

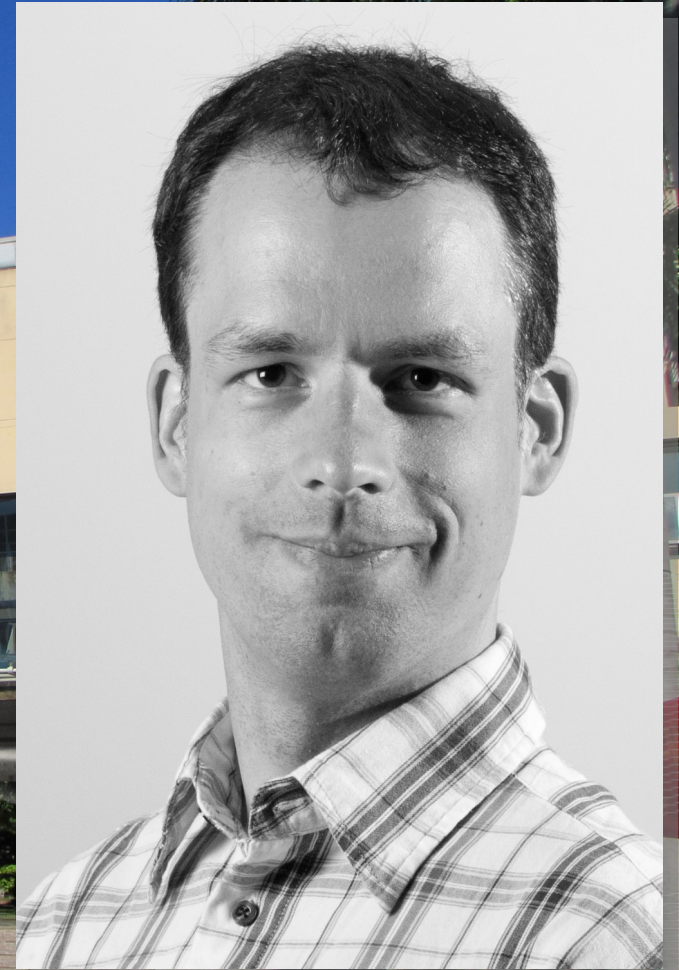
Invited Talk at Hainan University (海南大学)

MELODIC at Hainan University:
Combining NorNet Core
with MELODIC

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Simula Research Laboratory

18 April 2019

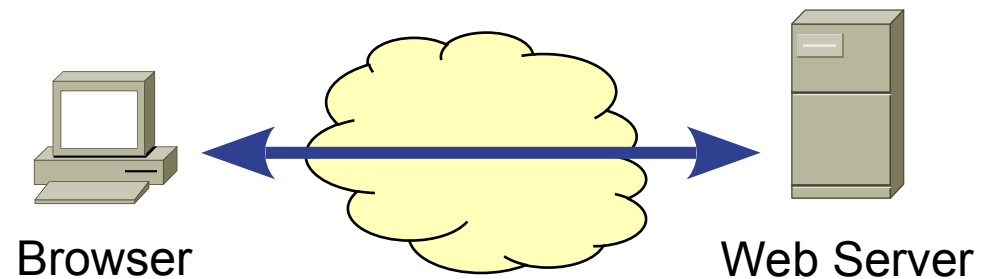


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„Classic“ Internet Communication

