# $\mathsf{MLCOM2017}$

MILITARY COMMUNICATIONS AND INNOVATION - PRIORITIES FOR THE MODERN WARFIGHT

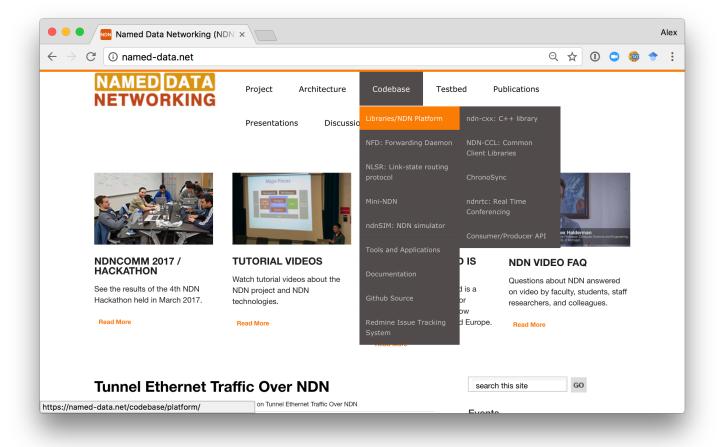
### **NDN Codebase and Tools**

Alex Afanasyev Florida International University

BALTIMORE, MD • OCTOBER 23–25, 2017



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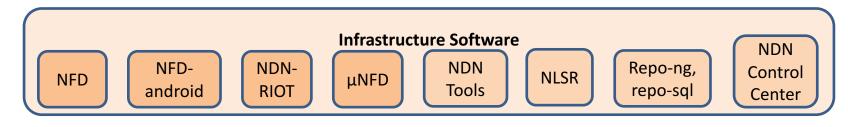


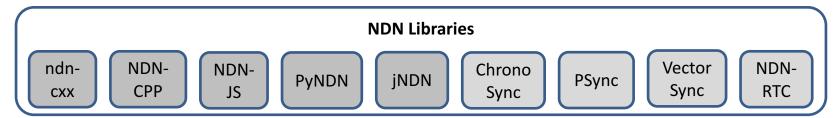
## Where to Find Source Code for NDN Codebase

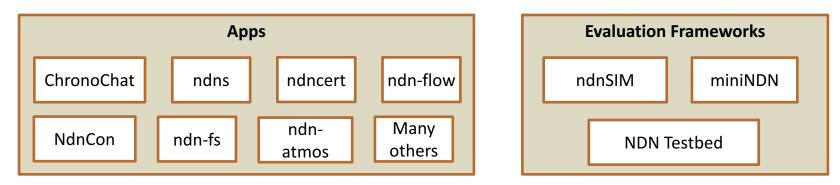
- Most linked from <a href="https://named-data.net">https://named-data.net</a> 
   Codebase
- Github organizations
  - <u>https://github.com/named-data</u>
    - NFD, core libraries, and other general use software
  - <u>https://github.com/named-data-mobile</u>
    - Android and related software
  - <u>https://github.com/named-data-iot</u>
    - IoT related software
  - <u>https://github.com/named-data-ndnsim</u>
    - ndnSIM core, example and real simulation scenarios



### NDN Codebase Overview









## Supported Platforms

- Desktop Systems
  - Ubuntu, OSX, FreeBSD and other Linux distributions
- Home routers
  - OpenWRT, DD-WRT
- Mobile:
  - Android, iOS (library only)
- IoT:
  - Arduino, ESP8266, RIOT-OS
  - Raspberry Pi (runs NFD, available binary packages)
- Web browser
  - NDN-JS library + microforwarder

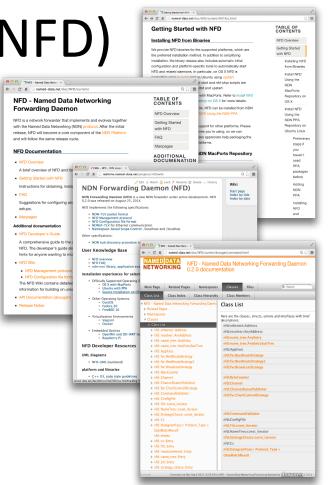
### https://redmine.nameddata.net/projects/nfd/wiki

• • Wiki - NFD - NDN project issue ×					4	٩le
→ C	€ ☆	•		۵		
Installation experiences for selected platforms						
<ul> <li>Officially Supported Operating Systems         <ul> <li>OS X with Homebrew</li> <li>OS X with MacPorts</li> <li>Ubuntu with PPA</li> <li>Source Installation on OS X or Ubuntu</li> </ul> </li> </ul>						
<ul> <li>Other Operating Systems         <ul> <li>CentOS</li> <li>Fedora</li> <li>FreeBSD 10</li> <li>OS X 10.8</li> <li>Windows</li> </ul> </li> </ul>						
<ul> <li>Virtualization Environments         <ul> <li>Vagrant</li> <li>Docker</li> </ul> </li> </ul>						
<ul> <li>Embedded Devices         <ul> <li>OpenWrt and DD-WRT home routers</li> <li>Raspberry Pi</li> <li>NDN on Galileo (Intel's x86 Arduino-certified</li> </ul> </li> </ul>	development	boa	rd)			



