

An Overview of NDN Codebase

NDN Tutorial – ACM ICN 2016

September 26, 2016, Kyoto, Japan

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<https://named-data.net/icn2016-tutorial>

Starting Point for NDN Codebase

The screenshot shows the website named-data.net in a browser window. The main navigation bar includes links for Project, Architecture, Codebase, Testbed, Publications, and Discussion. The Codebase menu is open, listing various components and tools. The main content area features a 'Named Data Networking' logo, a 'Project' section with a photo of a hackathon, a 'Tutorial Videos' section with a diagram of 'Major Pieces', and a 'FAQ' section. A search bar is located at the bottom right of the page.

NAMED DATA NETWORKING

Project Architecture **Codebase** Testbed Publications Discussion

Libraries/NDN Platform

- ndn-cxx: C++ library
- NFD: Forwarding Daemon
- NLSR: Link-state routing protocol
- Mini-NDN
- ndnSIM: NDN simulator
- Tools and Applications
- Documentation
- Github Source
- Redmine Issue Tracking System

NDN-CCL: Common Client Libraries

ChronoSync

ndnrtc: Real Time Conferencing

Consumer/Producer API

FAQ

Questions about NDN answered on video by faculty, students, staff researchers, and colleagues.

[Read More](#)

Named Data Networking (NDN) Project Newsletter for Summer 2016

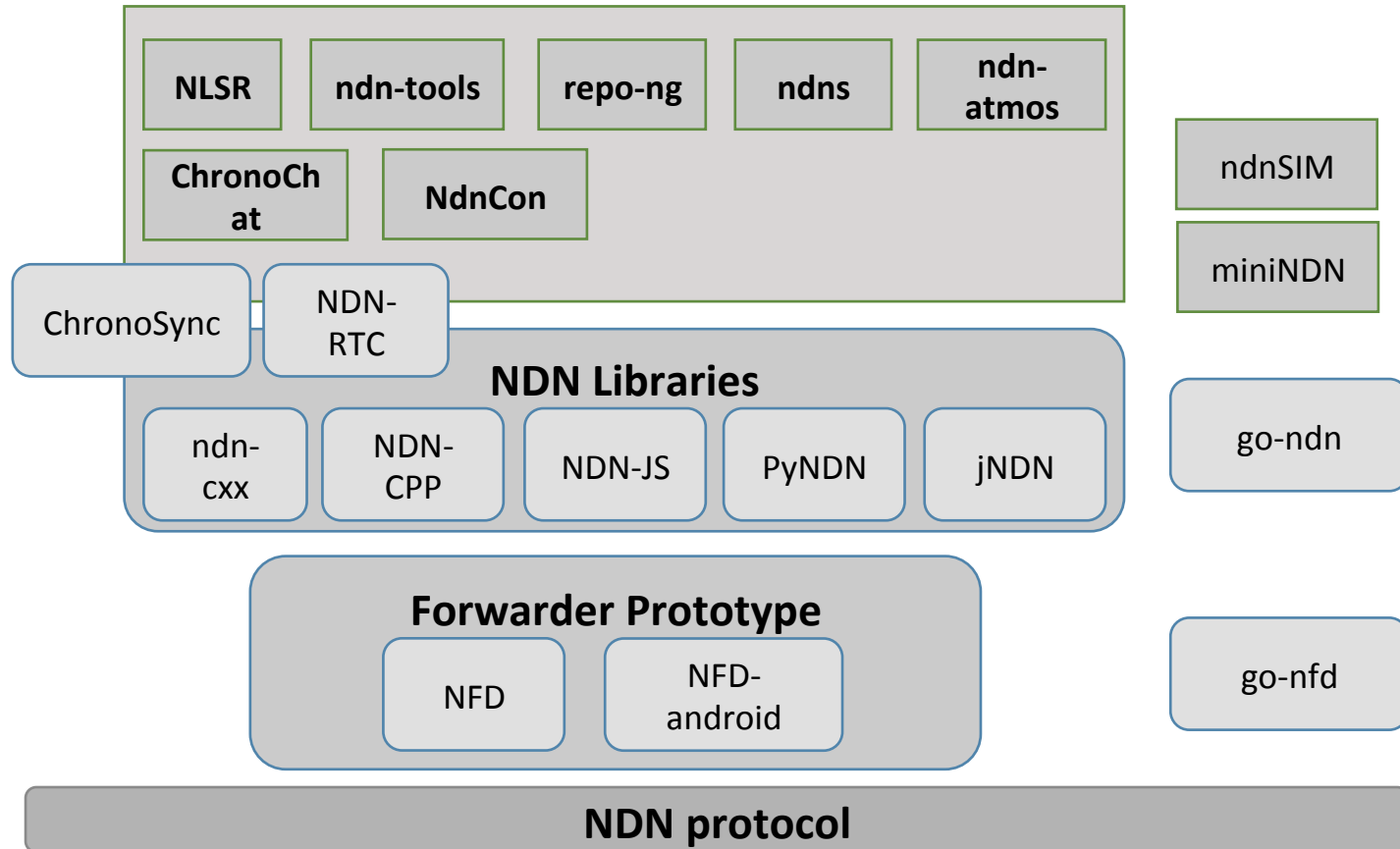
Events

<https://named-data.net/codebase/platform/>

NDN Platform: packages of essential software

- Libraries
 - ndn-cxx
 - NDN-CCL (Common Client libraries)
 - NDN-RTC (real-time communication)
 - ChronoSync (multiparty sync)
- Infrastructure software
