Tooling for NDN Development

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Simulators and Emulators

ndnSIM Simulator https://ndnsim.net

Based on ns-3 discrete-event network simulator.

Scalable to hundreds of nodes.

Runs the "core" of NFD as C++ objects, connected via modeled network links.

Applications must be ported to ns-3 model.

Not run in real time

Mini-NDN Emulator https://minindn.named-data.net

Based on Mininet network emulator.

Scaling is bound by CPU resources

Runs real forwarders in containers, connected via Linux bridges and pipes.

Most applications can run without changes.

named-data/**mini-ndn**

Mininet-based NDN emulator (mailing list: https://www.lists.cs.ucla.edu/mailman/listinfo/mini-ndn)

A 23 Contributors   ⊙ 20 Issues   ☆ 74 Stars   ⑂ 42 Forks

ndnsec: NDN Security Toolkit

ndnsec: Basic Operations

https://github.com/named-data/ndn-cxx
https://docs.named-data.net/ndn-cxx/curr
ent/manpages/ndnsec.html

Generate a key pair for name /example/Adam

```
$ ndnsec key-gen /example/Adam > Adam.pub
```

View Identities

```
$ ndnsec list -vv
Pib-sqlite3:
├──* /example/Adam Identity
│   └──* /example/Adam/KEY/%E8%C1%2A%1C%21%AD%5E%FA Key
│       └──* /example/Adam/KEY/%E8%C1%2A%1C%21%AD%5E%FA/self/v=1744754254866 Cert
```

Generate signing request

```
$ ndnsec sign-req /example/Adam > Adam.csr
```

ndnsec: Basic Operations (Continued)

https://github.com/named-data/ndn-cxx
https://docs.named-data.net/ndn-cxx/curr
ent/manpages/ndnsec.html

On the trust anchor side, issue a cert to /example/Adam

```
$ ndnsec cert-gen -s /example/anchor -i my-anchor Adam.csr > Adam.cert
```

Install the cert

```
$ ndnsec cert-install Adam.cert
OK: certificate with name
[/example/Adam/KEY/%E8%C1%2A%1C%21%AD%5E%FA/my-anchor/v=1744755310912] has
been successfully installed
```
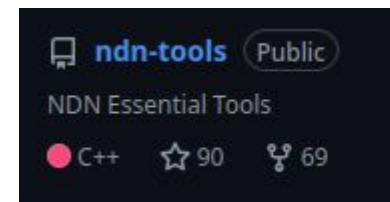
```
├──    /example/Adam
│   └──* /example/Adam/KEY/%E8%C1%2A%1C%21%AD%5E%FA
│         ├──   /example/Adam/KEY/%E8%C1%2A%1C%21%AD%5E%FA/self/v=1744754254866
│         └──* /example/Adam/KEY/%E8%C1%2A%1C%21%AD%5E%FA/my-anchor/v=1744755310912
│
```

Poke, Peek, and Dissect:
Basic Interest/Data Exchange

Poke and Peek: Produce and Fetch Data

https://github.com/named-data/ndn-tools/
tree/master/tools/peek

Produce data with ndnpoke:

```
$ echo "hello world" | ndnpoke
/localhost/demo/hello
```

Send Interest for produced data:

```
$ ndnpeek -p /localhost/demo/hello
hello world
```

(-p prints out the decoded content)

