# Tooling for NDN Development

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# Simulators and Emulators

## ndnSIM Simulator <a href="https://ndnsim.net">https://ndnsim.net</a>

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 <a href="https://minindn.named-data.net">https://minindn.named-data.net</a>

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.





# ndnsec: NDN Security Toolkit

## ndnsec: Basic Operations



Generate a key pair for name /example/Adam

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



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

Install the cert

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

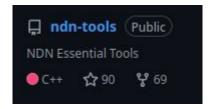
```
$ ndnsec cert-gen -s /example/anchor -i my-anchor Adam.csr > Adam.cert
```

```
$ 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

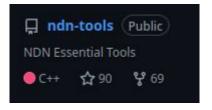
localhosdemhello

hello world

/\*examplK�i i�~self��



## 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]]

# 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]:

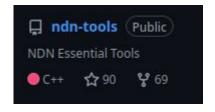
ndnputchunks [prefix] < [filename]</pre>

Retrieve (latest version of) published file:

ndncatchunks [prefix]

Performance measurements

- Congestion control schemes
- Throughput tests
- Resilience tests



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

#### https://github.com/named-data/ndn-tools/tr ee/master/tools/dissect-wireshark

#### Wireshark Dissector

```
4 0.000376
                                49.51.163.56
                                                                            241 Interest /ndn/org/md2k/sync/%06/%01/P%01%00%00%08%80%00%22%04%00%21
              172.31.0.3
                                                               UDP (NDN)
              172.31.0.3
                                49.51.163.56
                                                                            241 Interest /ndn/org/md2k/sync/%06/%01/P%01%00%00%08%80%00%22%04%00%21
 5 0.000376
                                                               UDP (NDN)
                                                                            241 Interest /ndn/org/md2k/sync/%06/%01/P%01%00%00%08%80%00%22%04%00%21
 6 0.000404
              131.179.196.48
                                49.51.163.56
                                                              UDP (NDN)
 7 0.005376
              172.31.0.3
                                128.196.203.36
                                                              UDP (NDN)
                                                                             58
 8 0.005376
              172.31.0.3
                                128, 196, 203, 36
                                                               UDP (NDN)
                                                                             58
 9 0.005414
              131.179.196.48
                                128, 196, 203, 36
                                                               UDP (NDN)
                                                                             58
10 0.155311
              49.51.163.56
                                131.179.196.48
                                                               UDP (NDN)
                                                                             62
11 0.155344
              49.51.163.56
                                                                             58
                                172.31.0.3
                                                               UDP (NDN)
                                                                             58
12 0.155351
              49.51.163.56
                                172.31.0.3
                                                               UDP (NDN)
                                                                            171 Interest /ndn/pcl/frankfurt/%C1.Router/vm/nlsr/INFO/%07%20%08%03ndn
13 3.508778
              172.31.0.3
                                49.51.163.56
                                                               UDP (NDN)
14 3.508778
              172.31.0.3
                                49.51.163.56
                                                              UDP (NDN)
                                                                            171 Interest /ndn/pcl/frankfurt/%C1.Router/vm/nlsr/INFO/%07%20%08%03ndn
                                                                            171 Interest /ndn/pcl/frankfurt/%C1.Router/vm/nlsr/INFO/%07%20%08%03ndn
15 3.508817
              131.179.196.48
                                49.51.163.56
                                                              UDP (NDN)
                                                              UDP (NDN)
                                                                            169 Interest /ndn/es/urjc/%C1.Router/insula/nlsr/INFO/%07%20%08%03ndn%0
16 3.514503
              172.31.0.3
                                193.147.79.41
              172.31.0.3
                                                              UDP (NDN)
                                                                            169 Interest /ndn/es/uric/%C1.Router/insula/nlsr/INFO/%07%20%08%03ndn%0
17 3.514503
                                193.147.79.41
18 3.514523
              131.179.196.48
                                                               UDP (NDN)
                                                                            169 Interest /ndn/es/uric/%C1.Router/insula/nlsr/INFO/%07%20%08%03ndn%0
                                193.147.79.41
```

```
> Frame 5: 241 bytes on wire (1928 bits), 241 bytes captured (1928
> Linux cooked capture v1
> Internet Protocol Version 4, Src: 172.31.0.3, Dst: 49.51.163.56
> User Datagram Protocol, Src Port: 6363, Dst Port: 6363
Named Data Networking (NDN), LpPacket, Sequence: 817425, TxSequen
  LpPacket, Type: 100, Length: 195, Sequence: 817425, TxSequence
       Sequence: 817425
       TxSequence: 820681
     ∨ Fragment, Type: 80, Length: 171
        Interest, Type: 5, Length: 169, Name: /ndn/org/md2k/sync/
           Name [truncated]: /ndn/org/md2k/sync/%06/%01/P%01%00%0
             CanBePrefix: Yes
             MustBeFresh: Yes
             Nonce: 0xc46e09b0
```

