An Experiment Tutorial for the NorNet Core Testbed at the University of Sydney

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24 January 2017

Contents

Overview:
Preparations

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

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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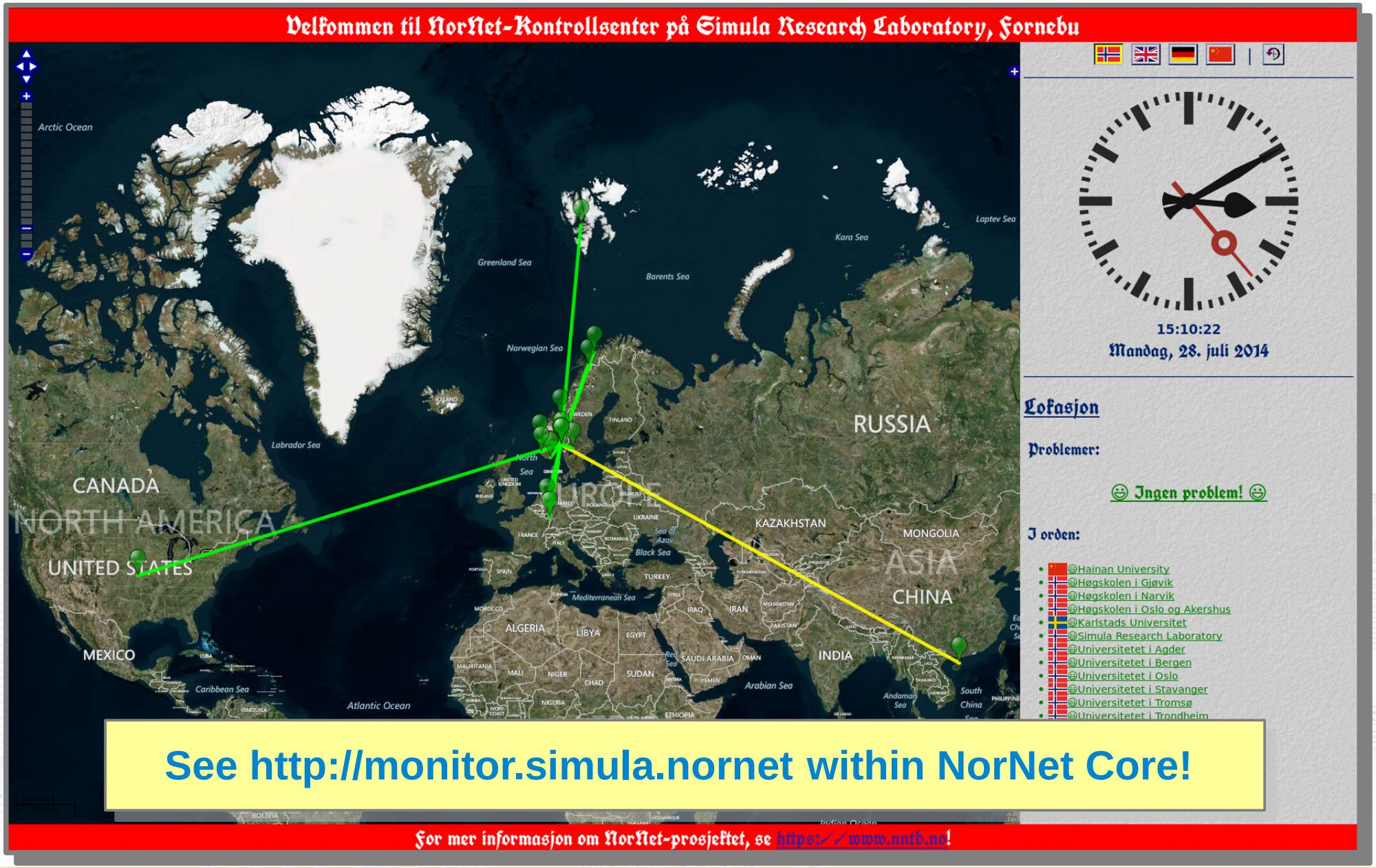
“Kontrollsenteret”



See http://monitor.simula.nornet within NorNet Core!

PLC User Interface: Sites View

Sites - all peers | NorNet Testbed - Mozilla Firefox

Fil Rediger Vis Historikk Bokmerker Verktøy Hjelp

Sites - all peers | NorNet Testbed

https://plc.simula.nornet/db/sites/index.php

NorNet Testbed edit primary links

thomas.dreibholz@googlemail.co...