Default ndnpeek prints the whole encoded data packet:

```
$ ndnpeek /localhost/demo/hello
�        localhosdemhello
                         hello world
/*examplK�i   i�~self��

�H0F!�[�J�Ʒ��u�i[W{�b-����
$k�'ꟿGH!�D�7��Ʒ��4��*L��]
�6u�V(���~�
```

ndn-dissect: Inspecting NDN Data

https://github.com/named-data/ndn-tools/
tree/master/tools/dissect

```
$ ndnpeek /localhost/demo/hello | ndn-dissect
6 (Data) (size: 165)
├─7 (Name) (size: 24)
│   ├─8 (GenericNameComponent) (size: 9) [[localhost]]
│   ├─8 (GenericNameComponent) (size: 4) [[demo]]
│   └─8 (GenericNameComponent) (size: 5) [[hello]]
├─20 (MetaInfo) (size: 0) [[]]
├─21 (Content) (size: 12) [[hello%20world%0A]]
├─22 (SignatureInfo) (size: 47)
│   ├─27 (SignatureType) (size: 1) [[%03]]
│   └─28 (KeyLocator) (size: 42)
│      └─7 (Name) (size: 40)
│         ├─8 (GenericNameComponent) (size: 7) [[example]]
│         ├─8 (GenericNameComponent) (size: 3) [[KEY]]
│         ├─8 (GenericNameComponent) (size: 8) [[%18%BAi%09i%9A~%AA]]
│         ├─8 (GenericNameComponent) (size: 4) [[self]]
│         └─54 (VersionNameComponent) (size: 8)
[[%00%00%01%95%96%0C%0A%D8]]
└─23 (SignatureValue) (size: 72)
[[0F%02%21%00%DE%5B%82J%95%D5%80%CA%EEu%D2i%5BW%7B%A2b-%95%9B%B9%06%83%24k%D3%27%02%D4%80GH%02%21%00%B0D%BC7%AB%ED%D5%80%AD%
9A4%F2%03%E9%2AL%B7%E4%5D%DD6u%E5V%28%FA%D9%10%AC~%EE%1F]]
```

10

What about entire files?

ndnputchunks and ndncatchunks: publish and fetch files

Files may be large, so they may fit into many
NDN Data packets

Publish a file at [filename] under a [prefix]:

```
ndnputchunks [prefix] < [filename]
```

Retrieve (latest version of) published file:

```
ndncatchunks [prefix]
```

Performance measurements

- Congestion control schemes
- Throughput tests
- Resilience tests

ndn-tools (Public)

NDN Essential Tools

C++   ☆ 90   ⑂ 69
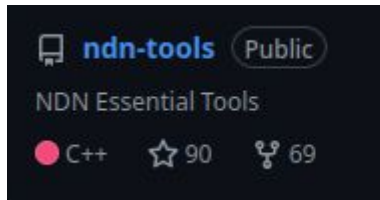
https://github.com/named-data/ndn-tools/
tree/master/tools/chunks

UPDATE: these tools are renamed to **ndnget** and **ndnserve**
during the 17th NDN hackathon.

