

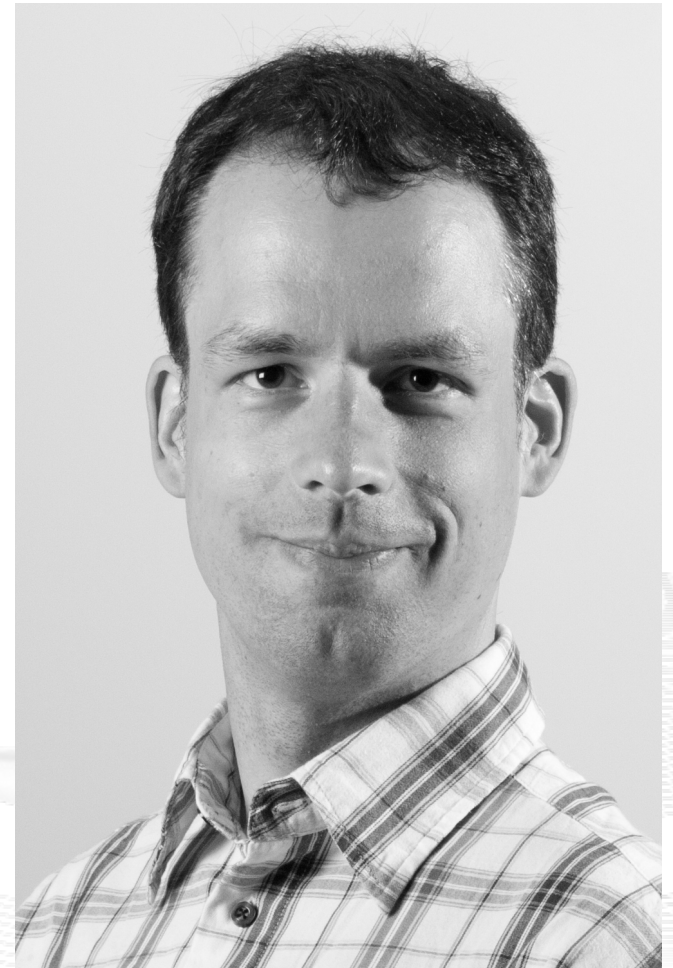
Tutorial at the Universidad de Castilla-La Mancha

An Experiment Tutorial for the
NorNet Core Testbed at the
Universidad de Castilla-La Mancha

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Contents

- Preparations
- Getting an Overview of the Testbed
- Using a Slice
- A Practical Example
- Conclusion

Overview: Preparations

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Tutorial Accounts

- You should have received an account
 - Username
 - Password
- Valid for:
 - SSH login server
 - PLC server

Do you have an account? If not, ask!

Initial Tasks

- **Account for our SSH login server** gatekeeper.nntb.no:
 - Server is gateway into NorNet Core network
 - `ssh <username>@gatekeeper.nntb.no`
 - Use port forwarding to access PLC and Monitor servers:
 - `ssh <username>@gatekeeper.nntb.no \`
 `-L 2000:plc.simula.nornet:443 \`
 `-L 2001:monitor.simula.nornet:80`
 - Forwards TCP port 2000 to PLC server's HTTPS port
 - Forwards TCP port 2001 to Monitor server's HTTP port
- **Account for the PLC server** plc.simula.nornet (inside NorNet Core only):
 - Login: `<username>@simula.nornet`
- **VPN into NorNet Core coming soon**

Try to directly connect to your NorNet Core switch

Access to PLC and Monitor

- Via port forwarding:
 - Monitor: <http://localhost:2001/>
 - PLC: <https://localhost:2000/>
- Inside NorNet Core network:
 - Monitor: <http://monitor.simula.nornet>
 - PLC: <https://plc.simula.nornet>

Is everybody able to log in?

