Performance

Share our view via 3 simple questions

How does the NDN team
… think about evaluation?
… demonstrate progress and capabilities?
… compare to the fast-moving real-world?
How does the NDN team think about evaluation?
Question 1 of 3

How does the NDN team think about evaluation?

Answer: We focus on demonstrating end-to-end effectiveness.
We focus on use cases

• Team includes two app-focused PIs
  – Jeff Burke (UCLA), Tarek Abdelzehar (UIUC)

• Developed a growing collections of apps
  – HD Audio/Video player, “DropBox”, decentralized group chat, building automation, stage lighting, …

• We conduct annual, real-world demonstrations

• We compare to the Internet’s state-of-the-art
End-to-end Focus is Primary

• Do NDN applications and services work, given real-world contexts?

• Many lower-level mechanisms are important to evaluate, but have secondary significance
  – Routing protocols, forwarding, transport-level synchronization

• The value of end-to-end demonstrations
  – They help the team focus on the right issues
  – They help dispel misunderstandings about the architecture
  – Real code in real environments keeps the team honest
Question 2 of 3

How does the NDN team demonstrate progress and capabilities?
Question 2 of 3

How does the NDN team demonstrate progress and capabilities?

Answer: We regularly demonstrate NDN applications and services operating at a modest scale.
## 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 react-to-change 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>
<td>Scalable video streaming*, multi-path routing</td>
</tr>
<tr>
<td>Integrated PKI, better security</td>
<td>Show key auth</td>
<td>Stage lighting ctrl</td>
</tr>
<tr>
<td>NDN-based device monitoring</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Enablers of evaluation

GENI SPPs in I2 PoPs
Enablers of evaluation
Enablers of evaluation
Enablers of evaluation

Between SPPs: I2, udp
SPPs and campuses: I2, udp
Campuses and clients: Internet, tcp
2013 Demo Highlights
2013 China-America Frontiers of Engineering Symposium
Demo Phase 1: Demonstrate Keys

- In NDN, all packet data is signed with the key of the publisher
- Keys can be signed transitively to form a chain of trust
0: Quit
1: for content signed by verified key
2: for content signed by unverified key using verified key name
3: for content signed by corrupted key
9: repeat last request

Sending interest for content signed by unverified key using verified key name
express interest ccnx:/ndn/wustl.edu/ndndemo/bad_key/n2ae21814/3
/ndn/wustl.edu/ndndemo/bad_key/n2ae21814/3

[VERIFYING] key name /ndn/keys/wustl.edu/jyotiparwatikar/%C1.M.K%0r%F3%E8%B5%B6%B9%01%C-%C9f%07%D9%E9%BD%
D4%8B%02%A%0B%9E%01%2F6%BF%601%9C%1C%5E%DF


[+] [AUTH KEY] /ndn/keys/wustl.edu/%C1.M.K%0r%F3%E8%B5%B6%B9%01%C-%C9f%07%D9%E9%BD%
D4%8B%02%A%0B%9E%01%2F6%BF%601%9C%1C%5E%DF

[VALID META] ValidTo: Sat Feb 22 11:20:15 2014

[+] [AUTH KEY] /ndn/keys/%C1.M.K%0r%F3%E8%B5%B6%B9%01%C-%C9f%07%D9%E9%BD%
D4%8B%02%A%0B%9E%01%2F6%BF%601%9C%1C%5E%DF


... self-signed NDN root

UNSAFE CONTENT: returned verified key for key name /ndn/keys/wustl.edu/jyotiparwatikar/%C1.M.K%0r%F3%E8%B5%B6%B9%01%C-%C9f%07%D9%E9%BD%
D4%8B%02%A%0B%9E%01%2F6%BF%601%9C%1C%5E%DF does not match signing key!
Demo Phase 2: Video Streaming

- 60-70 clients homed off each of 15 gateways
- Each client retrieving the same video stream
- Only one copy of data on any link
- Automatic multi-path route switching
- On-site client shows video delivery

- In total, video is shared with ~1000 video clients spread across 5 continents
Server & link load constant (1) as client count grows

Visualization app uses NDN to gather data from devices
Demo Phase 3: Lighting Control & Live Audio/Video

- 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
Live bluegrass band performance, NDN-based control of stage lights
Question 3 of 3

How does the NDN team compare to the fast-moving real-world?
Question 3 of 3

How does the NDN team compare to the fast-moving real-world?

Answer: We strive to regularly compare NDN to the best available alternative.
Case Study: Broadcast of Streaming Web Video

- Use case: how can I broadcast my laptop’s video feed to a global audience?

- Alternatives
  - NDN
  - **Build** an HTTP video streaming infrastructure
  - **Use** an HTTP video streaming service

- Evaluation
  - Use similar topologies and machines to compare
NDN for Video Broadcast

• The May 2013 CAFOE demonstration
  – NDN can support broadcast of one laptop camera to 1000 clients around the world

• Software required
  – NDN daemon running on gateways & clients
  – ndnvideo application on clients & server

• Management required
  – NDN clients must join NDN testbed
  – ndnvideo clients must know video name
Building an HTTP live video streaming infrastructure

- To compare, we built a comparable broadcast-capable video streaming infrastructure using HTTP
  - Distribute video to >100 clients, using HTTP-based clients & proxies

- Software required
  - VLC used as clients and server
  - Proxies run varnish, an HTTP video proxy/cache
    - Commercial-grade sw used by vimeo, BBC, and others
    - Version 3.0, Nov 2011, first support of video streaming

- Management required
  - Proxies must be configured to speak up stream
  - VLC client must know which proxy to connect to
  - VLC client must know video name
HTTP video streaming infrastructure

Proxies must be configured for topology (& load?)
HTTP live video streaming service

- Amazon CloudFront
  - Supports broadcast of video of HTTP
  - Leverages Amazon’s global footprint

- Software required
  - Amazon AWS Console
    - Video streaming, released Dec 2009
    - Live Video streaming, released Apr 2011
  - Wowza streaming video server (in EC2)
    - Live transcoding, released Oct 2011
  - Any HLS-compatible client

- Management
  - Use AWS Console
  - Clients must know video name
AWS CloudFront Organization

EC2 Wowza Server

Ind. Proxy

SF Proxy

Seattle Proxy

DC Proxy

Rotating Set of >= 90 Regional Proxies

Regional Proxies

Regional Proxies

Regional Proxies

Unknown Interconnection and Other Proxies?

WU Laptop

EC2 West2

EC2 West1

EC2 East1
Case Study Wrap-Up

• If you want to **use** a video streaming service
  – Use AWS CloudFront, it is shockingly good

• If you want to **build** a video streaming service
  – NDN was easier to setup
    • HTTP proxies and clients need topology-specific config
    • Using DNS/transparent proxies to avoid this would likely be just as complex
  – NDN required no tweaking
    • HTTP proxies needed to be tweaked to support changing topologies (and loads?)
Conclusion

How does the NDN team
... think about evaluation?

A: **Focus on end-to-end effectiveness**

... demonstrate progress and capabilities?

A: **Frequent real-world demonstrations**

... compare to the fast-moving real-world?

A: **Compare against the best alternatives**