 - NFD: Forwarding Daemon
 - NFD-Android
 - NLSR: link state routing protocol
 - repo-ng: repository
 - ndn-tools: ndnping, ndn[peek/poke], ndn[cat/put]chunks, ndn-dissect, and others
- Applications
 - ndncon: conferencing
 - ChronoChat
 - Many others
- Simulator
 - ndnSIM: ns-3 based NDN simulator
- Emulator
 - Mini-NDN: Mininet based emulator
- NDN Testbed

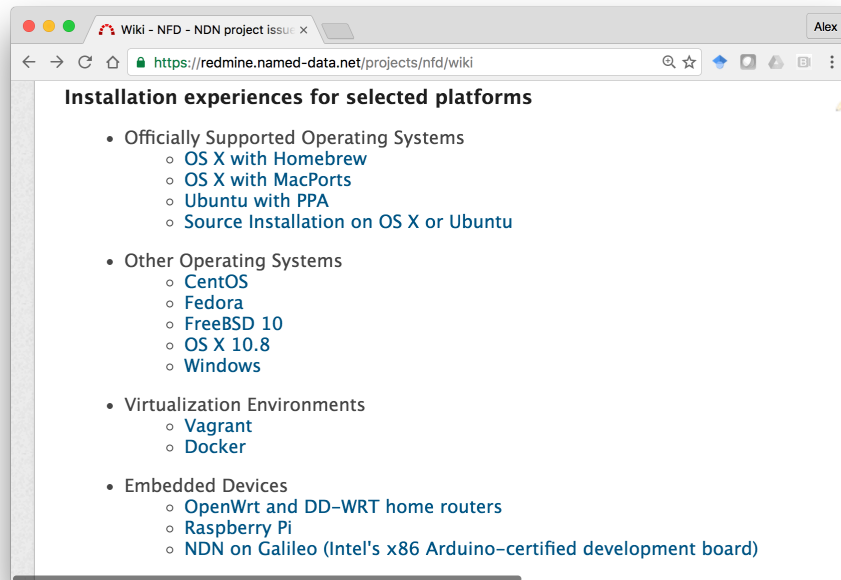
NDN Codebase



Working Platforms

- Desktop Systems
 - Linux, OSX, FreeBSD and other Linux distributions
- Home routers
 - OpenWRT, DD-WRT
- Mobile:
 - Android
- IoT:
 - Arduino, ESP8266
 - RIOT-OS
- Web browser

<https://redmine.named-data.net/projects/nfd/wiki>



Libraries

ndn-cxx, NDN-CCL, NDN-RTC, ChronoSync, ...

ndn-cxx and NDN-CCL

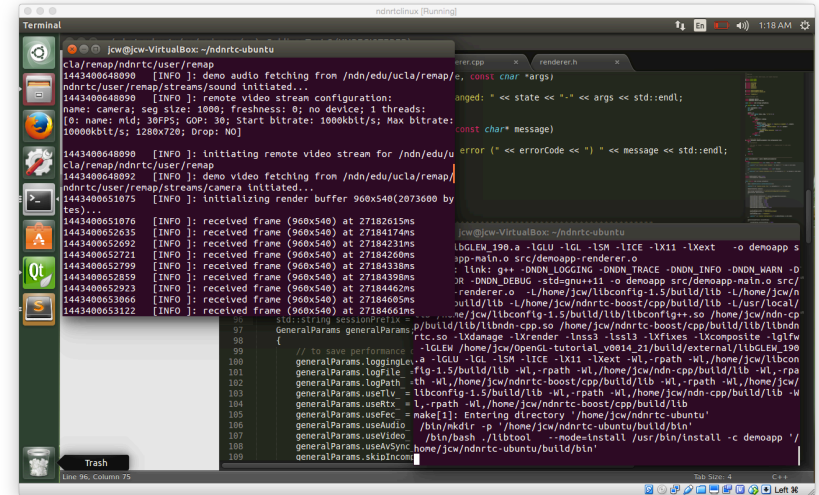
- Both Libraries are under active development with different emphasis.
- ndn-cxx: NDN C++ library with eXperimental eXtensions
 - C++ only, focusing on supporting NFD and new protocol feature development.
 - used in: NFD, NLSR, ndn-tools, ChronoChat, etc.
- NDN-CCL: NDN Common Client libraries suite
 - available in C++, Java, Python, JavaScript; partial C# .NET, Squirrel
 - Common APIs across languages.
 - Focusing on supporting general app development, used in: NDN-RTC, NdnCon, NFD-Android, etc.
- Both libraries support NDN application development, e.g.,
 - Send/receive, encode/decode, sign/verify Interest and Data packets.
 - Asynchronous I/O with various transports
 - Manage certificates and signing keys (RSA, ECDSA, HMAC)
 - Prefix registration on local NFD, manage NFD.
 - Validator to verify signatures and trust model
 - In-memory data storage