```
0000 00 00 00 01 00 06 46 22 2f 12 d6 0e 00 00 08 00
                                                        -----F" /-----
0010 45 00 00 e1 ef fc 00 00 40 11 09 82 ac 1f 00 03
0020 31 33 a3 38 18 db 18 db 00 cd 81 6c 64 c3 51 08
      00 00 00 00 00 0c 79 11 fd 03 48 08 00 00 00 00
0040 00 0c 85 c9 50 ab 05 a9 07 9d 08 03 6e 64 6e 08
      03 6f 72 67 08 04 6d 64 32 6b 08 04 73 79 6e 63
      08 01 06 08 01 01 08 0b 50 01 00 00 08 80 00 22
      04 00 21 08 72 78 da 63 60 60 60 3c 61 f3 df 44
      6c c5 93 b3 0c a8 80 f1 43 73 a4 b8 16 47 5c 21
      88 1d ec e9 1c 25 50 7d 09 5d 0d 31 80 31 f9 ed
       cc ac 55 f7 5b 9a c9 d1 1b 9a b8 f7 dc dc 43 e9
      52 c4 aa df 95 3f a1 ca a4 96 67 0a 03 65 00 d9
00b0
      ef a4 9a 4f eb b0 c2 15 26 38 e3 91 08 f7 30 cd
00c0
      8d 75 fa d5 9d d5 7c 9d 8a 6e 26 35 2e 70 85 39
      49 00 00 c1 0e 42 30 21 00 12 00 0a 04 c4 6e 09
00f0 b0
```

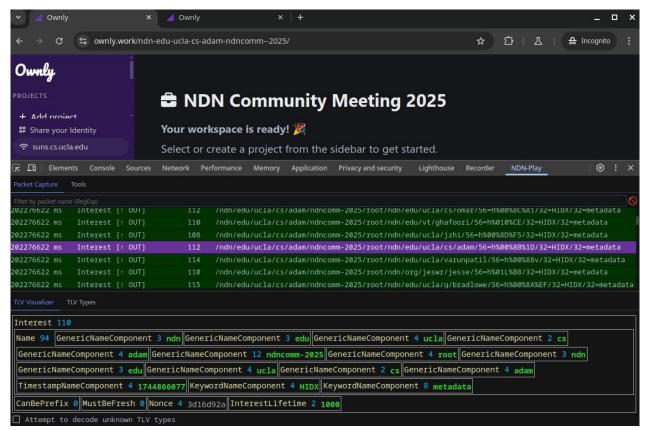


## NDN-Play Chrome Extension

https://chromewebstore.google.com/detail/iknhkednlmhmcooifnplndiahiopfmnh?utmsource=item-share-cb

Debugging for WebSocket

**NDN Browser Apps** 



#### vscode Extensions for NDN

VerSec Syntax Highlighting

https://marketplace.visualstudio.com/items?itemName=pulsejet.vers ec-language



NDN-Play TLV dissector and viewer

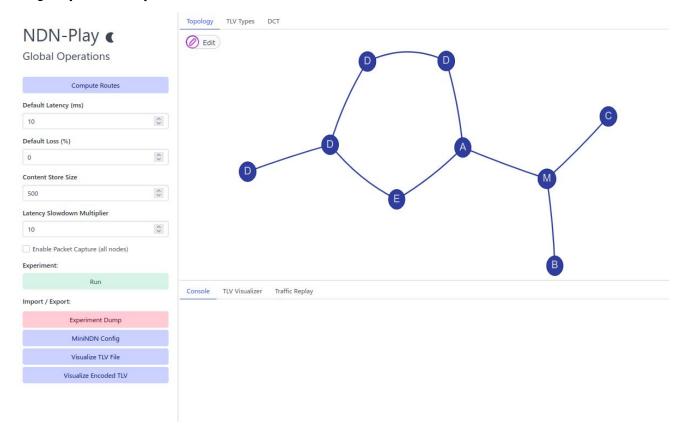
https://marketplace.visualstudio.com/items?itemName=pulsejet.ndn -play-vscode