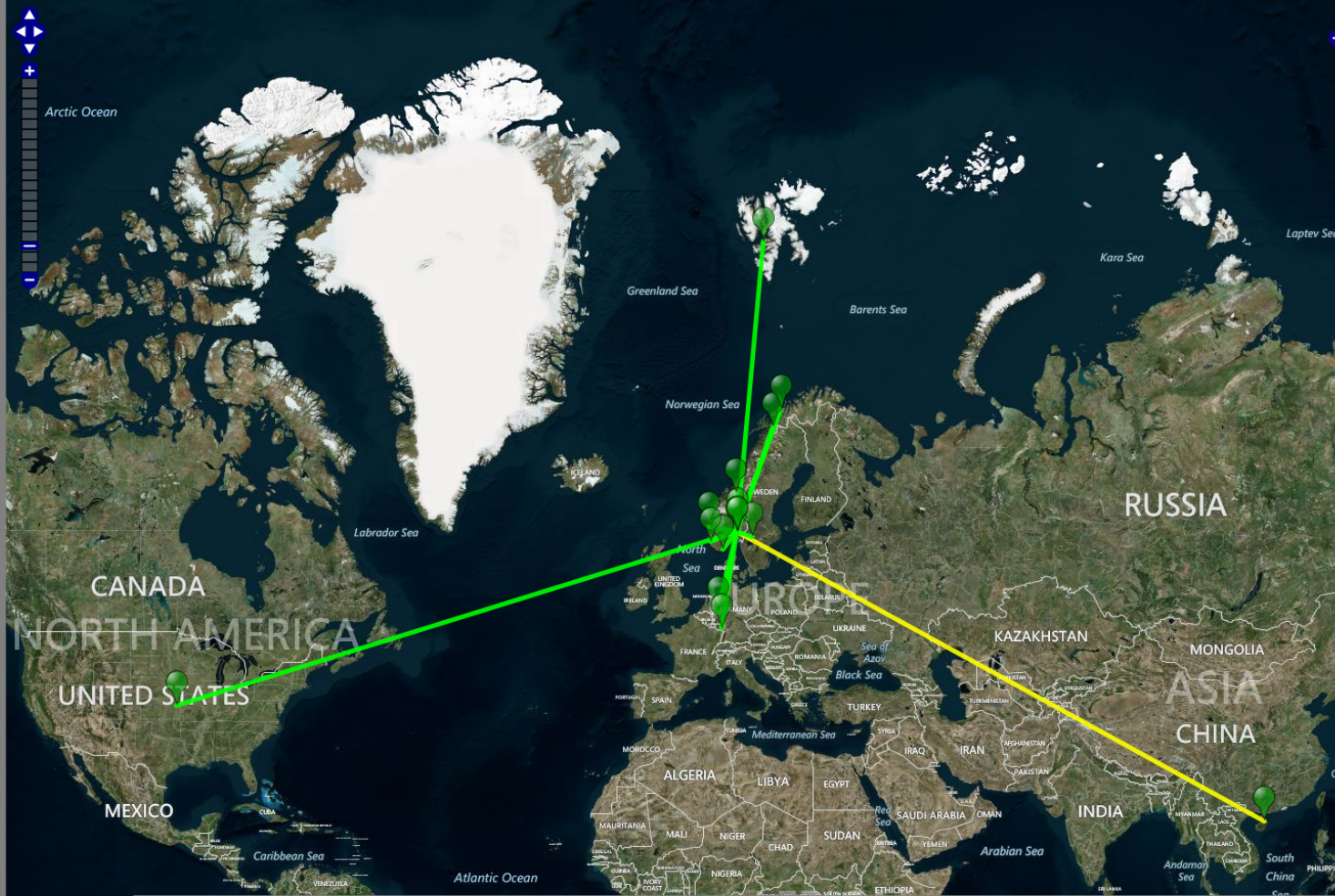
Overview:

Getting an Overview of the Testbed

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“Kontrollsenteret”

Velkommen til NorNet-Kontrollsenner på Simula Research Laboratory, Fornebu



15:10:22
Mandag, 28. juli 2014

Lofasjon

Problemer:

😊 Ingen problem! 😊

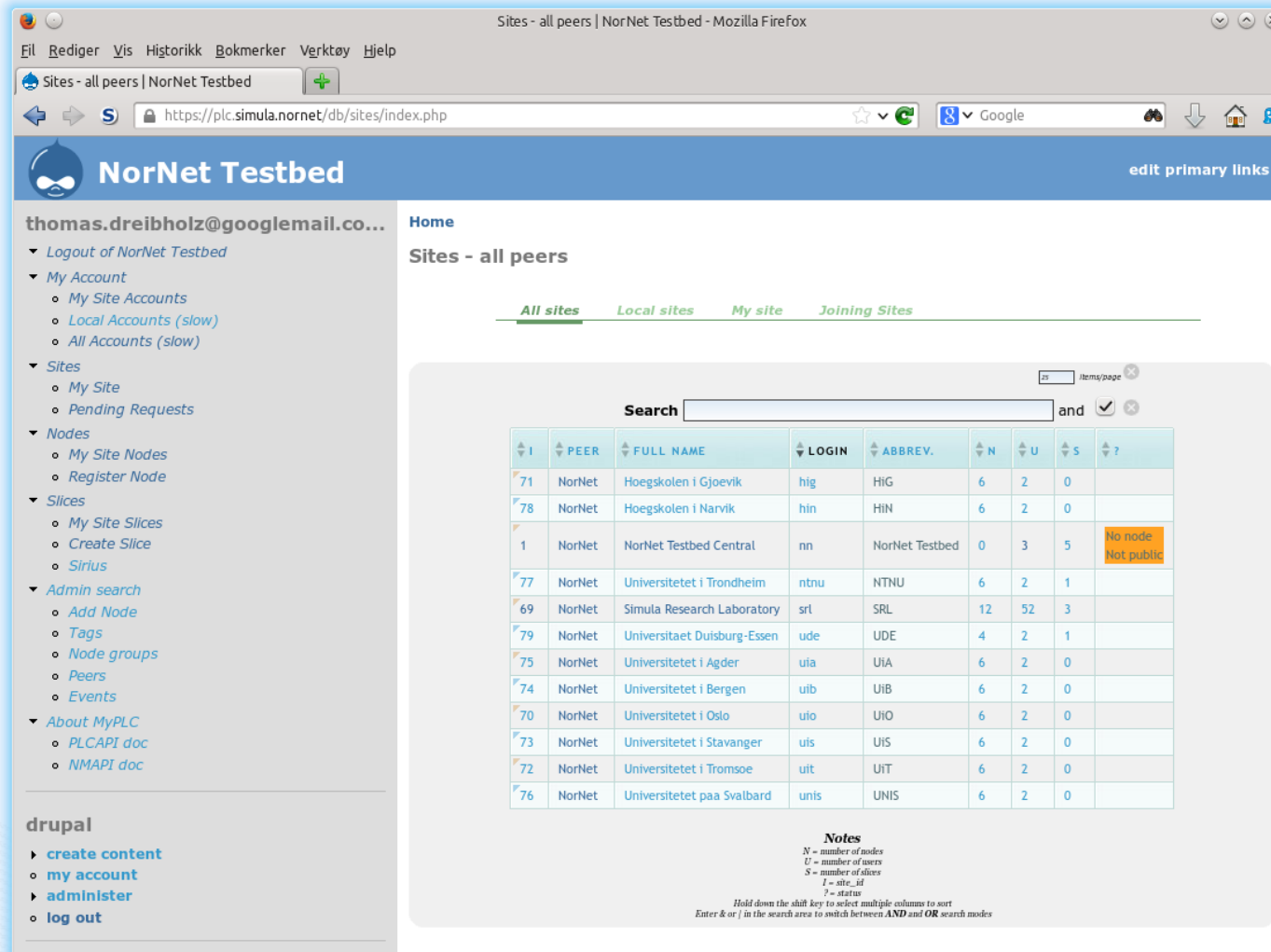
J orden:

- @Hainan University
- @Høgskolen i Gjøvik
- @Høgskolen i Narvik
- @Høgskolen i Oslo og Akershus
- @Karlstads Universitet
- @Simula Research Laboratory
- @Universitetet i Agder
- @Universitetet i Bergen
- @Universitetet i Oslo
- @Universitetet i Stavanger
- @Universitetet i Tromsø
- @Universitetet i Trondheim

See <http://monitor.simula.nor-net> within NorNet Core!

For mer informasjon om NorNet-prosjektet, se <https://www.nnfd.no>!