ChronoSync

- Synchronization library for distributed real-time applications.
 - Efficiently synchronize a collection of data among a group of nodes.
- Use cases:
 - group text messaging, example: ChronoChat
 - file sharing, example: ChronoShare

NDN-RTC

- C++ library for low-latency audio/video streaming over NDN
- VP8/9 encoder
- WebRTC audio processing pipeline
- Forward error correction (OpenFEC)
- Pull-based streaming control by consumers.
- OSX/Ubuntu headless (console) demo application



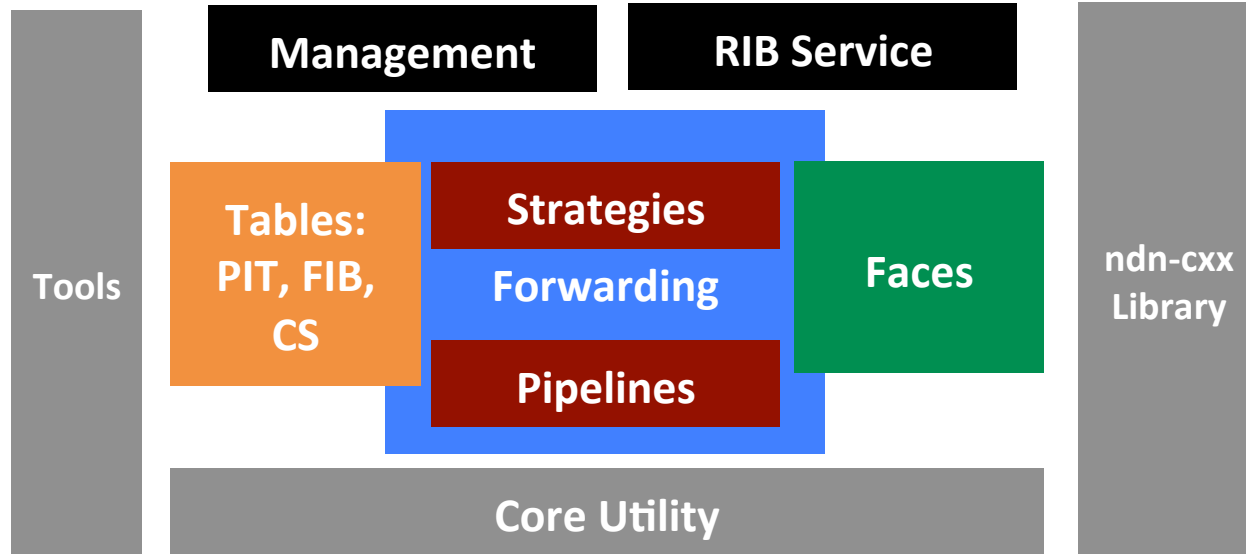
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Infrastructure Software

NDN Forwarding Daemon (NFD)

- The reference implementation of NDN network protocol.
- NFD design emphasizes modularity and extensibility, to support diverse experimentation with NDN architecture.



Faces

- Face = LinkService + Transport
- Transport: works with different socket types
 - Unix stream, UDP unicast, UDP multicast, TCP: implemented with Boost.Asio
 - Ethernet multicast: implemented with libpcap
 - WebSocket: implemented with websocket++
- LinkService: provides best-effort NDN packet delivery service
 - encoding and decoding of Interest, Data, Negative Acknowledgement (NACK)
 - fragmentation and reassembly on MTU-limited links
 - (planned) failure detection, link reliability improvement

Forwarding

- Packet processing is broken into a number of small “pipelines” and strategy callbacks.
- The pipelines are fixed packet processing.
- Strategies are customized for different prefixes and can react to network behaviors.
 - Interest/Data provide a closed-loop control.
 - Can take feedback from past events, make decisions on where to forward future Interests, and can store states in the forwarder.
 - Currently strategy choice is local to the node, and configured via management commands.
 - A number of strategies implemented in NFD, and more have been proposed in literature.

