Networking Named Content

Palo Alto Research Center
Motivation

How to retrieve content over a network?

- Traditional TCP/IP stack
- Retrieval based on where it is located
Motivation

These protocols were created with 1960s/70s use-cases in mind.

- A focus on resource sharing
- Host-to-host abstraction

These days the internet is about accessing a vast amount of content, regardless of location
Motivation

Three areas that the traditional model is ineffective

- Availability
- Security
- Location-dependence
Model Overview

Content-Centric Networking (CCN)
A new networking stack with a focus on what the content is rather than where it is located. Includes new transport and routing protocols as well as a built in security system.
Model Overview

**Interest packet**
- Content Name
- Selector
  (order preference, publisher filter, scope, ...)
- Nonce

**Data packet**
- Content Name
- Signature
  (digest algorithm, witness, ...)
- Signed Info
  (publisher ID, key locator, stale time, ...)
- Data
Model Overview

- Consumers broadcast the content they want
- Any node can respond with content
- A request is satisfied if the “ContentName” is the same in the request and response
- ContentName examples:
  - /ThisRoom/projector
  - /Local/Friends
Model Overview

Packet Forwarding Engine; composed of:

- **FIB (Forwarding Information Base)**
  - Similar to IP FIB, but allows multiple destinations

- **Content Store**
  - Like buffer memory in IP router, but CCN “remembers” packets for as long as possible

- **PIT (Pending Interest Table)**
  - Stores Interest packets sent upstream to data sources
Model Overview

Transport

● Like TCP, hides failure (retries packets)
● Unlike TCP, it is stateless
  ○ It is the consumers responsibility to retry
● Flow control of Interests is modelled like TCP ack packets
Model Overview

Routing

● CCN’s forwarding model is a strict superset of TCP’s
  ○ Existing routing schemes should work on CCN
  ○ CCN can be deployed incrementally, using existing hardware

● CCN can support both existing Link-state Intra-domain and Inter-domain routing
Model Overview

Security

- Security is property of packets rather than the connection they travel through
- *All* content is digitally signed
- Consumers must validate the data they want
- Different to IP where trust of content is based on where and how it was obtained
Model Overview

Security - Trust

● Signing of content is flexible
  ○ Legal document authorised by a court
  ○ A blog post verified by someone who signed other entries

● SDSI/SPKI model used to hierarchically map keys to identities via namespaces (next slide)
Model Overview

SDSI/SPKI example
Implementation

● Packets encoded in ccnb binary XML format
● CCN (ccnd) forwarder implemented as a C daemon
● Security layer is implemented as a C & Java library
● Runs on all widely used operating systems
● Currently v0.8.1 https://github.com/ProjectCCNx/ccnx
Evaluation

Tested 3 key areas:

● Data Transfer Efficiency
  ○ File downloading vs TCP
  ○ Web page downloading vs HTTP/HTTPS

● Content Distribution efficiency

● Voice-over-CCN
Evaluation

File downloading performance vs TCP
Evaluation

Web Page Download Comparison

<table>
<thead>
<tr>
<th></th>
<th>Bytes (packets)</th>
<th>Overheads</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sent</td>
<td>Received</td>
<td>Encap</td>
</tr>
<tr>
<td>Web page (6429 bytes)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HTTP</td>
<td>723</td>
<td>7364</td>
<td>15%</td>
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<tr>
<td>CCN/ETH</td>
<td>811</td>
<td>8101</td>
<td>26%</td>
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<tr>
<td>CCN/UDP</td>
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<td>6873</td>
<td>7%</td>
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<tr>
<td>Secured Web page (16944 bytes)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>HTTPS</td>
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<td>CCN/ETH</td>
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<tr>
<td>CCN/UDP</td>
<td>629</td>
<td>18253</td>
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</tr>
</tbody>
</table>
Evaluation

Content Distribution vs TCP
Evaluation

Voice-over-CCN with dropping links
Discussion

- Doesn’t seem hard to beat TCP/IP, real question is whether it can disrupt such an entrenched system
- In general a very ambitious project, but there is backwards compatibility support
  - It can run alongside TCP/IP
Recent Developments

- Android implementation
- Seem to be promoting mainly in more niche areas:
  - Medical devices
  - Home media networks
  - Lighting control systems
- Roadmap for v1.0 released Dec 2013
Questions?