Globally Accessible Names in Named Data Networking

19-4-2013

Network Architectures and Services

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Outline

- Named Data Networking
- Problem Statement
- Proposal
- Measurements
Named Data Networking

Introduction

- Route-and-cache by name
- Rely on next hop to either
  - Deliver ContentObject (from cache)
  - Send out Interest to a node closer to the information

Problem

Excessive global routing table size

- 200 million routable domain names
  - Excluding routable subdomains
  - Plus a more expensive string prefix over bit-wise prefix match

- Compare to 450,000 IP subnets over 45,000 ASes

- 500 x complexity increase
- Too large for global routing tables!
Problem

Content availability

• Compulsory participation in routing discovery to share data
• Difficult due to disconnection of routing scopes
• Too complex for end-users to configure and maintain
Proposal

Map context-related names to routable names

- Decouple user-registered names from routable names
- Routable names aggregate to underlying topology
- User-registered names translate into location-dependent names
- Receiving sites rename to original names
Mapping

Internet

/AS2/routerA/Alice.eu

AS1

/Client/Alice.eu

AS2

/Alice.eu

/Alice.eu
Mapping DNS

Alice.eu text = "v=ndn /AS2/routerA"

Internet

/AS2/routerA/Alice.eu

AS1

/Alice.eu

Client

AS2

/Alice.eu

/Alice.eu
Mapping

Alice.eu text = "v=ndn /AS2/routerA"
Alice.eu text = "v=ndn /AS3/routerB"

DNS

Internet

/AS2/routerA/Alice.eu
/AS3/routerB/Alice.eu

AS2

AS3

Client

/Alice.eu

/Alice.eu

/Alice.eu

/Alice.eu
Mapping

Alice.eu text = "v=ndn /AS2/routerA
Alice.eu text = "v=ndn /AS3/routerB
Alice.eu text = "v=ndn /AS4/PlaneA/RouterD

Internet

/AS2/routerA/Alice.eu
/AS3/routerB/Alice.eu
/AS4/.../Alice.eu

AS1

AS2

AS3

AS4

Client

/Alice.eu

/Alice.eu

/Alice.eu

/Alice.eu

/Alice.eu

/Alice.eu

/Alice.eu

/Alice.eu

/Alice.eu
Mapping

Functionality of entry-points

CCNx Daemon: Interest Renaming Process Initiator

Pending Interest Table

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Req. Faces</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Alice.eu/Photos</td>
<td>0</td>
</tr>
<tr>
<td>/tudelft.nl/nas/pcaAlice/Alice.eu/Photos</td>
<td>1</td>
</tr>
</tbody>
</table>

Forwarding Information Base

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Face list</th>
</tr>
</thead>
<tbody>
<tr>
<td>/Alice.eu</td>
<td>1</td>
</tr>
<tr>
<td>/tudelft.nl</td>
<td>2</td>
</tr>
</tbody>
</table>

Original Interest

Face 0

App

Rename

Face 1

Named Face

Face 2

Web

Renamed Interest
Signing and Authenticity

- CCNx / NDN signs each ContentObject
- Changing the name invalidates signature
Signing and Authenticity

- CCNx / NDN signs each ContentObject
- Changing the name invalidates signature

1. Ignore signatures while renamed
Signing and Authenticity

2. Encapsulate `ContentObject` into a new one

```
Signature
Name: /tudelft.nl/nas/pcalice/Alice.eu/Photos/AnyPhoto
SignedInfo

Content:

Signature
Name: /Alice.eu/Photos/AnyPhoto
SignedInfo

Content:

Picture content
```
Renaming and Signing Cost

Experiments

- Measured 3.600 RTTs using `ccnping`\(^1\)
  - Regular CCNx
  - Renaming CCNx
  - Encapsulating and re-signing CCNx

Renaming and Signing Cost

Results

- Ping RTT
  - CCNx: 2.338 ms
  - CCNx Renaming: 5.327 ms + 2.989
  - CCNx Encapsulation and re-signing: 9.031 ms + 3.704

Averages: Penalty:

2.338 ms  
5.327 ms + 2.989  
9.031 ms + 3.704
Take-home message

- Decreased global routing table complexity
  - From 200 million to 45,000 forwarding entries
  - Compared to 450,000 entries in IP

- Enabled content sharing using context-related names
  - Without the necessity to apply routing discovery

- Both by applying mapping and renaming of context-related names to routable names
Recursive Name Generation

By applying path-vector routing discovery
Recursive Name Generation

By applying path-vector routing discovery
Recursive Name Generation

By applying path-vector routing discovery

/ISP-A.net/routerBob/PC/Camera
/ISP-B.net/routerBob2/TV/Camera
Implementation Online

Delft University of Technology - Network Architectures and Services
TUDelftNAS

https://github.com/TUDelftNAS