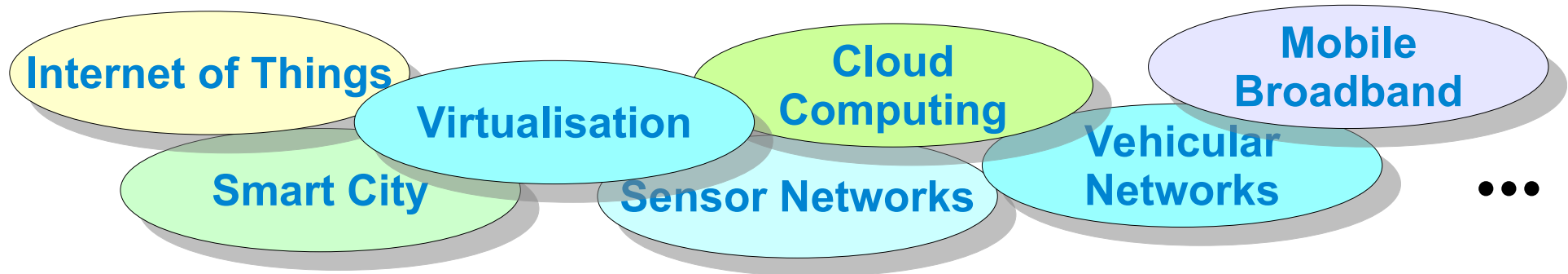
- Example: World-Wide Web



- Client ↔ Server Communication
 - 1 network interface per device → 1 **IPv4** address
 - Communication with Transmission Control Protocol (**TCP**)

The Current and Future Internet

The Big Picture



- IPv6
 - Devices are frequently IPv4/IPv6 dual stack
 - Usually multiple addresses per interface
- Mobility → address change
- Devices with multiple interfaces
 - Router
 - **Smartphone** (LTE/UMTS, WLAN, Bluetooth?)
 - **Laptop** (Ethernet, WLAN, LTE/UMTS?)



Multi-Homing and Multi-Path Transport

- Multi-Homing
 - Multiple interfaces (addresses)
 - **Redundancy** → Communication even when some paths fail
- Multi-Path Transport
 - Also utilise paths simultaneously → better throughput
 - **MPTCP**: Multi-Path TCP
 - **CMT-SCTP**: Concurrent Multi-Path Transfer for SCTP



SCTP: Stream Control Transmission Protocol
TCP: Transmission Control Protocol

We need a realistic Internet testbed for testing and research!

Idea: Distribution of NorNet Testbed over whole Norway

- **Challenging topology:**
 - Large distances
 - A few “big” cities, many large rural areas
 - Svalbard:
 - Interesting location
 - Many polar research institutions
- **Deployment:**
 - Core: 11 sites in Norway + CN, DE, SE, US, KR, AU, FR
 - Edge: hundreds of nodes in Norway



A NorNet Core Site Deployment

A usual NorNet Core site:

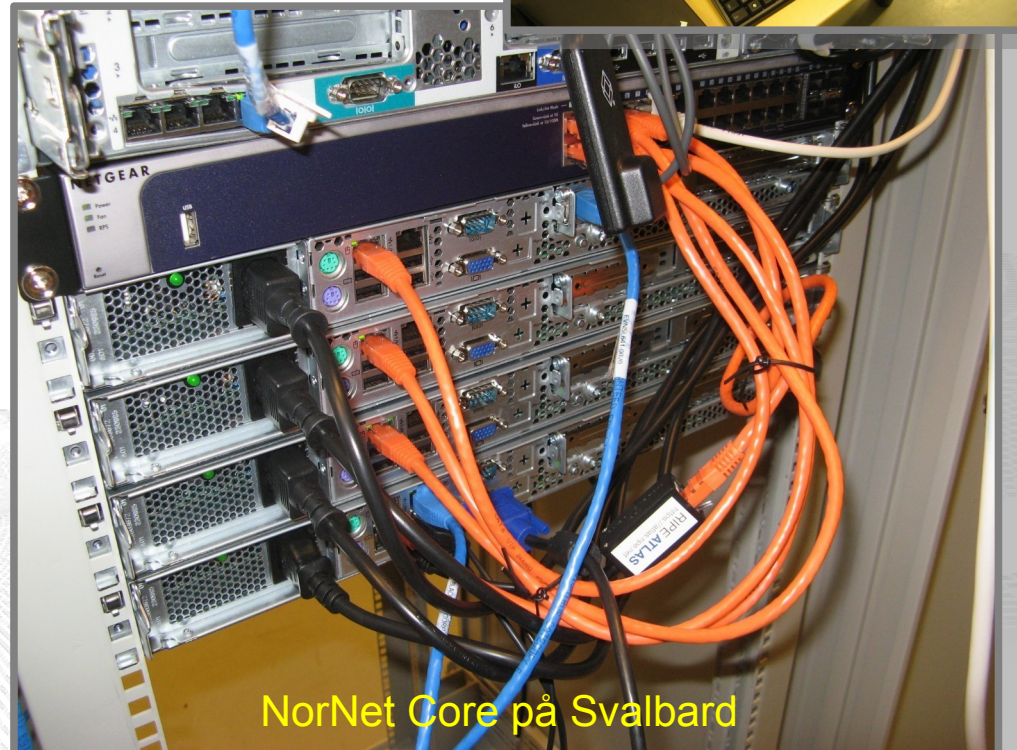
- 1x switch
- 4x server
 - 1x router (tunnelbox)
 - 3x research systems
- At least two ISP connections
 - Research network provider
 - Other providers
- IPv4 and IPv6 (if available)

Additional researcher-provided sites:

- Varying configurations
- VM setups, powerful servers, “retro-style” PCs ...