GUI Tooling

Wireshark Dissector

NDN-Play Chrome Extension

Debugging for WebSocket

NDN Browser Apps

vscode Extensions for NDN

VerSec Syntax Highlighting

https://marketplace.visualstudio.com/items?itemName=pulsejet.versec-language
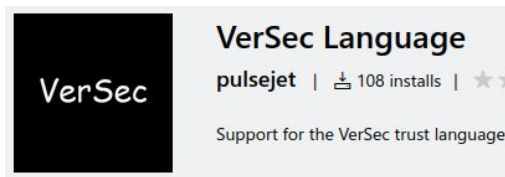
NDN-Play TLV dissector and viewer
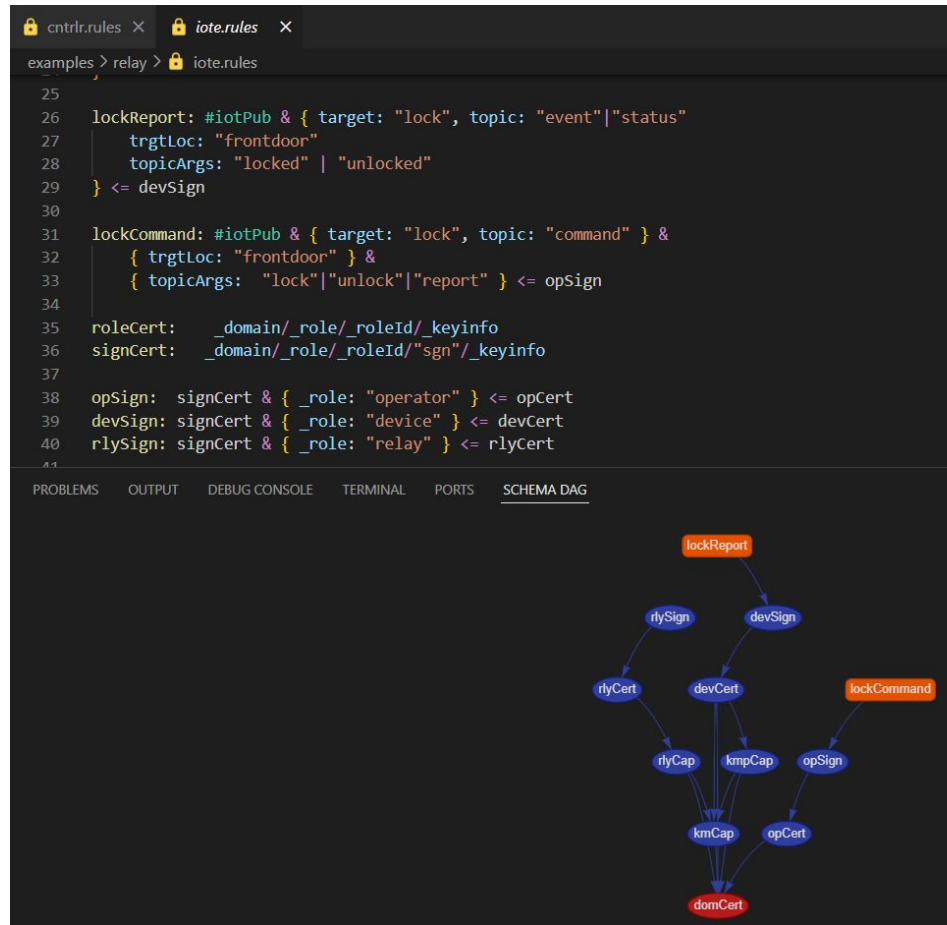
https://marketplace.visualstudio.com/items?itemName=pulsejet.ndn-play-vscode

NDN-Play (Web) - MiniNDN GUI
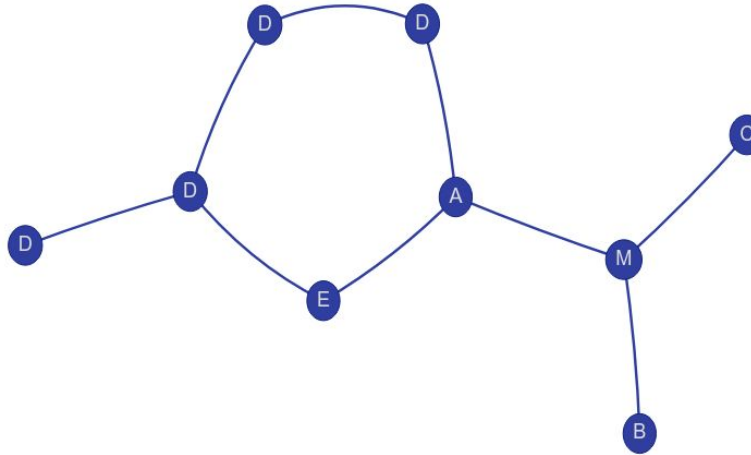
Testbed Status Pages

Global NDN Testbed

Research infrastructure operated by the NDN team.

- 24 routers in 5 continents.
- Open to all NDN users and developers.

Currently running:

- NDN Forwarding Daemon (NFD)
- NDN Link State Routing (NLSR)
- ndn6-file-server

May transition to NDNd later in 2025.

