Container-Based Testbed for ICN

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Information-Centric Networking (ICN)

- Efficient content access without depending on server/content location
  - From IP address based communications to content ID based communications
  - From server based communications to content based communication
- Better performance to retrieve contents
  - From server distribution to content (or cache/repository) distribution
  - Content retrieval from closest cache
- Flexible data forwarding
  - Naturally support one-to-many or many-to-many transmission

ICN proposals and projects
- CCN/NDN (USA)
  - In-network cache
  - Router extension
- NetInf → SEIL (EU)
  - Multi-layer overlay
- PSIRP → PURSUIT (EU)
  - Overlay + Rendezvous Point and Topology Manager
Content-Centric Networking (CCN)

- From IP address based, end-to-end communications, to content ID based, content-centric communications
  - Many users retrieve identical contents
  - Closest data (or copies) are not always on origin servers
    - Content you want to obtain may be near you
    - Accessing origin servers is not the fundamental requirement

CCNx: Prototype implementation
- Available on: http://www.ccnx.org/
**Content Name and Data Format**

<table>
<thead>
<tr>
<th>Interest</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content Name</strong></td>
<td><strong>Content Name</strong></td>
</tr>
<tr>
<td>Selector</td>
<td>Signature</td>
</tr>
<tr>
<td>Nonce</td>
<td>Signed Info</td>
</tr>
<tr>
<td></td>
<td>Data</td>
</tr>
</tbody>
</table>

Example of Content Name: /news.com/events/2013/10/01/festival.img
In-Network Cache

Interest (request)  Data (content data)

Router  Caching router

- CCN’s concept
  - Name-based routing
    - Content name for data retrieval / transmission
    - ID / Location independent content access
  - In-network cache
    - Performance improvement
    - Resource (or cost) reduction
Functional Components for ICN

- **Naming**
  - Global unique content IDs
  - Content / cache resolver (or discovery mechanism)

- **In-network cache**
  - From network’s perspective: on-path caching / off-path caching
  - From application’s perspective: content type based algorithm

- **Name-based routing**
  - Proactive vs. reactive
  - Intra-domain vs. Inter-domain

- **Transmission**
  - From end-to-end reliability to cache transmission reliability
  - One-to-one / one-to-many / many-to-many

- **Security**
  - From server based authentication to content or cache based authentication
  - Cache protection / integrity

- **Mobility**

- **Prototype implementation**

**Large scale testbed**
Container-Based Unified Testbed

• Container-Based Unified Testbed
  – Design
    • Testbed node: VM (detailed later)
    • User node: Linux Container (LXC) based logical space
  – Concept
    • ICN (basically, CCN/NDN based) experiments
      – All required components (e.g., compiler, library, CCNx, etc.) for ICN experiments pre-installed/configured on VM
      – Save hardware resources and operational costs (by eliminating install/set up common components per user)
        » But not prohibit to install original components under user space
    • It supports two types of experiments
      – User level experiment (e.g., I want to use CCNx, measure CCNx’s performance, develop some ICN applications on top of CCNx, etc.)
      – Developer level experiment (e.g., I develop new routing daemon, so want to measure its performance over the testbed, etc.)
  • Developers own “user node” having private IP address space
    – Possible to measure routing architecture
Requirements for Testbed Node

• Node requirement
  – PC or workstation
    • VMware vSphere (ESXi) or Linux running VMware player
    • Intel i5 / i7 / Xeon, 8GB (or higher) memory
  – VM
    • Ubuntu Server 12.04.3 LTS 64-bit or later
      – Linux Kernel 3.8
      – LXC 1.0 (alpha or later)

• Network requirement
  – Internet connectivity
    • One (or more) global IP address
      – IPv6-only IF will work
  – Private network
    • Virtual Ethernet (veth)
    • GRE tunnel
Shared Filesystem

VM1

User container (lxc1)
/home
/var
/etc

Mount (RO)

User container (lxc2)
/home
/var
/etc

Common container (lxc0)
/home
/var, /etc

VM2

/user/alternatives

User container (lxc1)

User container (lxc2)

Common container (lxc0)

Mount (RO)

/bin
/sbin
/lib
/usr
/etc/alternatives

CCNx
NLSR
Blackadder
Click

...
Experiments on Different Container Spaces

User2’s Containers
- LXCx
- LXC1
- ...

User1’s Containers
- LXC1
- LXC1
- LXCn
- ...

Common Containers
- LXC0
- LXC0
- LXC0
- ...

Container Level
- LXC1
- LXCx
- LXCy
- LXC1
- LXCz
- ...

OS Level
- VM
- VM
- Host

User2 Space
- ccnd
- ccnd

User1 Space
- ccnd
- ccnd
- ccnd

Common Space
- ccnd
- ccnd
- ccnd
Status

• Current status
  – Basic design and implementation (ver.0.1)
  – Ver.0.1 release (2013.11)
  – Initial deployment in AsiaFI community (6 site)
  – Primary experiment in the testbed

• Next steps
  – Ver.0.2 release (planned on June 2014)
Experiments (Path A/B)

<table>
<thead>
<tr>
<th>File Size (M Bytes)</th>
<th>TCP/IP (SCP) from SNU to PC</th>
<th>ccngetfile on Path-A (from publisher)</th>
<th>ccngetfile on Path-A (from in-network cache)</th>
<th>ccngetfile on Path-B (from publisher)</th>
<th>ccngetfile on Path-B (from in-network)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<tr>
<td>File Size (M Bytes)</td>
<td>TCP/IP (SCP) from Waseda U. to Tsinghua U.</td>
<td>ccngetfile on Path-C (from publisher)</td>
<td>ccngetfile on Path-C (from in-network cache)</td>
<td>ccngetfile on Path-D (from publisher)</td>
<td>ccngetfile on Path-D (from in-network)</td>
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The diagram shows the file download time in seconds for different file sizes. Each color represents a different method of file transfer, as described in the legend.
Call for Participation

• Our next testbed (ver.0.2) release will be around the end of June 2014
  – Alpha release would be around the middle of May
• JGN-X connection will be around the end of Dec. 2014
• If you are interested in participating in our ICN testbed (ver.0.2), please contact to;

  Hitoshi Asaeda <asaeda@nict.go.jp>

Thank you