Longyearbyen 78.2°N,15.6°E



NorNet Core på Svalbard

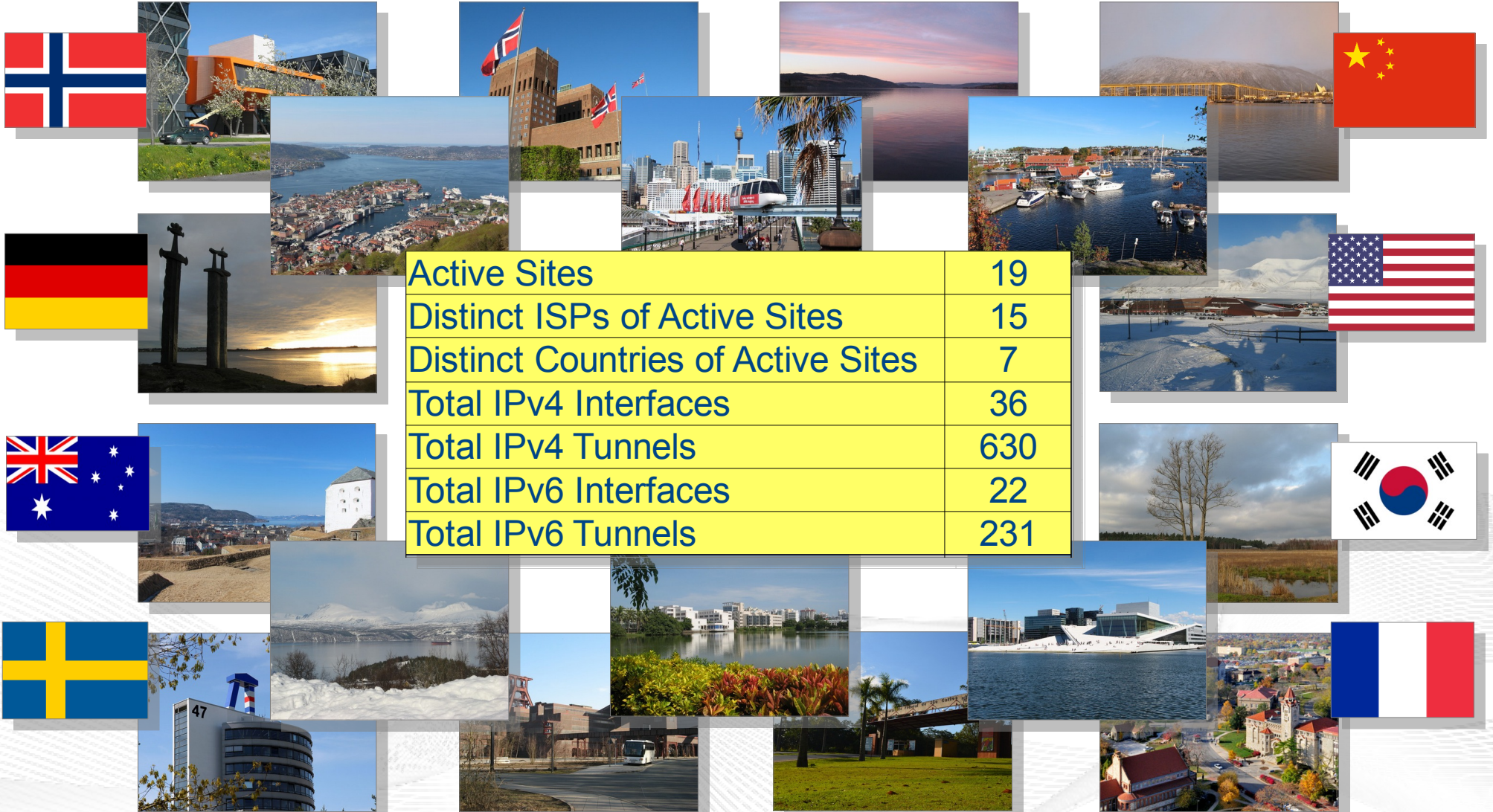
NorNet Core Site Deployment Status (April 2019)

