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

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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:
    - 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:

• 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-Kontrollsenter på Simula Research Laboratory, Førnebu

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

- 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

**Server** (physical)

**Node** (virtual)
- Sliver hu_multipath
- Sliver srl_tutorial
- Sliver ntnu_test
- Sliver due_rserpool
- Sliver uib_mptcp
- ...

**Slice**:
- User list
- Node list

**Node** (virtual)

- Sliver = an instance of a slice on a node

Forwarding to sliver!
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

- 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!
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:

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/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=Kvamtel, 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 -l 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

srl_tutorial@kettwig.ude.nornet # ping -c 1000 -s 1400 -f 10.2.1.129 -l 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

srl_tutorial@kettwig.ude.nornet # ping -c 1000 -s 1400 -f 10.1.1.129 -l 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

srl_tutorial@kettwig.ude.nornet # ping -c 1000 -s 1400 -f 10.2.1.129 -l 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

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

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

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

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

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

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!
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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” ...

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