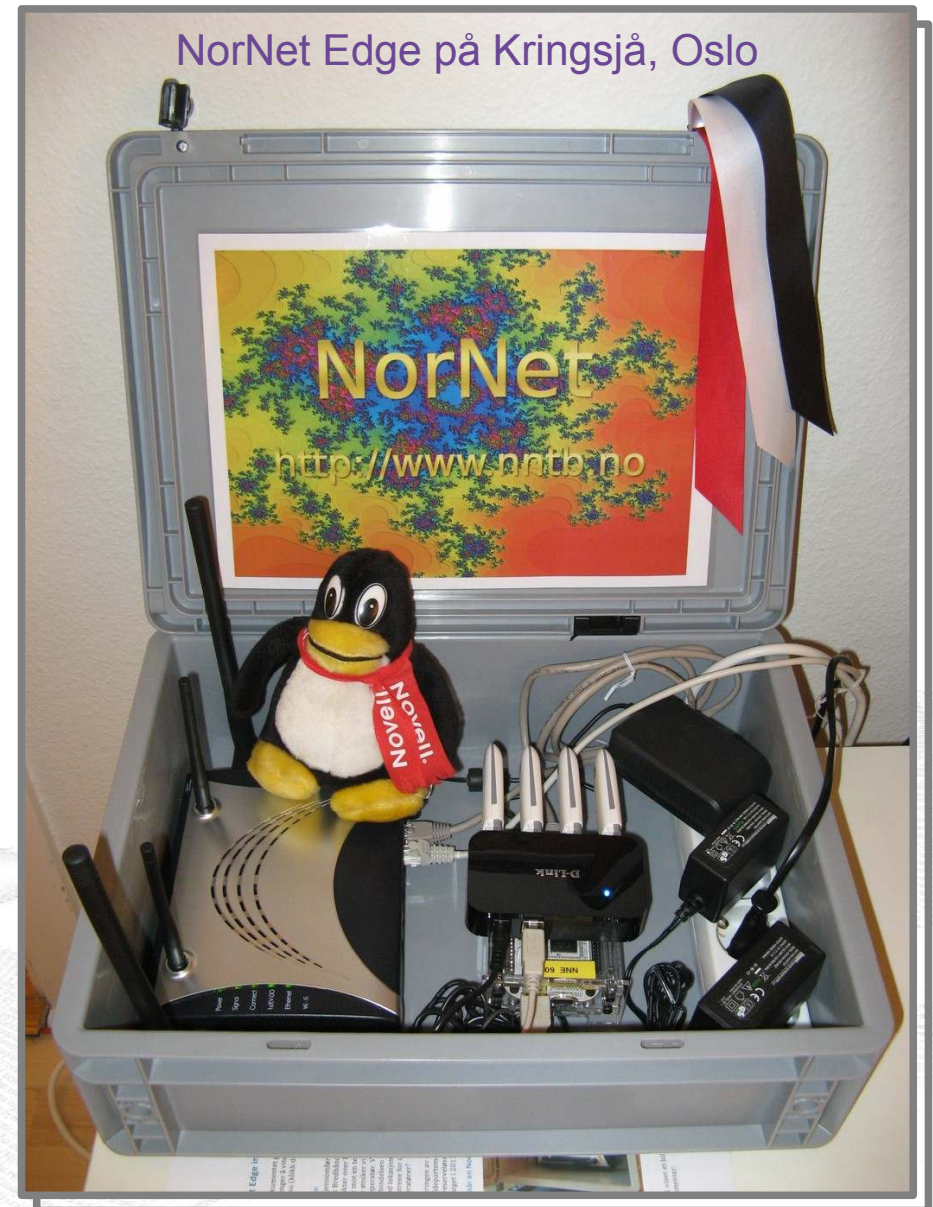
Overview:
NorNet Edge

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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

