Testing Applications with the NorNet Infrastructure

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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)
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

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 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 ...
### NorNet Core Site Deployment Status (September 2017)

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<th>No.</th>
<th>Site</th>
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<th>ISP 2</th>
<th>ISP 3</th>
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- 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](https://www.nntb.no/pub/nornet-configuration/NorNetCore-Sites.html)
Some Site Statistics (September 2017)

Active Sites | 22
Distinct ISPs of Active Sites | 16
Distinct Countries of Active Sites | 7
Total IPv4 Interfaces | 40
Total IPv4 Tunnels | 780
Total IPv6 Interfaces | 24
Total IPv6 Tunnels | 276

https://www.nntb.no/pub/nornet-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 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!

- 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?

Thomas Dreibholz, dreibh@simula.no
Dreibholz, T.: “An Experiment Tutorial for the NorNet Core Testbed at the Universidad de Castilla-La Mancha” (PDF, 5244 KiB), Tutorial at the Universidad de Castilla-La Mancha, Instituto de Investigación Informática de Albacete, Albacete, Castilla-La Mancha/Spain, February 16, 2017.

Dreibholz, T.: “Multi-Path Transport – From Simulations to Real-World Internet Measurements” (PDF, 14631 KiB), Keynote Talk at the Universidad de Castilla-La Mancha, Instituto de Investigación Informática de Albacete, Albacete, Castilla-La Mancha/Spain, February 16, 2017.

Dreibholz, T.: “NorNet – Building an Inter-Continental Internet Testbed based on Open Source Software” (PDF, 9587 KiB), Proceedings of the LinuxCon Europe, Berlin/Germany, October 5, 2016.