PLC User Interface: Sites View



thomas.dreibholz@googlemail.co... Home

Sites - all peers

[All sites](#) [Local sites](#) [My site](#) [Joining Sites](#)

Search and

↓ ↑	↓ ↑	↓ ↑	↓ ↑	↓ ↑	↓ ↑	↓ ↑	↓ ↑	↓ ↑	↓ ↑
ID	PEER	FULL NAME	LOGIN	ABBREV.	N	U	S	?	
71	NorNet	Hoegskolen i Gjoevik	hig	HiG	6	2	0		
78	NorNet	Hoegskolen i Narvik	hin	HIN	6	2	0		
1	NorNet	NorNet Testbed Central	nn	NorNet Testbed	0	3	5		No node Not public
77	NorNet	Universitetet i Trondheim	ntnu	NTNU	6	2	1		
69	NorNet	Simula Research Laboratory	srl	SRL	12	52	3		
79	NorNet	Universitaet Duisburg-Essen	ude	UDE	4	2	1		
75	NorNet	Universitetet i Agder	uia	UIA	6	2	0		
74	NorNet	Universitetet i Bergen	uib	UIB	6	2	0		
70	NorNet	Universitetet i Oslo	uio	UIO	6	2	0		
73	NorNet	Universitetet i Stavanger	uis	UIS	6	2	0		
72	NorNet	Universitetet i Tromsoe	uit	UIT	6	2	0		
76	NorNet	Universitetet paa Svalbard	unis	UNIS	6	2	0		

Notes
N = number of nodes
U = number of users
S = number of slices
I = site_id
? = status
Hold down the shift key to select multiple columns to sort
Enter & or | in the search area to switch between AND and OR search modes

drupal

- create content
- my account
- administer
- log out

See <https://plc.simula.nor-net> within NorNet Core!

PLC User Interface: Nodes View

The screenshot shows the 'Nodes - all peers' view in the NorNet Testbed interface. The browser window title is 'Nodes - all peers | NorNet Testbed - Mozilla Firefox'. The URL is 'https://plc.simula.nor-net.no/db/nodes/index.php'. The interface includes a sidebar with user information (thomas.dreibholz@googlemail.co...) and navigation links. The main content area shows a table of nodes with columns for ID, HOSTNAME, AU, ST, RES, IP, and SN. A yellow callout box points to the 'ST' column, stating 'Node state: should be "boot"'. The table data is as follows:

ID	HOSTNAME	AU	ST	RES	IP	SN	?
456	adventfjorden.unis.nor-net.no	NorNet	boot		10.1.4.104	unis	
404	akerbrygge.simula.nor-net.no	NorNet	boot		10.1.1.100	srl	
414	akerselva.simula.nor-net.no	NorNet	boot		10.1.1.110	srl	
470	altenessen.ude.nor-net.no	NorNet	boot		10.30.42.100	ude	
428	amundsen.uit.nor-net.no	NorNet	boot		10.1.4.100	uit	
432	arctandria.uit.nor-net.no	NorNet	boot		10.1.4.104	uit	
436	askje.uis.nor-net.no	NorNet	boot		10.1.5.102	uis	
430	aunegaarden.uit.nor-net.no	NorNet	boot		10.1.4.102	uit	
459	bakklandet.ntnu.nor-net.no	NorNet	boot		10.1.9.101	ntnu	
471	baldeneysee.ude.nor-net.no	NorNet	boot		10.30.42.101	ude	

PLC User Interface: Account View

The screenshot shows a web browser window with the URL `https://plc.simula.nornet/db/persons/index.php?id=25`. The page title is "Details for account Thomas Dreibholz". The left sidebar contains a navigation menu with options like "Logout of NorNet Testbed", "My Account", "Sites", "Nodes", "Slices", "Admin search", and "About MyPLC". The main content area is titled "Details for account Thomas Dreibholz" and includes buttons for "Become", "Disable", and "Delete". Below this is a "Details" section with form fields for "Title", "First Name" (Thomas), "Last Name" (Dreibholz), "Email" (thomas1@simula.nornet), "SFA hrn" (planetlab.test.srl.thomas1), "Phone", "URL" (thomas.dreibholz@googlemail.com), and "Bio". A "Password" field is also visible.

