NDN Project Progress

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IEEE INFOCOM 2014, April 30, 2014

www.named-data.net
NDN Project

- Started in August 2010
- 12 institutions
- Lixia Zhang: Lead PI
- Van Jacobson: Architect
- http://www.named-data.net/
NDN Architecture Development [1]

- application-driven
- test and deploy on operational testbed
- conduct real-world demos

Application Design*
(name space, trust model, data distribution, rendezvous, bootstrapping, ...)

Library Design
(messaging, security, repo, sync, ...)

Forwarder Design
(packet format, FIB, PIT, Content Store, forwarding strategy, fast forwarding, ...)

All code is open source at https://github.com/named-data/.

- Multimedia applications
  - NDNVideo [2]
  - ChronoChat [3]
  - NDN-RTC
  - ChronoShare [4]
- IoT applications
  - Building automation and management [5, 6]
  - Vehicular net [7]
- Routing protocol [8] and forwarding strategy
- Scalable forwarding engine
- Security
  - Trust model
  - DDoS
  - Anonymity
- Libraries
  - NDN-CCL, NDN-CXX, pyNDN2, ndn-js, ChronoSync [9], NDN repo
NDNVideo [2]

- Live and pre-recorded streaming to multiple consumers.
- No session semantics => scalability. Tested for ~1000 clients from 1 src
- First Interest sent can randomly access a keyframe at any timecode
- Leverages caching.

ChronoChat [3]

- **server-less** chat application based on ChronoSync
- chat messages are synchronized among participants
- leverage multicast nature of NDN

ndnrtc

- Real-time audio/video/text chat application enabling multi-peer conferencing over NDN.
- Explore how to handle packet losses and delays while maintaining a session-less approach.
- Supports new TLV packet format.
- Based on WebRTC codebase, using ChronoSync for conference discoveries.
- Expected release: June 2014.
ChronoShare: Distributed File Sharing and Editing [4]

- Think Google Drive, but no centralized server
  - Different users can share folders.
  - Each user can sync folders on different devices.

- How?
  - Each user’s actions (on file) form a stream of data.
  - Use ChronoSync to distribute knowledge of user actions

Building Automation and Management [5,6]

- Explore challenges in sensing and actuation at a campus scale.
- Improve application development process, management, interoperability and security.
- Practical work so far: NDN interfaces to BacNET and Modbus sensing, authenticated lighting control.
- Partner: UCLA Facilities Management.


Building Automation and Management [6]

• Next: Port the NDN platform to support work at the embedded device level, starting with Raspberry PI as a platform for experimentation.
• Target in-home appliance-to-appliance-to-gateway communication and applications (cf. AllSeen)
• Consider discovery, bootstrapping, storage / data custodian functionality.
• Three demo nodes planned:
  - Occupancy (PIR)
  - Remote A/V control (HDMI-CEC)
  - Security / webcam
Routing in NDN

- **Requirement: Routing based on “name”**
  - Guides each “interest” packet to all potential providers (all paths)
  - Some providers may not have all content in a “name”

- **Non-requirement: Fast routing convergence**
  - Stateful forwarding plane can adapt to changes

![Diagram of NDN routing concept]

C wants to read `/nytimes/art`

D’s FIB: `/nytimes/art` | A, B, E

A only has some content under `/nytimes/art`

Interest for `/nytimes/art/img3`

DATA
Named Data Link State Routing (NLSR) [8]

- Link State routing for NDN
- NLSR is designed to meet routing needs of NDN:
  - Generates FIB
  - FIB entries are name based
  - Calculates multiple faces for each FIB entry
Naming in NLSR

- Follow the hierarchy within a network
  - Easy to identify the relationship among entities
  - Easy to associate keys with key owners

- Router
  - /<network>/<site>/<router>: e.g., /ndn/memphis/rtr1

- Updates
  - /<network>/NLSR/LSA/<site>/<router>/<process>/<type>/<version>

- Keys
  - NLSR key: /<network>/<site>/<router>/<process>/key
  - Router key, operator key, ...
Routing Security and Trust Model

- Every NLSR Data packet is signed.
- “Key locator” includes information about the key.
- Receiver retrieves the key and verifies the signature.