Testbed Status Page

Show a list of NDN testbed routers. Includes: name prefix, software versions, service uptime and health, pairwise data plane reachability.

Also available as a JSON document for programmatic usage.

	Prefix	TLS Expiry	WSS	Revision	ARIZONA	DELFT	FRANKFURT	MEMPHIS	Host OS	Kernel	Docker	nfd
ARIZONA	/ndn/edu/arizona	in 56 days	OK	21e5a54-dirty	0.74	171.74	163.81	58.07	Ubuntu 20.04.6 LTS	5.4.0-196-generic	28.0.4	Up 13 days (healthy)
DELFT	/ndn/nl/delft	in 56 days	OK	a3ba1eb	171.56	0.62	8.21	114.33	Ubuntu 24.04.2 LTS	6.8.0-55-generic	28.0.1	Up 4 weeks (healthy)
FRANKFURT	/ndn/pcl/frankfurt	in 59 days	OK	21e5a54	163.53	8.27	0.72	121.54	Ubuntu 22.04.5 LTS	5.15.0-117-generic	28.0.4	Up 13 days (healthy)
MEMPHIS	/ndn/edu/memphis	in 78 days	OK	21e5a54	58.47	114.41	122.35	0.9	Ubuntu 24.04.2 LTS	6.8.0-51-generic	28.0.4	Up 13 days (healthy)
NEU	/ndn/edu/neu	[Errno -5]…	OK	21e5a54	81.96	172.31	179.34	58.83	Ubuntu 20.04.6 LTS	5.4.0-182-generic	28.0.4	Up 2 weeks (healthy)
OSAKA	/ndn/jp/ac/osaka-u	in 55 days	OK	21e5a54	131.94	233.08	240.38	191.71	Ubuntu 20.04.6 LTS	5.4.0-205-generic	28.0.4	Up 13 days (healthy)
SINGAPORE	/ndn/pcl/singapore	in 59 days	OK	21e5a54	205.48	177.75	170.94	261.07	Ubuntu 22.04.5 LTS	5.15.0-117-generic	28.0.4	Up 2 weeks (healthy)
UCLA	/ndn/edu/ucla	in 53 days	OK	21e5a54	12.77	158.53	152.25	70.38	Ubuntu 20.04.6 LTS	5.4.0-200-generic	28.0.4	Up 2 weeks (healthy)
WU	/ndn/edu/wustl	in 56 days	OK	21e5a54	51.21	140.83	148.21	27.11	Ubuntu 20.04.6 LTS	5.4.0-190-generic	28.0.4	Up 2 weeks (healthy)
QUB	/ndn/uk/ac/qub											

