Contents

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

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

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

Accounts are just temporary for this tutorial!
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:
    - 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:
  - 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

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

Velkommen til NorNet-Kontrollsenter på Simula Research Laboratory, Fornebu

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

For mer informasjon om NorNet-prosjektet, se https://www.nornet.no!
PLC User Interface: Sites View

See https://plc.simula.nornet within NorNet Core!
PLC User Interface: Nodes View

Node state: should be “boot”
PLC User Interface: Account View

- Your temporary SSH keys are on the login server!
- Public key is already provided to PLC for authentication to nodes
Overview:
Using a Slice

- Preparations
- Getting an Overview of the Testbed
- Using a Slice
- A Practical Example
- Conclusion
The Tutorial 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@nordberg.simula.nornet`
  - `ssh -i ~/.ssh/id_rsa srl_tutorial@amundsen.uit.nornet`
  - `ssh -i ~/.ssh/id_rsa srl_tutorial@altenessen.ude.nornet`
  - `ssh -i ~/.ssh/id_rsa srl_tutorial@bjoernfjell.hin.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 92 nodes!
Inside a Sliver

- Each sliver contains a Fedora Core 18 environment

- **Obtain root access:**
  - `su`
  - `sudo bash`

- **Install custom software:**
  - `yum install <package> ...`
  - **Example:** `yum 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!**
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's addresses
      ```
      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

```bash
olal@nordberg:~$ dig srl-tutorial.solvang.all.simula.nornet any
```

```text
; <<>> DiG 9.9.2-P1 <<>> srl-tutorial.solvang.all.simula.nornet any
...

;; ANSWER SECTION:

srl-tutorial.solvang.all.simula.nornet. 86400 IN A 10.2.1.146
srl-tutorial.solvang.all.simula.nornet. 86400 IN A 10.1.1.146
srl-tutorial.solvang.all.simula.nornet. 86400 IN AAAA 2001:700:4100:101::92:69
srl-tutorial.solvang.all.simula.nornet. 86400 IN AAAA 2001:700:4100:201::92:69
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: `10.2.1.146` and `10.1.1.146`
- Geographic location: `59 53 45.240 N 10 37 39.360 E 15.00m`
- Software: `"Amiga 5000" "Slice srl_tutorial"`
Overview:
A Practical Example

- Preparations
- Getting an Overview of the Testbed
- Using a Slice
- A Practical Example
- Conclusion
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-tutorial.kettwig.ude.nornet*: 10.30.42.148 10.31.42.148
      - ISPs: 30=DFN, 31=Versatel (an ADSL connection)
    - *srl-tutorial.frogner.simula.nornet*: 10.1.1.129 10.2.1.129 10.4.1.129 10.9.1.129
      - ISPs: 1=UNINETT, 2=Hafslund, 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 10.30.42.148
PING 10.1.1.129 (10.1.1.129) from 10.30.42.148 : 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

srl_tutorial@kettwig.ude.nornet # ping -c 1000 -s 1400 -f 10.2.1.129 -I 10.30.42.148
PING 10.2.1.129 (10.2.1.129) from 10.30.42.148 : 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

srl_tutorial@kettwig.ude.nornet # ping -c 1000 -s 1400 -f 10.1.1.129 -I 10.31.42.148
PING 10.1.1.129 (10.1.1.129) from 10.31.42.148 : 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

srl_tutorial@kettwig.ude.nornet # ping -c 1000 -s 1400 -f 10.2.1.129 -I 10.31.42.148
PING 10.2.1.129 (10.2.1.129) from 10.31.42.148 : 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

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

srl_tutorial@kettwig.ude.nornet # traceroute 10.1.1.129 -s 10.30.42.148
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-tutorial.frogner.uninett.simula.nornet (10.1.1.129) 105.432 ms 105.281 ms 105.220 ms

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

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

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

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