Management

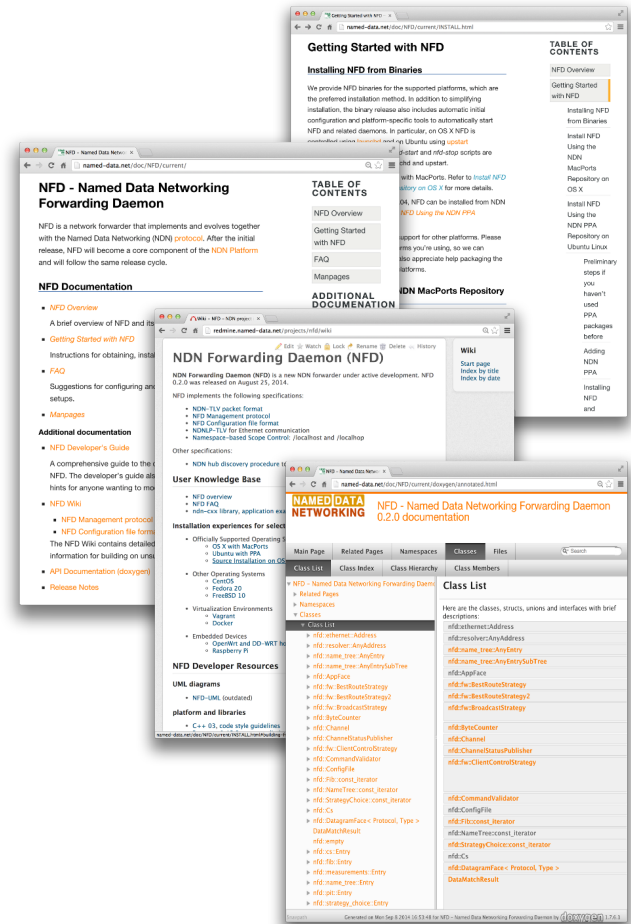
- Protocols to monitor and control NFD
 - Using Interest/Data exchange
 - E.g., `ndn:/localhost/nfd/faces/create/....`
- Face management
 - `faces/create`, `faces/destroy`
- Prefix and strategy management
 - `rib/register`, `rib/unregister`
 - `strategy-choice/set`, `strategy-choice/unset`
- Status and statistics retrieval

NFD Tools

- nfd-start, nfd-stop
 - scripts to start/stop the forwarder
- nfdc
 - control NFD at runtime via management interface
- nfd-status, nfd-status-http-server
 - read NFD status/statistics via management interface
 - serve status report XML over HTTP
- ndn-autoconfig
 - Find a testbed router through multicast or DNS

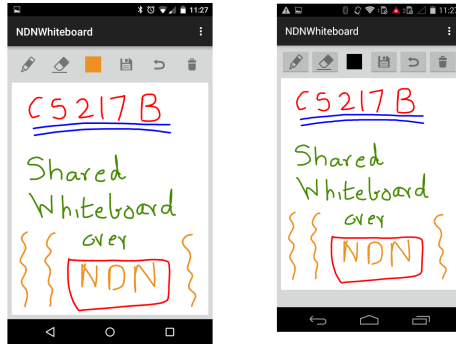
More information

- <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.



NFD-Android

- NDN forwarding daemon on Android.
- NFD source compiled with NDK.
- Management menus implemented with jNDN.
- Some simple apps such as V



NDN Forwarding Daemon (NFD)
(Beta)

Alex Afanasyev Communication

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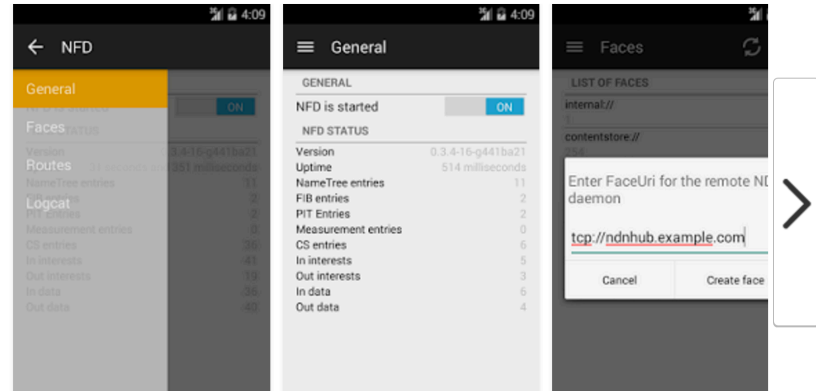
Everyone

Woohoo! You're a beta tester for this app.

