

Invited Talk at Qiongzhou University

The NorNet Testbed at Qiongzhou University

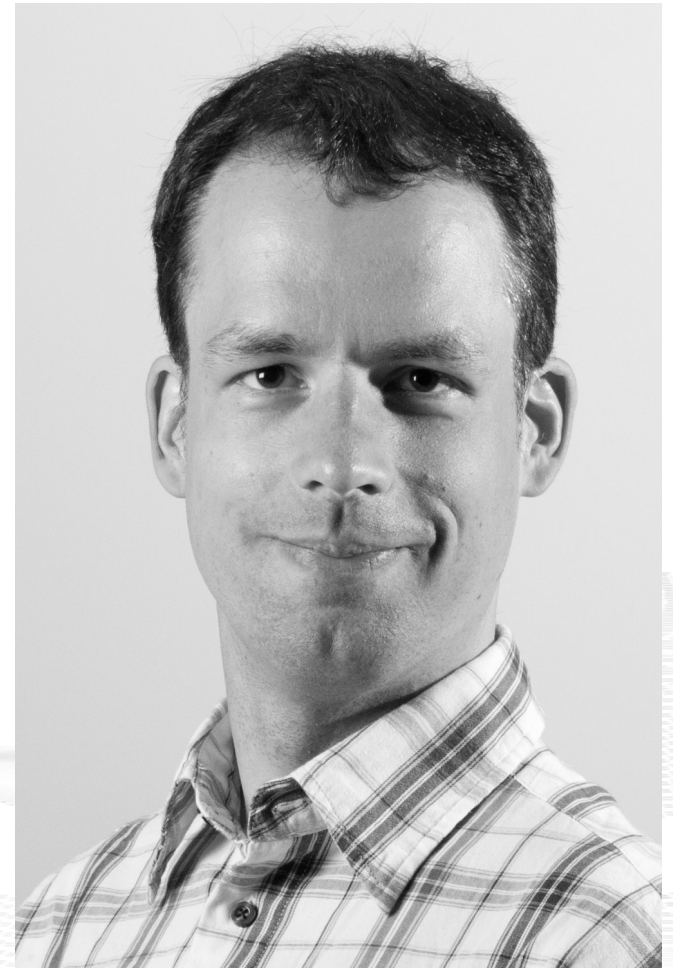
—

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

Thomas Dreibholz, dreibh@simula.no

Simula Research Laboratory

27 October 2014



Contents

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

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?



Oslo 奥斯陆

ca. 8,700 km



Haikou 海口

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

[**simula** . research laboratory]



Visit <https://www.simula.no> for further information!

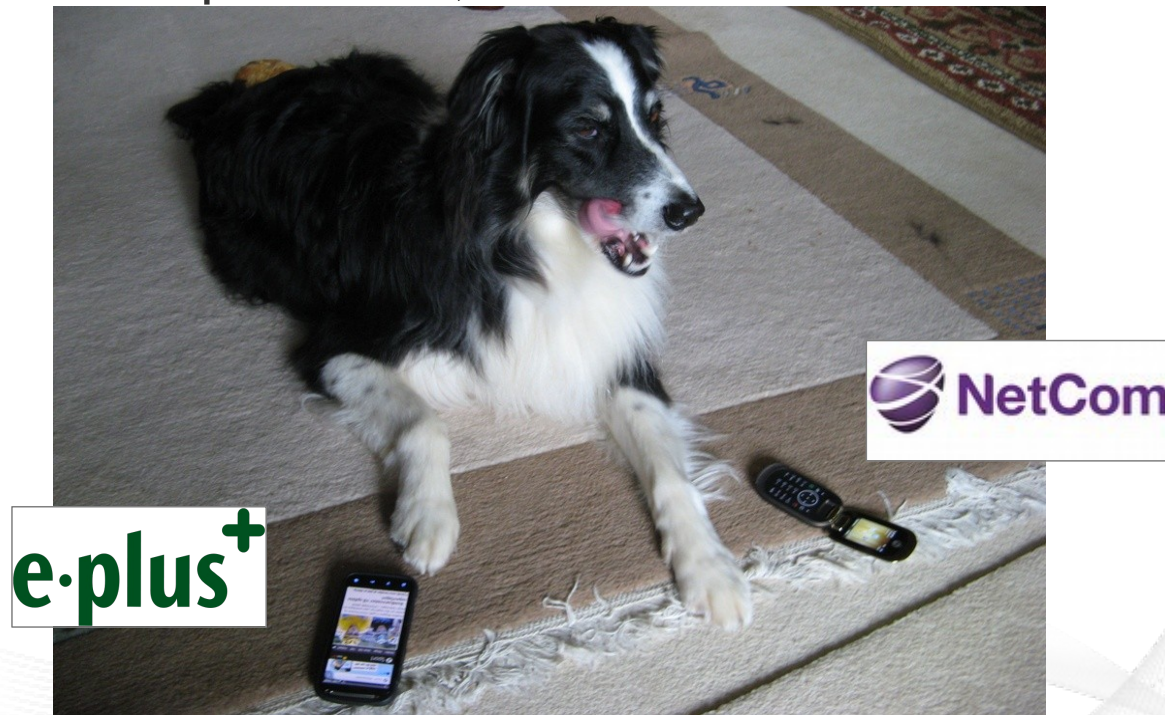
Overview: Motivation

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

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
- Users and Research
- Conclusion

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

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

A NorNet Core Site Deployment

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 ...