A yellow callout box contains the following text:

- Upload your SSH public key here!
- Public keys get distributed to all nodes (may take up to 1 hour!)

Below the callout, a "One key" section shows a table with columns "TYPE" and "KEY". The table contains one entry:

TYPE	KEY
ssh	ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQDboXaLZxyrD3njS5ZvN59tsrJ2F9ou gn/VL_Ohni+182GZ8dDpE1wHse0R05oHrOL8kUWmahJ/zGrlSpo1tRBknZCIX lsZY5EV+hwJndOnjFCovr3FJ3QuOmyO6UY0oMH/fsah7zhmrVENw3739yslJ kbbxGIBF8lnC CqahywxHJzS2Gh0DbC 4pCbTTAmk1 TWl7bWGQoEINadhFK4z 1OeYW2GvLV2YWppfrWxfBjDjJ6nTY2xBGDlr2aL3AQYxhdiDstwnr1GVKqP BaWcyBIDU6zVJkbDU9tarMLuDH8DQqGsv8OCq61eESbZYWjAWLJsJNWYUp+n /DZIFLBy5KQH thomas1@oesthorn.simula.nornet

Below the table are buttons for "Remove keys", "Upload new key", "Bla gjennom ...", "Ingen fil valgt.", and "Upload key". A large black arrow points from the callout box to the "KEY" column of the table.

Overview: Using a Slice

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The Test Slice *srl_tutorial*

- A test slice has already been created:
 - Name: *srl_tutorial*
 - Special NorNet Core properties:
 - Own IP addresses on each node
 - IPv4 and IPv6
 - Multiple ISPs (at sites with several ISPs)
- The slice is instantiated on all nodes by a sliver (LXC container)
- Your account is mapped as user to *srl_tutorial*

Logging In

- From the login server:
 - `ssh -i <your private key> <slice name>@<node name>`
- Examples (private key is in `~/.ssh/id_rsa`, slice is `srl_tutorial`):
 - `ssh -i ~/.ssh/id_rsa srl_tutorial@boao.hu.nor-net`
 - `ssh -i ~/.ssh/id_rsa srl_tutorial@altenessen.ude.nor-net`
 - `ssh -i ~/.ssh/id_rsa srl_tutorial@nordlys.unis.nor-net`
 - `ssh -i ~/.ssh/id_rsa srl_tutorial@julenisse.uia.nor-net`
 - `ssh -i ~/.ssh/id_rsa srl_tutorial@watson.ku.nor-net`
- Note: login is via node's SSH server to sliver on the node!

Use PLC to find other nodes. There are more than 100 nodes!

Note the Different Entities: Server, Node, Sliver

```
ssh <Slice>@<Node>
```

Server (physical)

Node (virtual)

- Sliver hu_multipath
- Sliver srl_tutorial
- Sliver ntnu_test
- Sliver due_rserpool
- Sliver uib_mptcp
- ...

Node (virtual)



Slice:

- User list
- Node list

Forwarding
to sliver!

Sliver = an instance
of a slice on a node

Inside a Sliver

- Each sliver contains a Fedora Core 24 environment
- **Obtain root access:**
 - su
 - sudo bash
- **Install custom software:**
 - `dnf install <package> ...`
 - Example: `dnf install netperf`
- **Show IP addresses and routes:**
 - `ip -4 addr show ; ip -4 route show`
 - `ip -6 addr show ; ip -6 route show`

Remember: slivers have their own addresses!

Inside a Sliver

- Each sliver contains a Fedora Core 24 environment
- **Obtain root access:**
 - su
 - sudo bash
- **Install custom software:**
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Remember: slivers have their own addresses!