You don't have any devices

Add to Wishlist

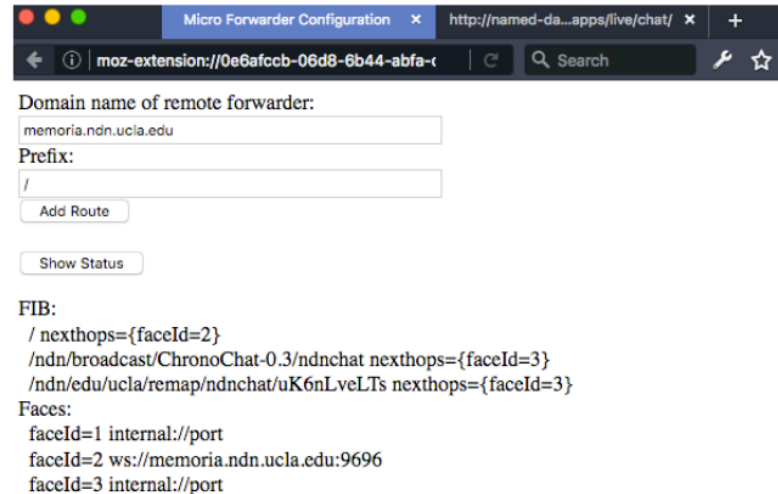
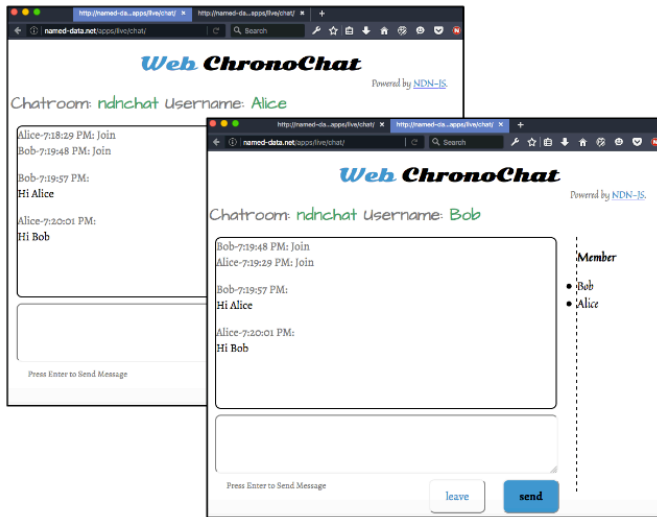
Install



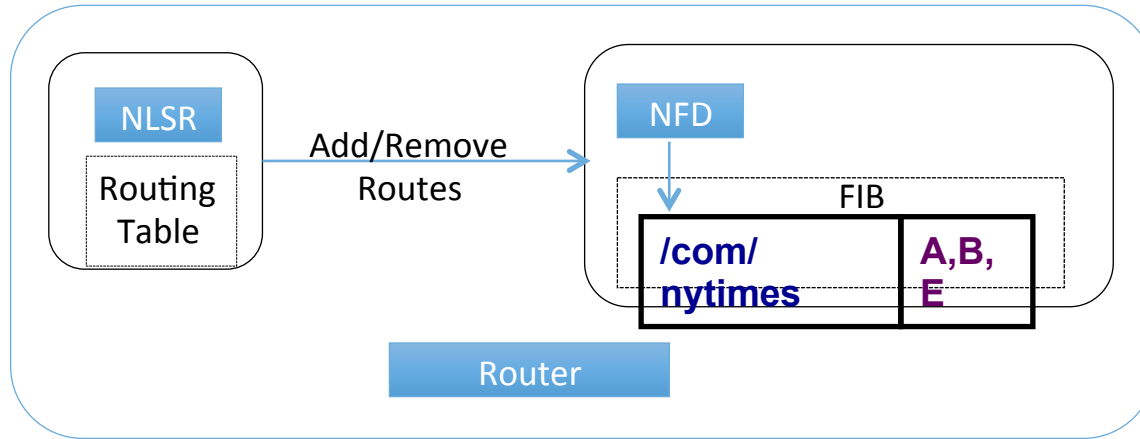
https://play.google.com/store/apps/details?id=net.named_data.nfd&hl=en
<https://github.com/named-data-mobile>

NDN Micro Forwarder in browsers

- NDN forwarder as a Firefox/Chrome extension, written in JavaScript
- Enable users to try NDN without installing NFD.
- NDN-JS apps in browser tabs can inter-communicate through the Micro Forwarder, or communicate with NDN testbed through WebSockets.