Longyearbyen 78.2°N,15.6°E



NorNet Core på Svalbard

Site Deployment Status (October 2014)

No.	Site	ISP 1	ISP 2	ISP 3	ISP 4
1	Simula Research Laboratory	Uninett	Kvantel	Telenor	PowerTech
2	Universitetet i Oslo	Uninett	Broadnet	PowerTech	
3	Høgskolen i Gjøvik	Uninett	PowerTech		
4	Universitetet i Tromsø	Uninett	Telenor	PowerTech	
5	Universitetet i Stavanger	Uninett	Altibox	PowerTech	
6	Universitetet i Bergen	Uninett	BKK		
7	Universitetet i Agder	Uninett	PowerTech	–	
8	Universitetet på Svalbard	Uninett	Telenor		
9	Universitetet i Trondheim	Uninett	PowerTech		
10	Høgskolen i Narvik	Uninett	Broadnet	PowerTech	
11	Høgskolen i Oslo og Akershus	Uninett	–		
12	Karlstads Universitet	SUNET			
13	Universität Kaiserslautern	DFN			
14	Universität Duisburg-Essen	DFN	Versatel		
15	Hainan University	CERNET	China Unicom		
16	The University of Kansas	KanREN			

 IPv4 and IPv6
 ISP negotiation in progress

 IPv4 only (ISP without IPv6 support ☹)
 IPv4 only (site's network without IPv6 support)

<https://www.nntb.no/pub/nornet-configuration/NorNetCore-Sites.html>

Some Site Statistics (October 2014)



Active Sites	16
Distinct ISPs of Active Sites	13
Distinct Countries of Active Sites	5
Total IPv4 Interfaces	34
Total IPv4 Tunnels	561
Total IPv6 Interfaces	22
Total IPv6 Tunnels	231
Inactive Sites	0

<https://www.nntb.no/pub/nor-net-configuration/NorNetCore-Sites.html>

Remote Systems

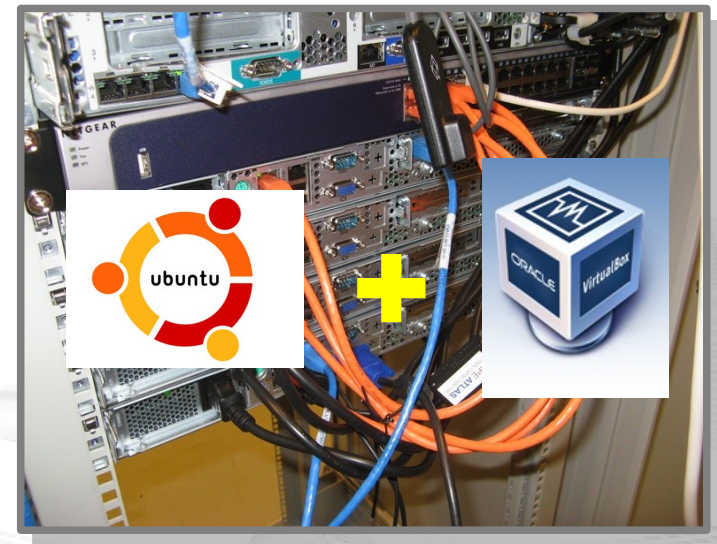
Our servers may be really remote!

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 VServers*
 - 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

Special requirements for your experiment? Ask!