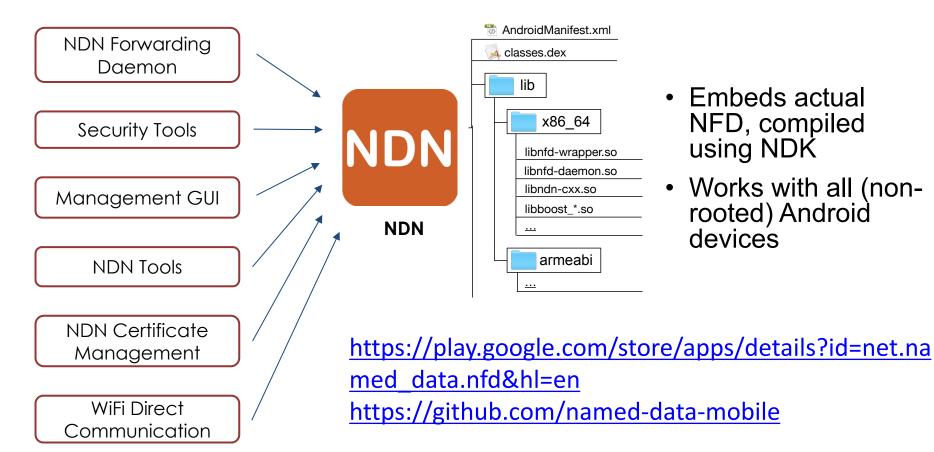
# NDN Forwarding Daemon (NFD)

- The reference implementation of NDN forwarder
- https://named-data.net/doc/NFD/current/
  - Overview
  - Getting started
  - NFD Developer's Guide
  - Manpages
  - Wiki
  - API documentation (doxygen)
- Feedback, suggestions, and contributions are welcome.





### NDN-Android: NDN Stack for Android

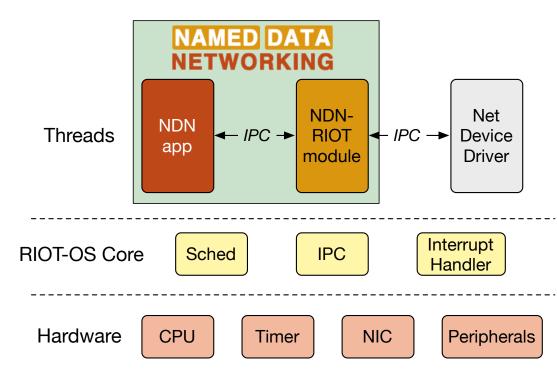




## NDN-RIOT: NDN for RIOT-OS

- Optimized for IoT apps
- Support
  - Data-centric security
  - Stateful NDN packet forwarding
  - Replaceable forwarding strategies
  - 802.15.4 and Ethernet
- Simple application APIs
- Several simple examples to get started

https://github.com/named-data-iot





### Getting Started with NDN-RIOT Examples

### • Downloading

- mkdir riot
- cd riot
- git clone https://github.com/named-data-iot/RIOT
- git clone https://github.com/named-data-iot/ndn-riot
- git clone https://github.com/named-data-iot/ndn-riot-examples
- Compiling an example
  - cd ndn-riot-examples/<APP>
  - For host architecture (for debugging)
    - make
  - For a specific RIOT board
    - make BOARD=samr21-xpro
    - make flash BOARD=samr21-xpro # to flash firmware
    - make term BOARD=samr21-xpro # to access board via serial interface

ndn-benchmark

ndn-consumer

ndn-ping

ndn-producer

ndn-rtt



# NDN Tools

- ndnping, ndnpingserver
  - Rechability testing tools
- ndncatchunks, ndnputchunks
  - Segmented file transfer between a consumer and producer
- ndnpeek, ndnpoke
  - Transmit a single packet between a consumer and a producer
- ndndump, dissect, wireshark-dissect
  - Debug NDN packet flow
- repo-ng, repo-sql: NDN repositories providing managed persistent s







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#### MILITARY COMMUNICATIONS AND INNOVATION - PRIORITIES FOR THE MODERN WARFIGHT



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### ndn-cxx: NDN C++ library with eXperimental eXtensions

- C++11
- The reference library and security library implementation
- Used in: NFD, NLSR, ndn-tools, ChronoChat, etc.
- <u>https://named-data.net/doc/ndn-cxx/current/</u>
  - Overview
  - Getting started
  - Trivial applications
  - Tutorials
  - Specifications
  - Manpages
  - API documentation (doxygen)
- Feedback, suggestions, and contributions are welcome.