Nodes, Slivers and Addresses

- Node:
 - The node itself, e.g. altenessen.ude.nor-net
 - Used for SSH login
- How to find sliver addresses of a node?
 - Look inside the sliver itself (login to sliver → ip addr show)
 - Ask the DNS server:
 - Use “dig” (part of bind-utils package for Fedora Core)
 - `dig <slice name>.<node name>.<site name>.nor-net`
 - But replace “_” by “-” in slice name!
 - Examples for srl_tutorial slice:
 - `dig srl-tutorial.altenessen.ude.nor-net any` to obtain primary provider (it is in the CNAME, here: “dfn”)
 - `dig srl-tutorial.altenessen.all.ude.nor-net any` to obtain all providers' addresses
 - `dig srl-tutorial.solvang.all.simula.nor-net` without “any” → gets only A RRs (i.e. IPv4 addresses)

A dig Example

```
ola1@nordberg:~$ dig srl-tutorial.solvang.all.simula.nornet any
; <<>> DiG 9.9.2-P1 <<>> srl-tutorial.solvang.all.simula.nornet any
...
;; ANSWER SECTION:
srl-tutorial.solvang.all.simula.nornet. 86400 IN A 10.2.1.130
srl-tutorial.solvang.all.simula.nornet. 86400 IN A 10.1.1.130
srl-tutorial.solvang.all.simula.nornet. 86400 IN AAAA 2001:700:4100:101::82:69
srl-tutorial.solvang.all.simula.nornet. 86400 IN AAAA 2001:700:4100:201::82:69
srl-tutorial.solvang.all.simula.nornet. 86400 IN HINFO "Amiga 5000" "Slice srl_tutorial"
srl-tutorial.solvang.all.simula.nornet. 86400 IN LOC 59 53 45.240 N 10 37 39.360 E 15.00m
;; AUTHORITY SECTION:
simula.nornet. 86400 IN NS ns.ntnu.nornet.
...
```

IPv4

IPv6

Geographic location

Software

Overview: A Practical Example

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A Multi-Path Routing Test

- Select two nodes at different sites
 - List: <https://www.nntb.no/pub/nor-net-configuration/NorNetCore-Sites.html>
 - Login to *srl_tutorial* sliver: `ssh srl_tutorial@<node name>`
 - Check IP addresses: `ip -4 addr show dev eth0`
 - Example:
 - `srl-test.kettwig.ude.nor-net:` 10.30.42.122 10.31.42.122
 - ISPs: 30=DFN, 31=Versatel (an ADSL connection)
 - `srl-test.frogner.simula.nor-net:` 10.1.1.131 10.2.1.131 10.4.1.131 10.9.1.131
 - ISPs: 1=UNINETT, 2=Kvantel, 4=Telenor, 9=PowerTech
- Try ping/traceroute:
 - `ping [-f] [-s <size>] [-c <count>] <dest IP> -I <src IP>`
 - `traceroute <dest IP> -s <src IP>`
 - Look at the second and third hop (and their reverse DNS lookups)!
 - What do you see?

Some Flood Ping Results

```
srl_tutorial@kettwig.ude.nornet # ping -c 1000 -s 1400 -f 10.1.1.129 -I 10.30.42.122
PING 10.1.1.129 (10.1.1.129) from 10.30.42.122 : 1400(1428) bytes of data.
1000 packets transmitted, 1000 received, 0% packet loss, time 14591ms
rtt min/avg/max/mdev = 70.115/108.064/177.958/26.870 ms
```

DFN → UNINETT

```
srl_tutorial@kettwig.ude.nornet # ping -c 1000 -s 1400 -f 10.2.1.129 -I 10.30.42.122
PING 10.2.1.129 (10.2.1.129) from 10.30.42.122 : 1400(1428) bytes of data.
1000 packets transmitted, 1000 received, 0% packet loss, time 14783ms
rtt min/avg/max/mdev = 31.009/76.446/136.024/27.666 ms
```

DFN → Kvantel

```
srl_tutorial@kettwig.ude.nornet # ping -c 1000 -s 1400 -f 10.1.1.129 -I 10.31.42.122
PING 10.1.1.129 (10.1.1.129) from 10.31.42.122 : 1400(1428) bytes of data.
1000 packets transmitted, 999 received, 0% packet loss, time 14412ms
rtt min/avg/max/mdev = 121.153/175.432/252.685/28.585 ms
```

Versatel → UNINETT

```
srl_tutorial@kettwig.ude.nornet # ping -c 1000 -s 1400 -f 10.2.1.129 -I 10.31.42.122
PING 10.2.1.129 (10.2.1.129) from 10.31.42.122 : 1400(1428) bytes of data.
1000 packets transmitted, 999 received, 0% packet loss, time 14182ms
rtt min/avg/max/mdev = 78.643/124.496/207.773/26.729 ms
```