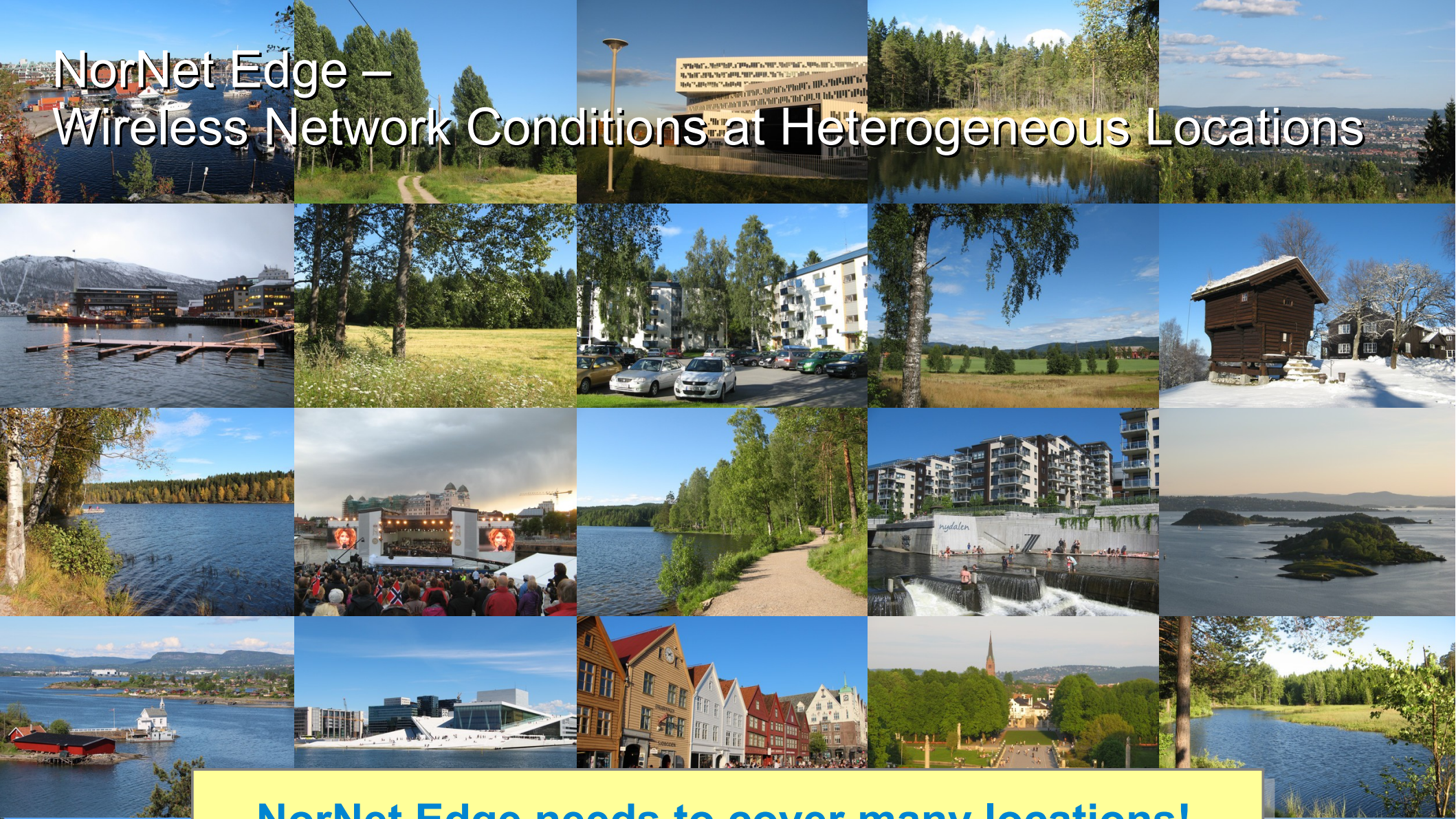
- **NorNet Core can satisfy special setup requirements for experiments!**
- Example: VMs with **custom operating system**
 - For example: custom Linux, **FreeBSD**, AROS, ...
 - Currently still requires manual setup, automation as future work
- Other example: VoIP **SIP honeypot**
 - Security project 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

UNIVERSITÄT
DUISBURG
ESSEN

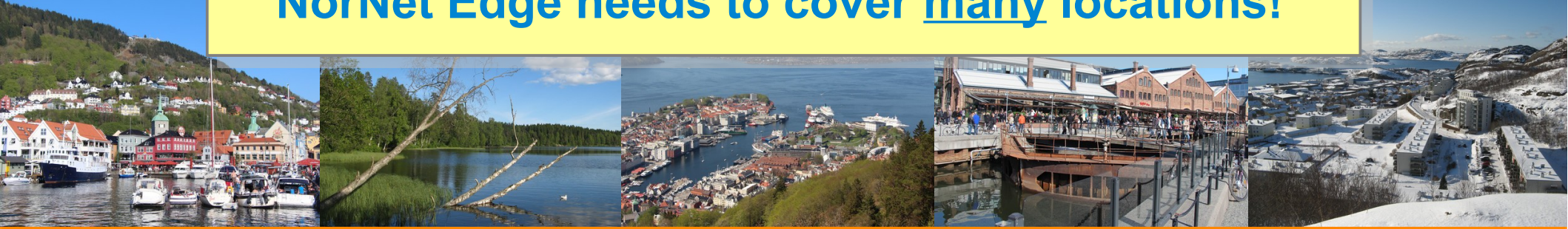
Overview: NorNet Edge

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

NorNet Edge – Wireless Network Conditions at Heterogeneous Locations



NorNet Edge needs to cover many locations!