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### NDN Common Client Libraries (NDN-CPP, NDN-JS, iNDN, PyNDN)

Name.Compor ImplicitSha256 ProtobufTlv SeamentFetche

- C++, Java, Python, JavaScript, C#, Squirrel
- Used in: NDN-RTC, NdnCon, NFD-Android, etc. ullet
- https://namedulletdata.net/codebase/platform/ndn-ccl/
  - NDN Common Client Libraries API
  - NDN-CPP API
  - PyNDN API
  - NDN-JS API
  - jNDN API

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Documentation								Signature Class		
								DigestSha256Signature Class		
								GenericSignature Class		
The NDN Common Client Libraries (NDN-CCL) are written in C++, Python, JavaScript and								Sha256WithRsaSignature C		
Are not solution can be carried a very concept and an in over; yound, variable prima Java and provide a common API for client applications to use NDA. Any library in NDA-CCL suite allows an application to send interests to and receive data from an NDN forwarding deamon (NFD) and provide a large set of other functions necessary for any NDA application.							Sha256WithEcdsaSignature			
							KeyLocator Class			
							InterestFilter Class			
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	opeoiner	00000						Blob Class		
Python – PyNDN								SignedBlob Class		
Javascript - NDN-JS								KeyChain Class		
Java – jNDN								MemoryContentCache Class		
Function and class documentatio	n: NDN-C							ChronoSync2013 Class		
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Supported Features								Time representation		
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	NDN-							DelegationSet.Delegation Cla		
Feature	CPP	PyNDN	NDN-JS	jNDN	Notes			ForwardingFlags Class		
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ChronoSync2013	√	1	1	√						
Name.Component from*	1	1	1	4						
Name.Component is*	√	√	√	√						
Name.Component to*	√	1	1	1						
ImplicitSha256DigestComponent	√	√	√							
ProtobufTly	√ API	√ API	√ API	√ API						

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### **EVALUATION TOOLS AT DIFFERENT SCALES**

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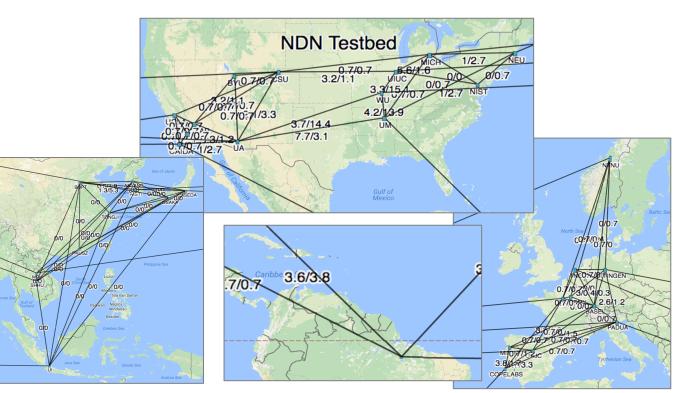
### NDN Testbed

• Network of 37 sites across 4 continents, 14 countries

### Open to join and use

https://named-data.net/ndn-testbed/policiesconnecting-nodes-ndn-testbed/

- Examples applications and experiments: videoconferencing, network management, virtual machine migration, strategies, nTorrent, etc.
- Small scale evaluations





## **Open Network Lab (ONL)**

- Remotely accessible network testbed
  - Operated and maintained by Applied Research Lab in Department of Computer Science and Engineering at Washington University in St. Louis
  - Real Hardware for running repeatable network experiments with trusted results. (NOT simulations)
- Use for NDN
  - NDN installed on each host/VM
  - NFD performance study
  - NDN Testbed Emulation to test new releases
- How to join?
  - <u>https://onl.wustl.edu/</u>
    - And "Get an account"





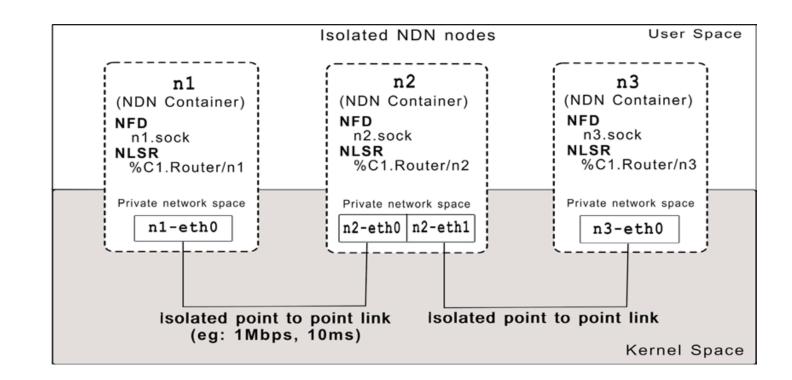
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# MiniNDN: NDN Emulation Framework (Based on MiniNet)

### **Runs actual instances of NFD, NLSR**

Medium-scale evaluations

- Easy to configure network emulation
- Runs any real application
- Number of emulated nodes
   ∝CPU power
- Cluster edition can be used to scale emulations





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### ndnSIM: NDN Simulation Framework (Based on NS-3)

### Fully integrated with NDN prototype implementations: NFD & ndn-cxx

Large scale evaluations

- Provide interoperability between simulation and prototyping
- Enable a two-way of experimentation and evaluation
- Enable high-fidelity NDN simulations
- 1500+ nodes with WiFi channels in the evaluation of NDN for vehicular networking