- Logout of NorNet Testbed
- My Account
  - My Site Accounts
  - Local Accounts (slow)
  - All Accounts (slow)
- Sites
  - My Site
  - Pending Requests
- Nodes
  - My Site Nodes
  - Register Node
- Slices
  - My Site Slices
  - Create Slice
  - Sirius
- Admin search
  - Add Node
  - Tags
  - Node groups
  - Peers
  - Events
- About MyPLC
  - PLCAPI doc
  - NMAPI doc

drupal

- create content
- my account
- administer
- log out

Home

Sites - all peers

All sites | Local sites | My site | Joining Sites

25 Items/page

Search and

I	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*

See https://plc.simula.nornet within NorNet Core!

PLC User Interface: Nodes View

Nodes - all peers | NorNet Testbed - Mozilla Firefox

Fil Rediger Vis Historikk Bokmerker Verktøy Hjelp

Nodes - all peers | NorNet Testbed

https://plc.simula.nornet/db/nodes/index.php

NorNet Testbed

edit primary links

thomas.dreibholz@googlemail.co...

- Logout of NorNet Testbed
- My Account
  - My Site Accounts
  - Local Accounts (slow)
  - All Accounts (slow)
- Sites
  - My Site
  - Pending Requests
- Nodes
  - My Site Nodes
  - Register Node
- Slices
  - My Site Slices
  - Create Slice
  - Sirius
- Admin search
  - Add Node
  - Tags
  - Node groups
  - Peers
  - Events
- About MyPLC
  - PLCAPI doc
  - NMAPI doc

drupal

- create content
- my account
- administer
- log out

Home

Nodes - all peers

All nodes | My site nodes | Local nodes

Node table layout

can't open file

Add/remove columns | Column description and configuration

A	Architecture name
DA	Date added
DL	Deployment
DN	Toplevel domain name
IP	IP address
OS	Operating system
SN	Site name