NLSR: Named-data Link State Routing



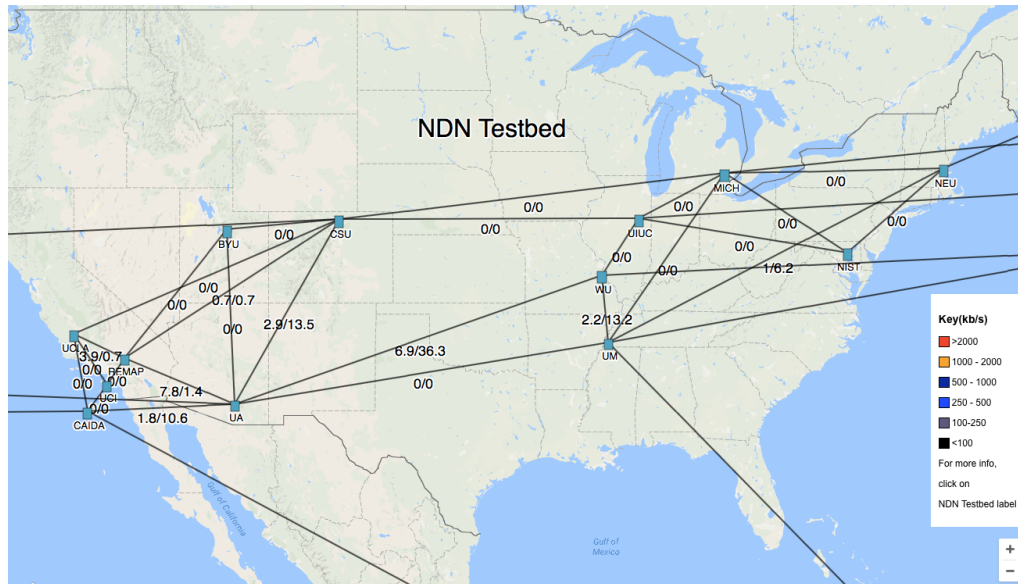
- NLSR implements a link state routing protocol.
- Also supports the hyperbolic routing protocol.
- NLSR instances exchange routing announcements as NDN Interest/Data, and installs learned routes into NFD.
 - Use ChronoSync to sync routing states.
 - Use a hierarchical trust model to validate routing messages.
- NLSR offers command-line tools to manage routes at runtime.

Other infrastructure software and useful tools

- repo-ng: NDN repository providing managed persistent storage.
- ndn-tools: essential tools
 - ndnping: reachability test
 - Ndn[cat|put]chunks: file transfer
 - ndndump: packet capture and analysis
 - ndn-dissect: Wireshark dissector
 - A traffic generator

NDN Testbed

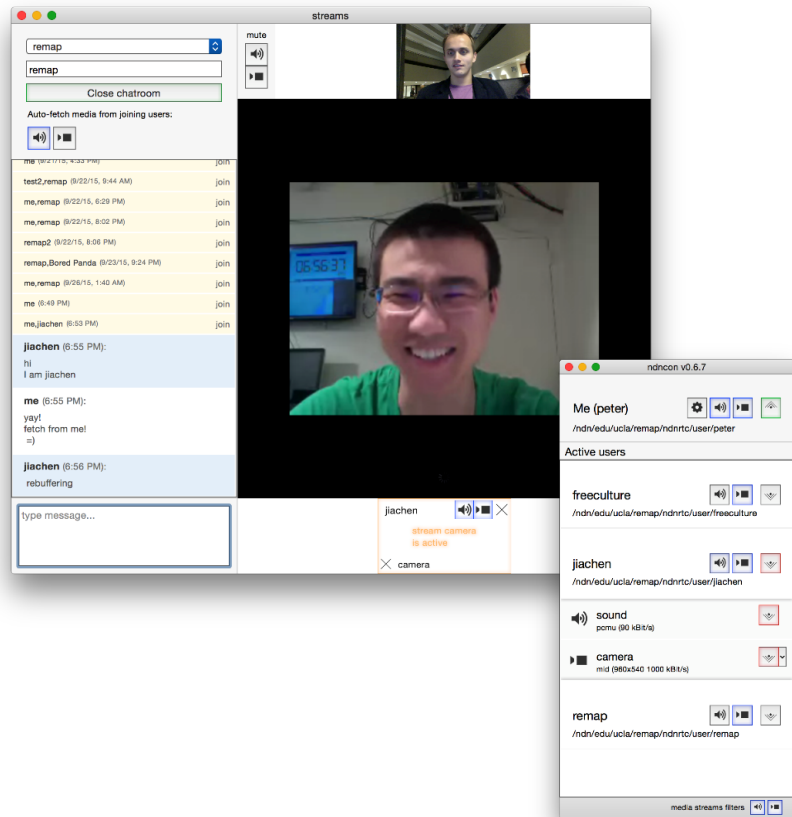
- A global testbed to support NDN research.
- 33 nodes, 90 links, nodes run NFD, NLSR, repo-ng.
- Real-time status monitoring and bandwidth measurement.
- Examples applications and experiments: videoconferencing, network management, virtual machine migration, strategies, nTorrent, etc.