```
€ cntrlr.rules × € iote.rules ×
 examples > relay > 🔒 iote.rules
       lockReport: #iotPub & { target: "lock", topic: "event"|"status"
            trgtLoc: "frontdoor"
           topicArgs: "locked" | "unlocked"
       } <= devSign
       lockCommand: #iotPub & { target: "lock", topic: "command" } &
            { trgtLoc: "frontdoor" } &
            { topicArgs: "lock"|"unlock"|"report" } <= opSign
                    domain/ role/ roleId/ keyinfo
       roleCert:
       signCert: domain/ role/ roleId/"sgn"/ keyinfo
       opSign: signCert & { role: "operator" } <= opCert</pre>
       devSign: signCert & { _role: "device" } <= devCert</pre>
       rlySign: signCert & { role: "relay" } <= rlyCert</pre>
```

## NDN-Play (Web) - MiniNDN GUI

#### https://play.ndn.today



# **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

https://testbed-status.named-data.net

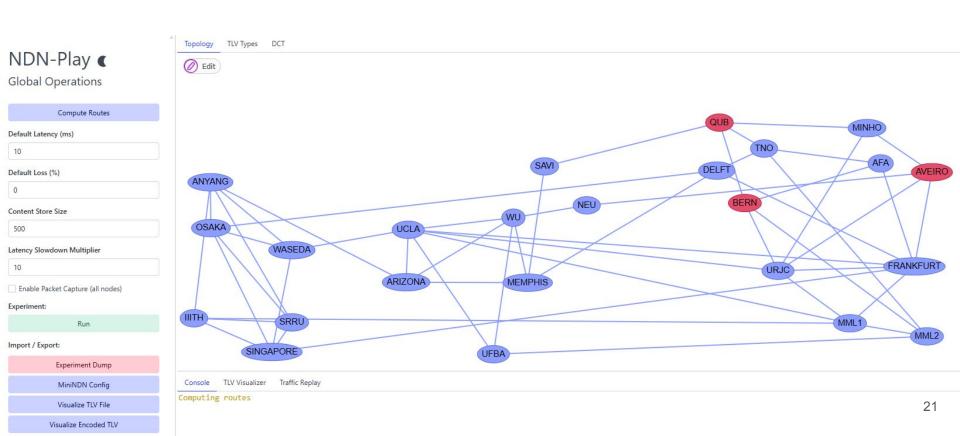
Show a list of NDN testbed routers. Includes: name prefix, software versions, service uptime and health, pairwise data plane reachability.

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	ОК	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	ОК	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	ОК	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	ок	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]	ОК	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	ок	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	ок	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	ОК	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	ок	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											20

## NDN Play - testbed template

Topology map rendered from testbed status page JSON document.



## NFD Status Page

UDP 49.51.163.56 (FRANKFURT)

UDP 195.251.234.11 (MML1)

UDP 193.136.92.155 (AVEIRO)

#### (click → from testbed status page)

#### 26 faces

282

285

288

id	title	routes	traffic	local
1	NFD management	0	3	remote
254	Content Store	0	0	MTU
255	packet drop	0	0	flags
256	Ethernet multicast on eth0	0	0	RX Interest
257	NFD-RIB management	2	2	RX Data
258	UDP IPv4 multicast on 172.19.0.8	0	0	RX Nack
259	ping server /ndn/es/urjc	1	1	TX Interest
261	NLSR /ndn/es/urjc/%C1.Router/	117	2	TX Data
264	UNIX fd=32	4	0	TX Nack
204	ONIX IU-32	1000	U	Routes
265	UNIX fd=33	1	0	Houses
266	UNIX fd=34	1	0	name
279	UDP 131.179.196.48 (UCLA)	108	1	/ndn/CA

108

108

2

1

1

0

## **Face 279**

local	udp4://172.1	19.0.8:6363		
remote	udp4://131.1	79.196.48:6363		
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		

0.16 /s 0.03 /s	191868	TX Interest
03/5		
	156066	TX Data
0.00 /s	139	TX Nack
0.00	139	TX Nack

/ndn/ca/utoronto

outes		
name	origin	cost
ndn/CA	nlsr	171

nlsr

Routes					
name	origin	cost			
/ndn/CA	nlsr	171			

301

/ndn/br/ufba nlsr /ndn/br/ufba/%C1.Router/ndn-testbed-ufba nlsr

301

252

22

#### 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	/ndn/edu/arizona	<ul> <li>ucla/suns (12)</li> <li>memphis/titan (41)</li> <li>wustl/wundngw (50)</li> </ul>		
seqNum=195954 expire=2025-04-09 15:32:56	/ndn/web/stats	• 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	<ul> <li>arizona/hobo (41)</li> <li>wustl/wundngw (27)</li> <li>utoronto/ndnrtr (28)</li> <li>delft/ndn-testbed (119)</li> </ul> seqNum=165122 expire=2025-04-09 15:08:17		
	/ndn/pcl/frankfurt			
	/yoursunny			

/yoursunny/ /iah /yoursunny/ /lil ucla/suns (149) /yoursunny/ /mdw • urjc/insula (36) mmlab1/mmlab1 (50) /ndn/pcl/frankfurt/%C1.Router/vm /yoursunny/ /otp delft/ndn-testbed (9) seqNum=17204 expire=2025-04-09 15:10:55

/yoursunny/ /syd

 afasystems/ndn (28) • singapore/vm (178)

# 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=10613593691095029481 time=104.164 ms
content from /ndn/edu/ucla: seq=10613593691095029482 time=104.514 ms
content from /ndn/edu/ucla: seq=10613593691095029483 time=102.629 ms
content from /ndn/edu/ucla: seg=10613593691095029484 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

- 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: <a href="https://101.named-data.net/">https://101.named-data.net/</a>

NDN Testbed: <a href="https://named-data.net/ndn-testbed/">https://named-data.net/ndn-testbed/</a>