NorNet Edge på Kringsjå, Oslo
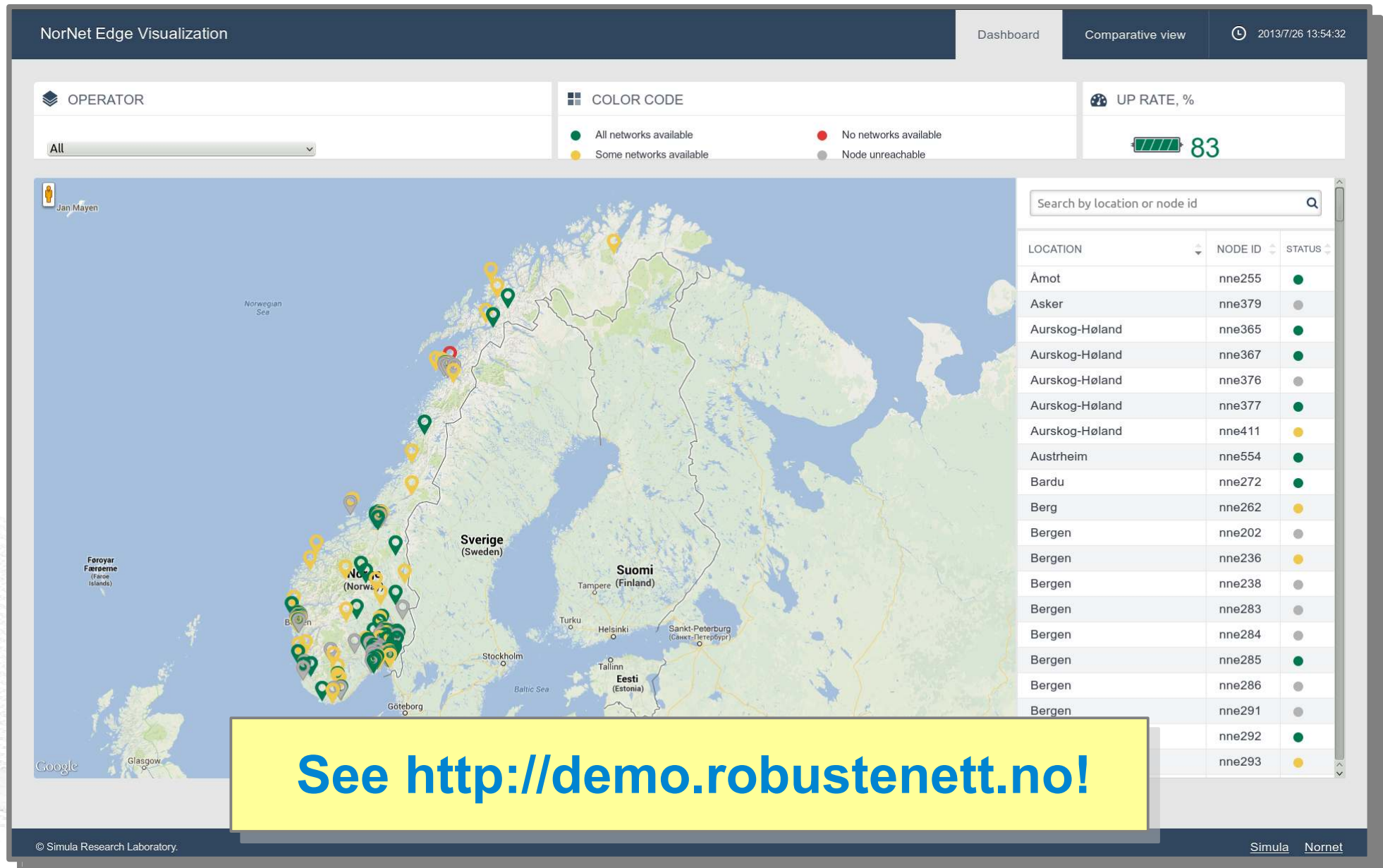
NorNet
http://www.nntb.no

The NorNet Edge Box: Ready for Deployment (2)

Box contents:

- Ufoboard
  embedded Linux system (3.11.x)

- **MPTCP (0.88)**

- 4x USB UMTS:
  - Telenor, NetCom,
  - Network Norway, Tele2
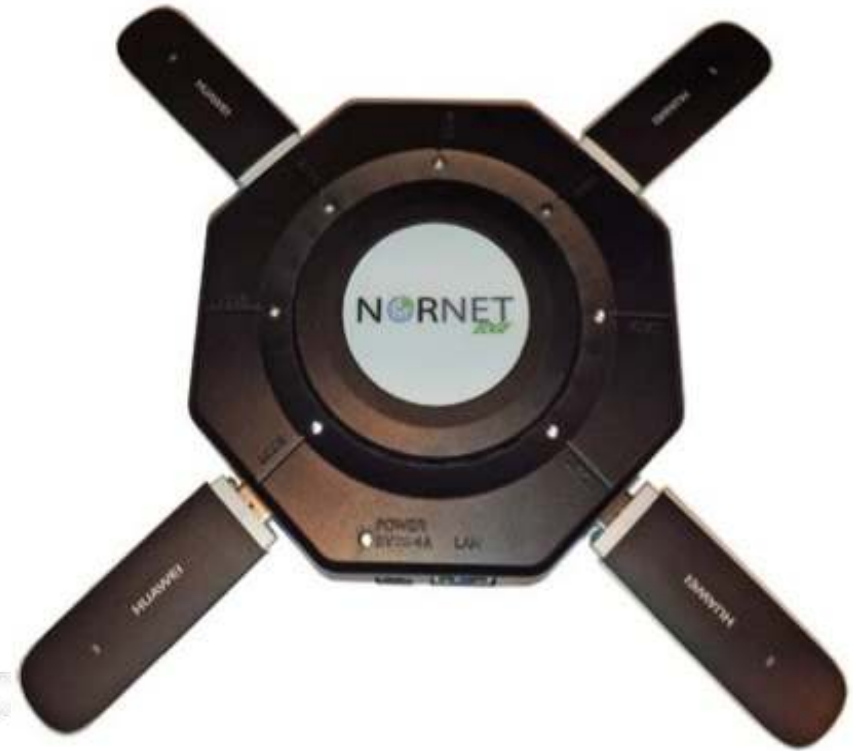
NorNet Edge Visualisation

See http://demo.robustenett.no!

Overview:
Research

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Research and 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!
  Goal: "NorNet wants to be a building block of the railroad to heaven."

- NorNet will be open for all interested researchers!

  - Similar to *PlanetLab* ...

  - ... but with higher node availability and tighter monitoring

  - ... and, of course, **multi-homing and IPv6**

- **Particularly, it can also be used by CAIA/Swinburne University!**

> **Just talk with us about the details!**

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Conclusion and Future Work

- The NorNet testbed is progressing!

  - Initial deployment completed

  - Software setup already used for some experiments

- Future work:

  - Make more NorNet Core sites multi-homed (second and third ISP, IPv6)

  - Some additional sites

  - Improve and refine management software

  - Get more users

And, of course, do some <u>research</u>!

"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!