

Presentation at the 93<sup>rd</sup> IETF Meeting

# MPTCP Experiences in the NorNet Testbed

draft-dreibholz-mptcp-nornet-experience-01

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# Motivation: MPTCP in the Internet

- Redundancy
  - Multiple interfaces and addresses
  - **Redundancy** → communication still possible in case of path failures
- Multi-Path Transport
  - Simultaneous usage of paths → better throughput, ...
  - **Multi-Path TCP (MPTCP)!**



How well is MPTCP performing in the real-world Internet?

# The NorNet Testbed

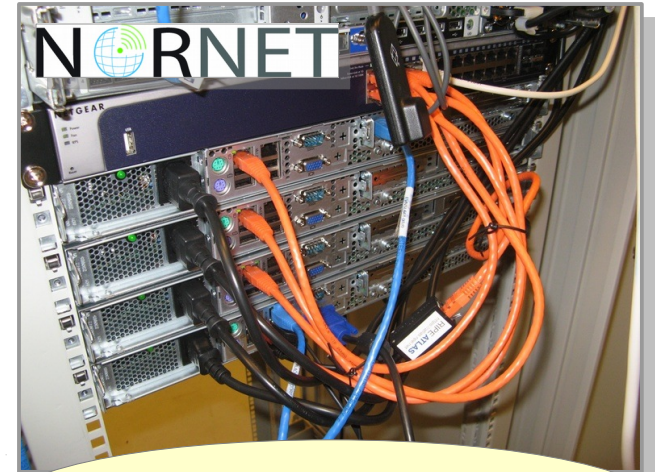
- NorNet Core

- Cabled, up to 4 ISPs, IPv4+IPv6 (fibre, consumer-grade DSL, etc.)
- Hosts for virtual machines
- 20 locations (11 in NO, 9 abroad)

[ **simula** . research laboratory ]

- NorNet Edge

- Embedded system „Ufoboard“
- Up to 4x 2G/3G/4G, 1x CDMA, 1x cable
- Hundreds of locations (in NO)




<https://www.nntb.no>



# NorNet Core Site Deployment Status (July 2015)

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			
17	Korea University	KREONET			
18	National ICT Australia (NICTA)	AARNet			
19	Univ. Federal de São Carlos	RNP			
20	HAW Hamburg	DFN			

 IPv4 and IPv6

 ISP negotiation in progress

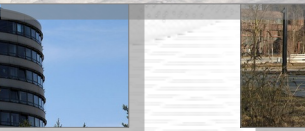
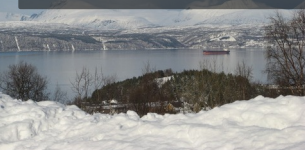
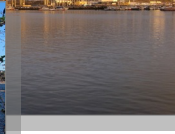
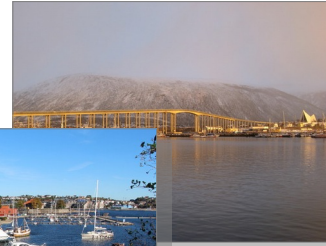
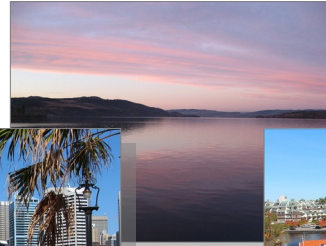
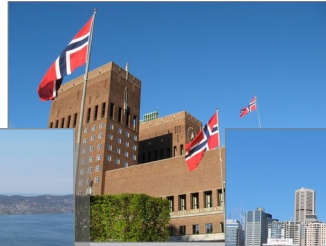
 IPv4 only (ISP without IPv6 support ☹)

 IPv4 only (site's network without IPv6 support)

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

# The Challenge of the Real-World Internet: MPTCP in NorNet Core

- Internet Scenario:
  - Many sites, up to 4 ISPs per site
  - Heterogeneous connections (DSL, fibre, etc.)
- Goal:
  - MPTCP uses all possible paths
  - Does it work as expected?



# Overview of NorNet Core Results

- MPTCP in heterogeneous Internet setups:
  - **It works!**
  - Some IPv6 issues (with old version 0.88.11 of Linux MPTCP) → new tests needed
  - Details in *Dreibholz; Zhou; Fa: „Multi-Path TCP in Real-World Setups – An Evaluation in the NorNet Core Testbed“, PAMS 2015.*
- IPv4/IPv6 identity duality:
  - Making simultaneous use of IPv4 and IPv6 paths
  - Improvements already for single-ISP endpoints
  - Details in *Livadariu; Ferlin; Alay; Dreibholz; Dhamdhere; Elmokashfi: “Leveraging the IPv4/IPv6 Identity Duality by using Multi-Path Transport”, Global Internet Symposium 2015.*

Papers: <https://www.nntb.no/publications/>

# The Challenge of Mobile Broadband: MPTCP in NorNet Edge

ice.net

network  
norway™

TEL. E2

Configuration  
by ISP

Locations

telenor

Utilization of Cells

NetCom



# Overview of NorNet Edge Results

- What to expect from MBB paths?
  - Path characteristics of 5 Norwegian MBB ISPs
  - Details in *Ferlin; Dreibholz; Alay; Kvalbein: “Measuring the QoS Characteristics of Operational 3G Mobile Broadband Networks”, PAMS 2014.*
- Handling buffer bloat:
  - **Multi-path transport buffer bloat mitigation (MPT-BM):**
    - Details in *Ferlin; Dreibholz; Alay: “Tackling the Challenge of Bufferbloat in Multi-Path Transport over Heterogeneous Wireless Networks”, IWQoS 2014.*
  - **Dynamic Relative Path Scoring (DRePaS):**
    - Details in *Ferlin; Dreibholz; Alay: “Multi-Path Transport over Heterogeneous Wireless Networks: Does it really pay off?”, GLOBECOM 2014.*

Papers: <https://www.nntb.no/publications/>

Any Questions?



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