NDN Play - testbed template

Topology map rendered from testbed status page JSON document.
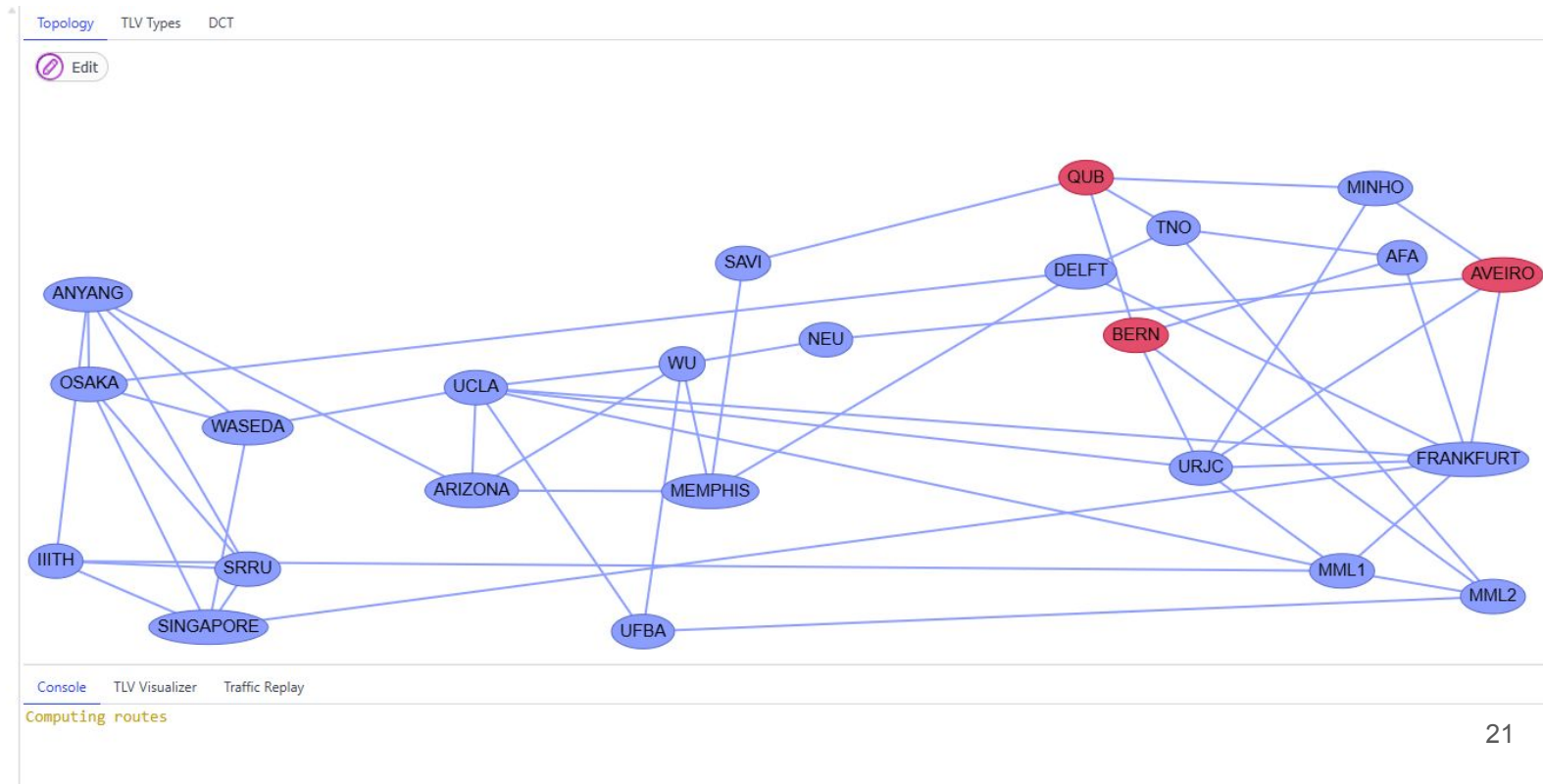
NFD Status Page (click ↗ from testbed status page)

26 faces

id	title	routes	traffic
1	NFD management	0	3
254	Content Store	0	0
255	packet drop	0	0
256	Ethernet multicast on eth0	0	0
257	NFD-RIB management	2	2
258	UDP IPv4 multicast on 172.19.0.8	0	0
259	ping server /ndn/es/urjc	1	1
261	NLSR /ndn/es/urjc/%C1.Router/ insula	117	2
264	UNIX fd=32	4	0
265	UNIX fd=33	1	0
266	UNIX fd=34	1	0
279	UDP 131.179.196.48 (UCLA)	108	1
282	UDP 49.51.163.56 (FRANKFURT)	108	1
285	UDP 195.251.234.11 (MML1)	108	1
288	UDP 193.136.92.155 (AVEIRO)	2	0

Face 279

local	udp4://172.19.0.8:6363	
remote	udp4://131.179.196.48:6363	
MTU	1450	
flags	P CM	
RX Interest	207673	0.10 /s
RX Data	138921	0.16 /s
RX Nack	34	0.00 /s
TX Interest	191868	0.16 /s
TX Data	156066	0.03 /s
TX Nack	439	0.00 /s

Routes

name	origin	cost
/ndn/CA	nlsr	171
/ndn/br/ufba	nlsr	301
/ndn/br/ufba/%C1.Router/ndn-testbed-ufba	nlsr	301
/ndn/ca/utoronto	nlsr	252

NLSR Status Page · https://nlsr-status.ndn.today

Show prefix announcements and link state routing status across the network.