Versatel → Kvantel

RTT differences among provider combinations; higher ADSL delay (Versatel)

Some Traceroute Results

```
srl_tutorial@kettwig.ude.nornet # traceroute 10.1.1.129 -s 10.30.42.122
```

```
traceroute to 10.1.1.129 (10.1.1.129), 30 hops max, 60 byte packets
```

- 1 essen.dfn.ude.nornet (10.30.42.1) 2.104 ms 2.849 ms 2.831 ms
- 2 dfn.ude.uninett.simula.nornet (192.168.178.10) 95.059 ms 95.024 ms 94.961 ms
- 3 srl-test.frogner.uninett.simula.nornet (10.1.1.129) 105.432 ms 105.281 ms 105.220 ms

DFN → UNINETT

```
srl_tutorial@kettwig.ude.nornet # traceroute 10.2.1.129 -s 10.30.42.122
```

```
traceroute to 10.2.1.129 (10.2.1.129), 30 hops max, 60 byte packets
```

- 1 essen.dfn.ude.nornet (10.30.42.1) 1.190 ms 1.739 ms 1.031 ms
- 2 dfn.ude.uninett.simula.nornet (192.168.178.10) 56.972 ms 56.722 ms 56.853 ms
- 3 srl-test.frogner.kvantel.simula.nornet (10.2.1.129) 100.773 ms 99.513 ms 99.337 ms

DFN → Kvantel

```
srl_tutorial@kettwig.ude.nornet # traceroute 10.1.1.129 -s 10.31.42.122
```

```
traceroute to 10.1.1.129 (10.1.1.129), 30 hops max, 60 byte packets
```

- 1 essen.versatel.ude.nornet (10.31.42.1) 1.830 ms 2.633 ms 2.609 ms
- 2 versatel.ude.uninett.simula.nornet (192.168.133.222) 127.768 ms 127.954 ms 127.507 ms
- 3 srl-test.frogner.uninett.simula.nornet (10.1.1.129) 182.544 ms 182.564 ms 182.269 ms

Versatel → UNINETT

```
srl_tutorial@kettwig.ude.nornet # traceroute 10.2.1.129 -s 10.31.42.122
```

```
traceroute to 10.2.1.129 (10.2.1.129), 30 hops max, 60 byte packets
```

- 1 essen.versatel.ude.nornet (10.31.42.1) 1.178 ms 1.805 ms 1.769 ms
- 2 versatel.ude.uninett.simula.nornet (192.168.133.222) 88.834 ms 91.932 ms 96.620 ms
- 3 srl-test.frogner.kvantel.simula.nornet (10.2.1.129) 79.603 ms 75.599 ms 69.910 ms

Versatel → Kvantel

Hop 2: Router's ICMP TTL Exceeded is sent back via Simula's primary ISP!

What else to do?

- Try the same with IPv6!
 - `ping6 [-f] [-s <size>] [-c <count>] <dest IP> -I <src IP>`
 - `traceroute6 <dest IP> -s <src IP>`
- Try NetPerfMeter!
 - Supports TCP including **MPTCP**, SCTP, UDP, DCCP
 - Server side: `netperfmeter <port>`
 - Client side: `netperfmeter <server>:<port> <flow details> ...`
(see manpage for details!)
- Install custom software
 - But note: do not assume the slivers to be permanent storages
 - Write scripts to automatise installation
 - **In case of problems, nodes may just be wiped and reinstalled**

And, of course, try your own experiments in NorNet!

Overview: Conclusion

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Conclusion and Future Work

- **NorNet Core is ready for your ideas!**
 - Think about your experiments
 - Let them run in NorNet Core
- How to get permanent access?
 - **Talk to us!**
 - Provide some information on your project
Let us **discuss the details** about running your experiment in NorNet Core!

In case of questions, ask us!

“NorNet wants to be a building block of the railroad to heaven” ...



<https://www.nntb.no>

... and not be another unused testbed that paves the road to hell!