<table>
<thead>
<tr>
<th>Key Owner</th>
<th>Key Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root</td>
<td>/&lt;network&gt;/key</td>
</tr>
<tr>
<td>Site</td>
<td>/&lt;network&gt;/&lt;site&gt;/key</td>
</tr>
<tr>
<td>Operator</td>
<td>/&lt;network&gt;/&lt;site&gt;/&lt;operator&gt;/key</td>
</tr>
<tr>
<td>Router</td>
<td>/&lt;network&gt;/&lt;site&gt;/&lt;router&gt;/key</td>
</tr>
<tr>
<td>NLSR</td>
<td>/&lt;network&gt;/&lt;site&gt;/&lt;router&gt;/&lt;process&gt;/key</td>
</tr>
</tbody>
</table>
Web-of-Trust Model

• secure ChronoSync-based applications
  - hierarchical trust model does not match peer-to-peer synchronization
• invitation-based management of sync group membership
• endorsement-based certificate authentication
Scalable Forwarding Engine Design

• Requirements
  - data structures to store millions to billions of names
  - fast table lookup of variable-length names
  - fast packet processing

• NDN project’s progress
  - multi-million entry FIBs stored in less than 10MB [10]
  - FIB lookup speeds on the order of microseconds [10]
  - PIT: 37 to 245 MiB memory for 100 Gbps throughput (small enough to fit in fast memory chips) [11]

NDN Common Client Libraries (NDN-CCL) []

- Clean slate/portable libraries with a consistent API
- Make it easy for developers to create applications
- Multiple languages: C++, JavaScript, Python, Java
- Main classes follow architectural abstractions: Name, Interest, Data, Face
- Wire-format independent
- TLV support
- Experimental digital signature/security API that will evolve with research.

(named-data.net/codebase/platform/documentation/ndn-ccl-api)

4/30/2014

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NDN Platform Release

- http://named-data.net/codebase/platform/
  - building blocks of NDN platform
  - ndnSIM simulator

- a new release every few months

- Latest version: Version 0.3 alpha 1 released on Feb. 27, 2014.

- Next release (soon) will contain new forwarder (NFD), new library and NLSR.
NDN Testbed

More info at http://named-data.net/ndn-testbed/
Contact us if interested in joining the testbed.
## Annual Demonstrations

<table>
<thead>
<tr>
<th>Demo Feature</th>
<th>2012 Demo</th>
<th>2013 Demo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large-scale, <strong>wide-area operation</strong></td>
<td>All 4 US time zones, ~300 machines</td>
<td>5 continents, ~1000 machines</td>
</tr>
<tr>
<td>Mix of content distribution and interactive apps</td>
<td>4 distinct services</td>
<td>Multiple services</td>
</tr>
<tr>
<td><strong>Visualization</strong> of both app-level and net-level activity</td>
<td>NDN map</td>
<td>NDN map</td>
</tr>
<tr>
<td>Demonstrate both steady-state and <strong>react-to-change</strong> modes</td>
<td>Drop links during app sessions</td>
<td>Forwarding strategy</td>
</tr>
<tr>
<td><strong>Something IP+HTTP cannot do</strong></td>
<td>Scalable video streaming*, multi-path routing</td>
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</tr>
<tr>
<td>Integrated PKI, better security</td>
<td></td>
<td>Show key auth</td>
</tr>
<tr>
<td>NDN-based device monitoring</td>
<td></td>
<td>Stage lighting ctrl</td>
</tr>
</tbody>
</table>
Live bluegrass band performance, NDN-based control of stage lights

- Delivery of live audio and video from performance studio at UCLA
  - Jeff Burke’s Center for Research in Engineering, Media and Performance (REMAP)
- Lighting control application is NDN-based
- Server at studio homed off REMAP gateway
- Laptop on-site homed off Tokyo gateway
Next Step

- Applications
  - Open M-Health
  - E-BAMS
  - Mobile Media Application Cluster
- Forwarding and routing: Interdomain routing, forwarding strategy
- Security: privacy, trust management
References


4. A. Afanasyev, Z. Zhu, L. Zhang, The story of ChronoShare, or how NDN brought distributed file sharing back, under review


References (cont’d)