Router	Prefix	Adjacencies
/ndn/edu/arizona/%C1.Router/hobo seqNum=195954 expire=2025-04-09 15:32:56	/ndn/edu/arizona /ndn/web/stats	• ucla/suns (12) • memphis/titan (41) • wustl/wundngw (50) • anyang/anyanghub (234) seqNum=20614 expire=2025-04-09 15:21:04
/ndn/edu/memphis/%C1.Router/titan seqNum=166145 expire=2025-04-09 15:19:34	/ndn/edu/memphis	• arizona/hobo (41) • wustl/wundngw (27) • utoronto/ndnrtr (28) • delft/ndn-testbed (119) seqNum=165122 expire=2025-04-09 15:08:17
/ndn/pcl/frankfurt/%C1.Router/vm seqNum=17204 expire=2025-04-09 15:10:55	/ndn/pcl/frankfurt /yoursunny /yoursunny/_/iah /yoursunny/_/lil /yoursunny/_/mdw /yoursunny/_/otp /yoursunny/_/syd	• ucla/suns (149) • urjc/insula (36) • mmlab1/mmlab1 (50) • delft/ndn-testbed (9) • afasystems/ndn (28) • singapore/vm (178)

23

Tools for Connecting to Testbed

NDN-FCH "Find Closest Hub" API service

Help end hosts connect to NDN network.

- API returns nearby NDN routers based on IP geolocation.
- Periodical health checks ensure returned routers are UP / available.

Built at 11th NDN hackathon (2021).

NDN-FCH API clients are available in popular NDN libraries.

```
$ http --json GET https://fch.ndn.today/?k=2

{
  "routers": [
    {
      "connect": "srru.testbed.named-data.net:6363",
      "prefix": "/ndn/th/ac/srru",
      "transport": "udp"
    },
    {
      "connect": "ndn.ist.osaka-u.ac.jp:6363",
      "prefix": "/ndn/jp/ac/osaka-u",
      "transport": "udp"
    }
  ],
  "updated": 1744140344832
}
```

ndnping: test prefix reachability

```
$ ndnping -c4 /ndn/edu/ucla

PING /ndn/edu/ucla

content from /ndn/edu/ucla: seq=106135936910950294481 time=104.164 ms
content from /ndn/edu/ucla: seq=106135936910950294482 time=104.514 ms
content from /ndn/edu/ucla: seq=106135936910950294483 time=102.629 ms
content from /ndn/edu/ucla: seq=106135936910950294484 time=102.683 ms


--- /ndn/edu/ucla ping statistics —
4 packets transmitted, 4 received, 0 nacked, 0% lost, 0% nacked, time 413.99 ms
rtt min/avg/max/mdev = 102.629/103.498/104.514/0.850749 ms
```

Available in C++ (ndn-tools) and Go (NDNd).

Prefix Propagation to Testbed Router

1. Obtain a certificate: "[user guide to obtain a testbed certificate](#)".

    ```
    ndncert-client
    ```

2. Make your certificate (and intermediates) available for retrieval.

    ```
    ndn6-serve-certs --inter /var/lib/ndn/serve-certs/*.ndncert
    ```

3. Send a prefix registration command to the testbed router.

    ```
    ndn6-register-prefix-remote --face udp4://49.51.163.56:6363 \
      --prefix /example/my-prefix --expiry 600
    ```

Information + Q&A

NDN 101: https://101.named-data.net/

NDN Testbed: https://named-data.net/ndn-testbed/