Applications

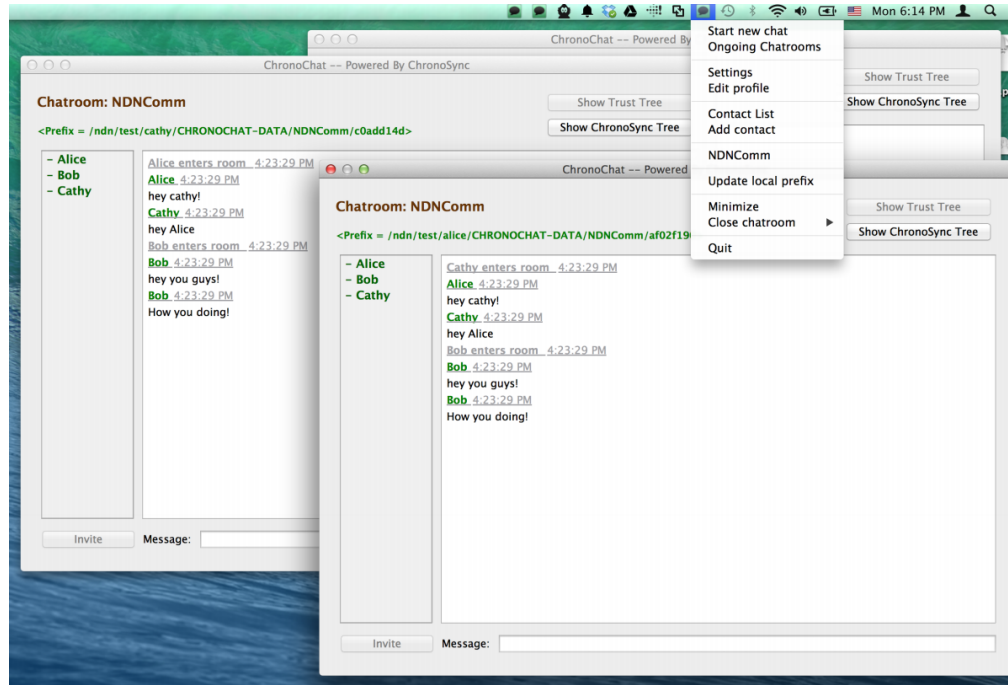
ndncon

- OSX GUI application built on top NDN-RTC library
 - user discovery
 - screen sharing
 - multi-party conferencing
 - group text chat
- HD video capable
- github.com/remap/ndncon



ChronoChat

- Server-less multi-user instant message application.
- Built with ChronoSync protocol.



Enterprise Building Automation and Management Systems

- Simpler, secure alternative to middleware and cross-layer stacks in industrial control / SCADA.
- Second-generation prototype bridging live UCLA campus data to NDN testbed with hierarchical aggregation and trust model.