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	Oslo Metropolitan University	Uninett			
12	Karlstads Universitet	SUNET			
13	Universität Kaiserslautern	DFN			
14	Universität Duisburg-Essen	DFN			
15	Hainan University 海南大学	CERNET	China Unicom		
16	The University of Kansas	KanREN			
17	Korea University 고려대학교	KREONET			
18	HAW Hamburg	DFN			
19	Technische Universität Darmstadt	DFN			
20	Lab. Informatique Grenoble	RENATER			
21	New York University	Lightower			
22	Haikou Cg. of Econ. 海口经济学院	China Telecom	CERNET		

- IPv4 and IPv6
- IPv4 only (ISP without IPv6 support ☹)
- IPv4 only (site's network without IPv6 support)
- ISP negotiation in progress

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

Some Site Statistics (April 2019)



Active Sites	19
Distinct ISPs of Active Sites	15
Distinct Countries of Active Sites	7
Total IPv4 Interfaces	36
Total IPv4 Tunnels	630
Total IPv6 Interfaces	22
Total IPv6 Tunnels	231

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

Our servers may be really remote!

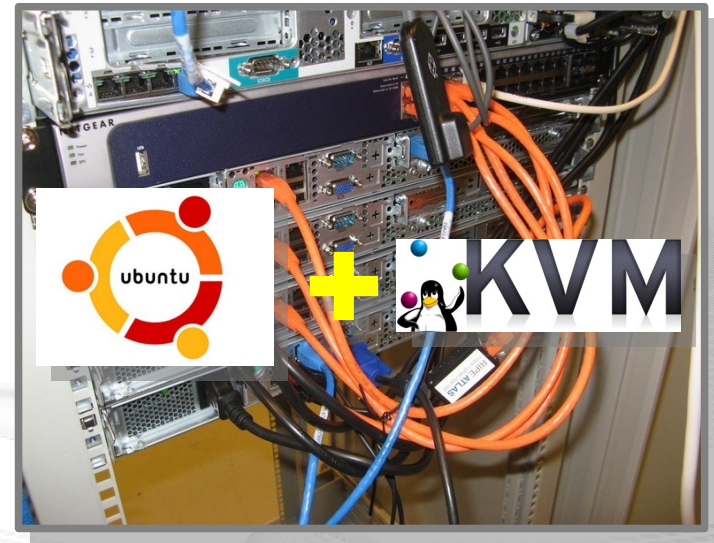


The “road” to Longyearbyen på Svalbard, 78.2°N

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 16.04 LTS
 - KVM (Kernel-based Virtual Machine)
 - Other software runs in VMs:
 - Tunnelbox (router)
 - Research nodes (users' experiments)
 - In case of problem: manual/automatic restart or reinstall of VM



Combination of NorNet Core with MELODIC!

NorNet Core systems on top of MELODIC!

- OpenStack for managing VMs
 - VMs with different operating systems (Linux, FreeBSD, AROS, ...)
 - Access to multiple ISPs per site
 - IPv4 and IPv6
 - Easy management of sites, VMs, users, storage, ...
- VMs for MELODIC users at interesting locations
- Current status:
 - Controller at Simula (nisse.nntb.no)
 - 2 powerful new servers (troll.nntb.no, huldra.nntb.no)

Details for further discussion!

Conclusion and Ongoing Work

“The road to hell is paved with unused testbeds.”
[James P. G. Sterbenz]

- The NorNet Core testbed is ready for experiments!
 - Do you have experiment ideas? → Talk to us!
- Ongoing work:
 - NorNet Core combination with MELODIC
 - **OpenStack support**
 - Opportunities for interesting tests, experiments, student projects, ...



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

Thank you for your attention!

Questions?

Fragen?

Spørsmål?

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Literature (1)

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