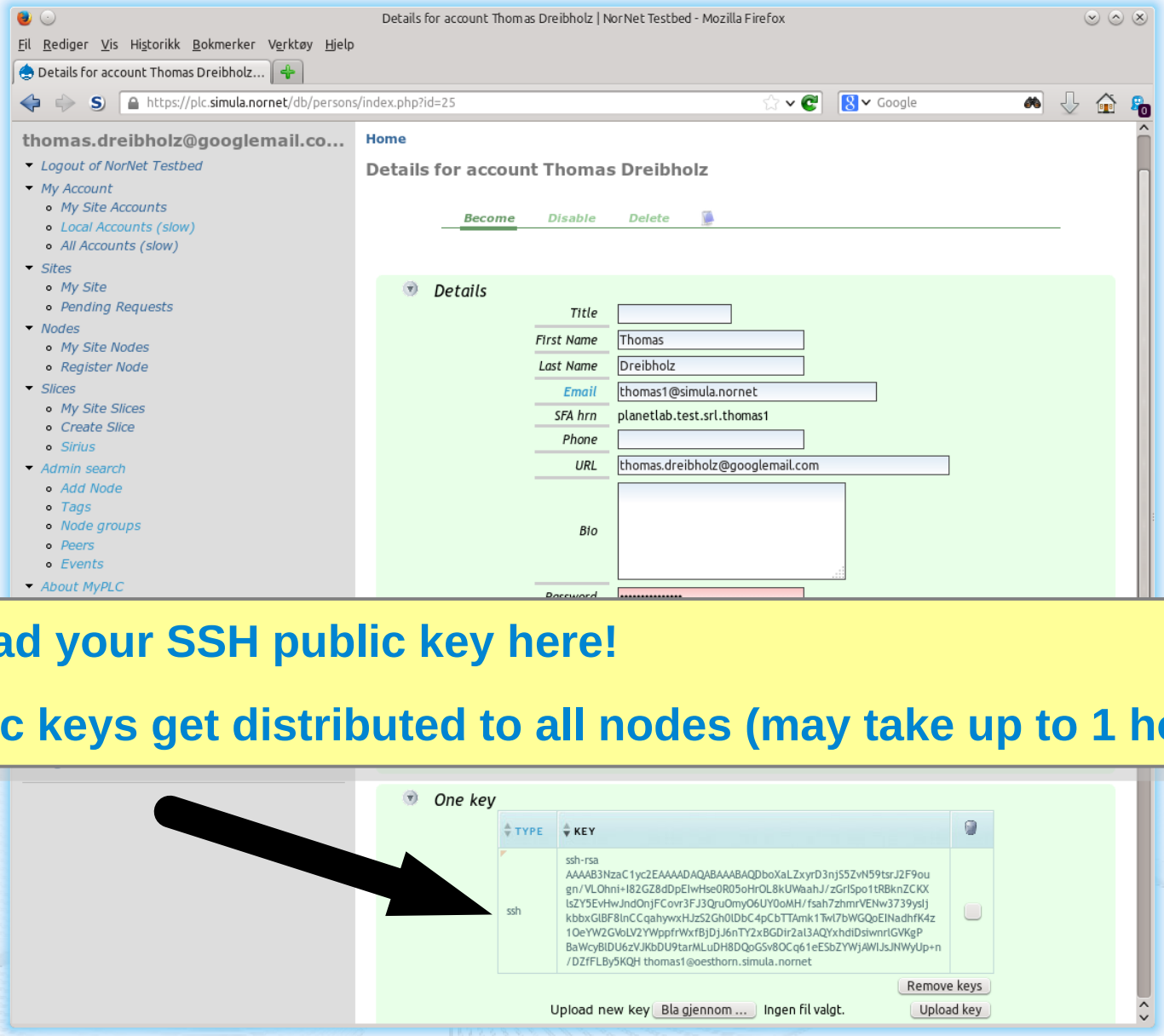
Authority

Search

ID	HOSTNAME	AU	ST	RES	IP	SN	?
456	adventfjorden.unis.nornet	NorNet	boot		04	unis	
404	akerbrygge.simula.nornet	NorNet	boot		.1.100	srl	
414	akerselva.simula.nornet	NorNet	boot		.1.110	srl	
470	altenessen.ude.nornet	NorNet	boot		10.30.42.100	ude	
428	amundsen.uit.nornet	NorNet	boot		10.1.4.100	uit	
432	arctandria.uit.nornet	NorNet	boot		10.1.4.104	uit	
436	askje.uis.nornet	NorNet	boot		10.1.5.102	uis	
430	aunegaarden.uit.nornet	NorNet	boot		10.1.4.102	uit	
459	bakklandet.ntnu.nornet	NorNet	boot		10.1.9.101	ntnu	
471	baldeneysee.ude.nornet	NorNet	boot		10.30.42.101	ude	

Node state: should be “boot”

PLC User Interface: Account View



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

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.nornet`
  - `ssh -i ~/.ssh/id_rsa srl_tutorial@altenessen.ude.nornet`
  - `ssh -i ~/.ssh/id_rsa srl_tutorial@nordlys.unis.nornet`
  - `ssh -i ~/.ssh/id_rsa srl_tutorial@julenisse.uia.nornet`
  - `ssh -i ~/.ssh/id_rsa srl_tutorial@watson.ku.nornet`
- 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 <Sliver>@<Node>
```

Server (physical)

Node (virtual)

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

Node (virtual)

•••

Forwarding to sliver!

Slice:
- User list
- Node list

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 netperfmeter`
- **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

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Remember: slivers have their own addresses!

Nodes, Slivers and Addresses

- Node:
  - The node itself, e.g. altenessen.ude.nornet
  - 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>.nornet`
    - But replace “_” by “–” in slice name!
  - Examples for srl_tutorial slice:
    - `dig srl-tutorial.altenessen.ude.nornet any`
      to obtain primary provider (it is in the CNAME, here: “dfn”)
    - `dig srl-tutorial.altenessen.`**`all`**`.ude.nornet any`
      to obtain all providers' addresses
    - `dig srl-tutorial.solvang.`**`all`**`.simula.nornet`

      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

Software

Geographic location

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A Practical Example

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A Multi-Path Routing Test

- Select two nodes at different sites
  - List: https://www.nntb.no/pub/nornet-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.nornet: 10.30.42.122 10.31.42.122
      - ISPs: 30=DFN, 31=Versatel (an ADSL connection)
    - srl-test.frogner.simula.nornet: 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 <u>not</u> assume the slivers to be permanent storages
  - Write scripts to automatise installation
  - **In case of problems, nodes may just be <u>wiped and reinstalled</u>**

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

Overview: Conclusion

- Preparations
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Conclusion and Future Work

- **NorNet Core is ready for <u>your</u> 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!