UCLA NDN Building Monitoring Testbed

Snapshot - Strathmore

Snapshot - Melnitz

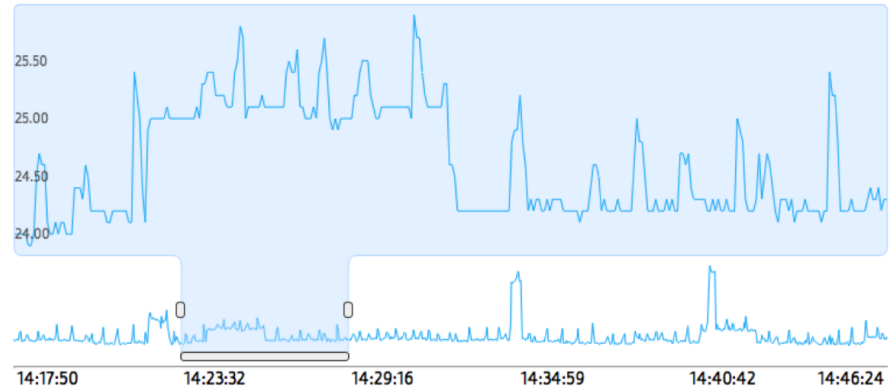
All data - Melnitz

About

Strathmore Building

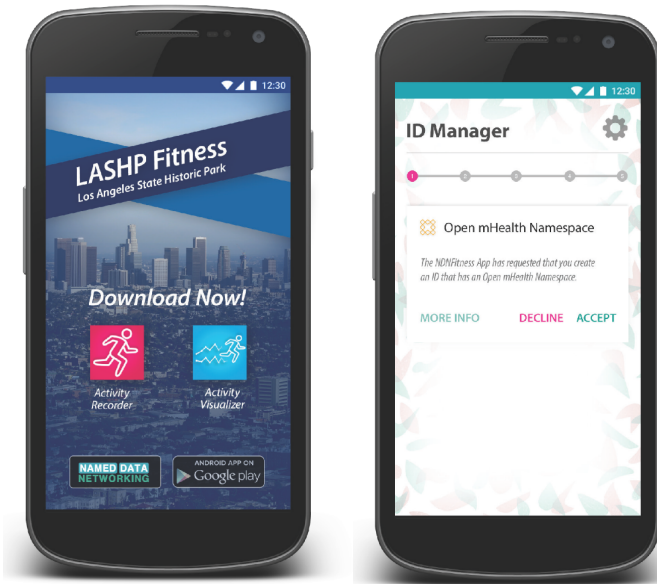


Electrical Demand - Current (unit: Amperes)



Open mHealth

- User-centric health data exchange
 - inspired by Estrin & Sim Open mHealth project



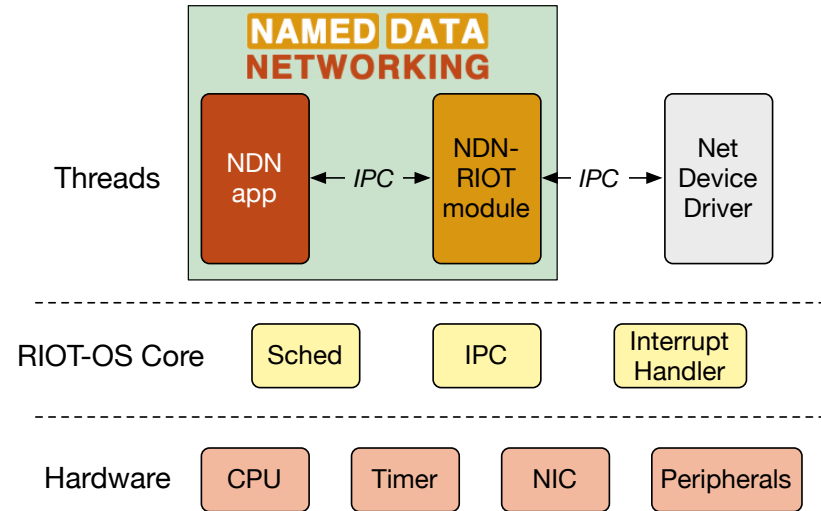
- User at root of trust model for their own health data.
- Simplification of minimum requirements for interoperability.
- Likely better at building distributed processing flows that cross administrative entities.
- End-to-end system with data capture, storage, processing, and visualization using NDN
- Prototype end-user interfaces for identity management (now), and name-based access control (soon).

Some other applications

- NDNFS
 - a FUSE-based filesystem readable over NDN
- ndn-atmos
 - API to publish, query, and retrieve climate science datasets
- NDN-Whiteboard (Android)
 - a shared whiteboard

NDN-RIOT: NDN for RIOT-OS

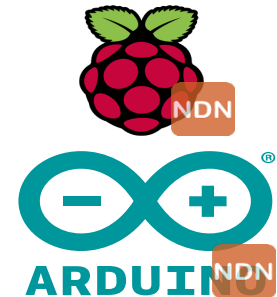
- Optimized for IoT apps
- Memory efficient packet encoding & decoding
- Data-centric security support
- Basic stateful NDN packet forwarding
- Support for 802.15.4 and Ethernet
- Application APIs



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

Other IoT-related efforts

- NDN-BMS: encryption-based access control
- NDN-ACE: authorization framework for actuation apps
 - NDN-0036
- NDN-IoT: toolkit for NDN development on Raspberry Pi
 - <https://github.com/remap/ndn-pi>
- NDN on Arduino: minimal app for Arduino
 - <https://github.com/ndncomm/ndn-btle>
- esp8266ndn: NDN library for ESP8266 microcontroller



NDN Codebase