NorNet Edge Nodes

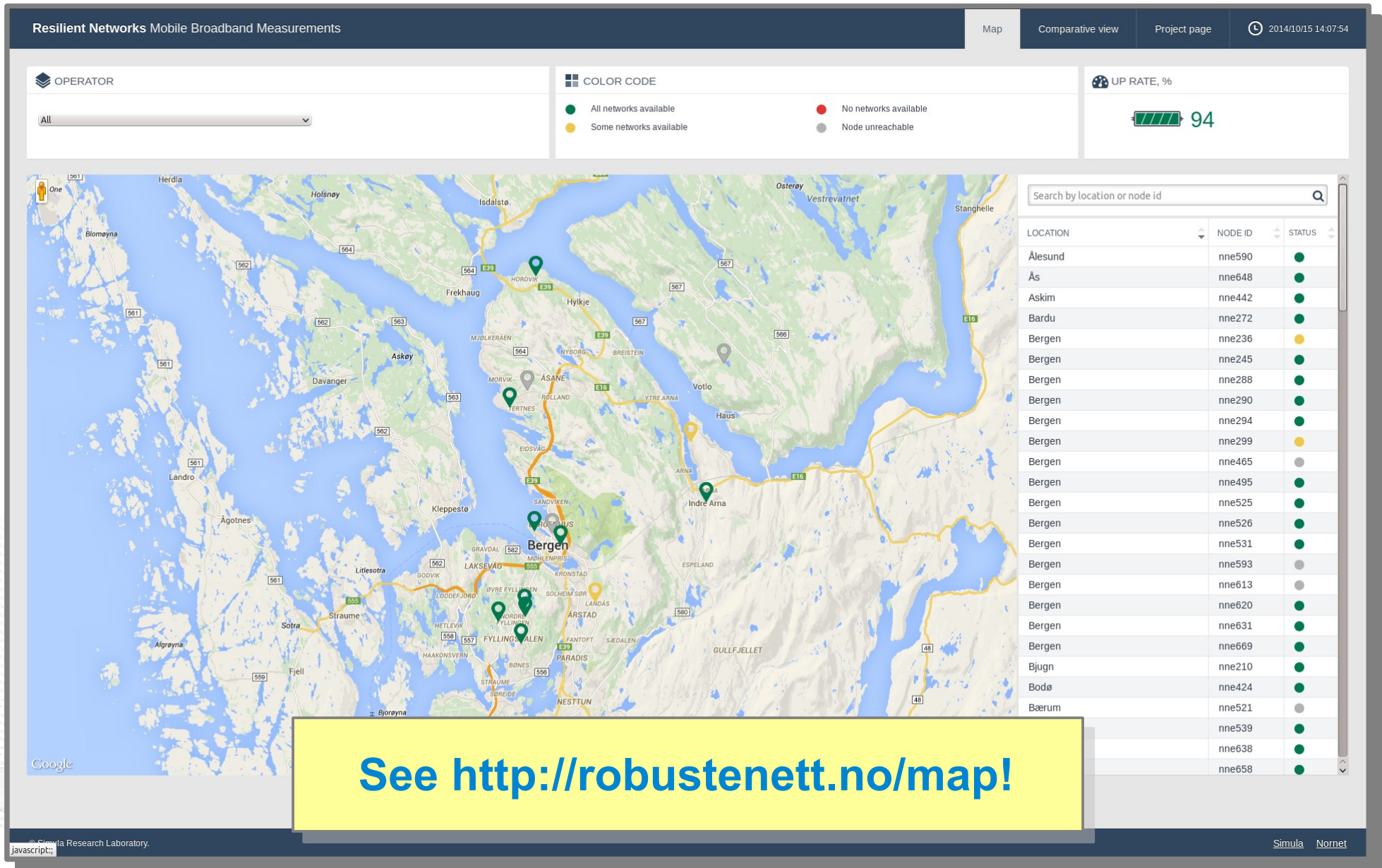
Solution: embedded systems instead of servers!

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

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

Users and Research

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

[James P. G. Sterbenz]

- 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)
 - ...

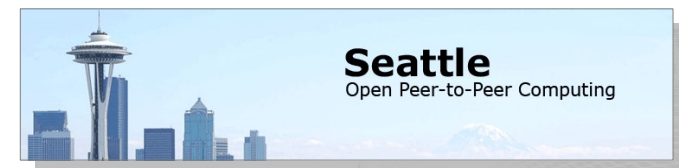
List to be extended!

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?

Overview: Conclusion

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

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?

N  RNET

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