

Advanced Network Architecture Research Group, Osaka University

The Impact of FQDN Database Updates on Name-based Routing Architecture

Haesung Hwang¹, Shingo Ata², and Masayuki Murata¹
¹Graduate School of Information Science and Technology, Osaka University
²Graduate School of Engineering, Osaka City University
 {h-hwang, murata}@ist.osaka-u.ac.jp
 ata@info.eng.osaka-cu.ac.jp

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 1

Advanced Network Architecture Research Group, Osaka University

Sketch of Proposal

I want to send an email to Alice
 To: Alice
 Alice → 192.168.128.111
 router

I want to download proc. of NOMS 2010
 "NOMS 2010"
 router

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 1

Advanced Network Architecture Research Group, Osaka University

Goal

Feasibility Evaluation of name-based routing

- Hardware
 - Is storing routing information of 'names' to currently deployed routers possible?^[1]
- Network
 - How does topology change when the database is updated? → **THIS WORK**

[1] Haesung Hwang, Shingo Ata, Masayuki Murata, "A Feasibility Evaluation on Name-based Routing," in Proceedings of the 5th IEEE International Workshop on IP Operations and Management (IPOM), pp.130-142, Venice, Italy, October 2009.

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 2

Advanced Network Architecture Research Group, Osaka University

Name-based Routing

- FQDN (Fully Qualified Domain Name)
 - Hierarchical
 - Generalize to resource-based routing

```
XRI xri://authority/path?query#fragment
LSID urn:lsid:authority.org:namespace:object:revision
DOI prefix/suffix
<scheme name>:<hierarchical part>[?<query>][#<fragment>]
```

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 3

Advanced Network Architecture Research Group, Osaka University

Distribution

- FQDN - variable length, usually longer than IP address
 → distribute routing information to multiple routers
- Distribution Algorithms
 - Hierarchical Longest Alphabet Match (HLAM)
 - Inspired by longest prefix match
 - Takes full advantage of TCAM
 - Hybrid Distribution (HD)
 - Grouping by TLD + hashing function
 - Balanced distribution

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 4

Advanced Network Architecture Research Group, Osaka University

TCAM (Ternary Content Addressable Memory)

<RAM>

0	1	0	1	1	0
1	1	1	0	0	1
2	0	0	1	1	0
3	1	0	1	0	1
4	0	1	0	1	0
5	1	1	0	1	1
6	0	1	0	1	0

Address In → 4

Data Out

<TCAM>

0	1	0	*	*	
1	0	1	1	0	
2	0	0	1	1	0
3	1	1	0	0	1
4	0	0	1	1	0
5	0	1	0	1	0
6	0	1	0	1	0
7	1	1	0	1	1

Data In ↓

Address Out → 4

- Searched using the content of memory, returns the memory content or the memory address
- Cell representation: 0/1/*
- Fast search speed, excellent performance in longest prefix match

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 5

HLAM

Content	TCAM cell
Hyphen, digit	01****
a ~ c	11000**
d ~ g	11001**
h ~ o	1101***
p ~ s	11100**
t ~ w	11101**
x ~ z	1111***

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 6

HLAM

Router R1's Routing Table

com.*	port P
net.*	port P
jp.*	port P

Router R2's Routing Table

com.*	port Q
net.*	port Q
jp.ac.*	port X
jp.ac.osaka-u.*	port A

Router R3's Routing Table

com.**	port X
net.**	port Y
jp.***	port A

Router R4's Routing Table

jp.**	port Z
net.**	port V
com.*	port A

Router R5's Routing Table

com.*	port Q
net.*	port Q
jp.*	port Q
com.yahoo.*	port A

The routing tables are stored in TCAM

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 7

HD

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 8

HD

$H(\text{name}) = \text{Group\#} \pmod{x}$

Router R1's Routing Table

ld1	port P
ld2	port P
ld3	port P
ld3:ld5:ld6	port X
ld3:ld5:ld6:ld7	port A

Router R2's Routing Table

ld1	port Q
ld2	port Q
ld3	port Q
ld3:ld5	port X
ld3:ld5:ld6	port A

Router R3's Routing Table

ld1	port X
ld2	port Y
ld3	port A

Router R4's Routing Table

ld3	port Z
ld2	port V
ld1	port A

Router R5's Routing Table

ld1	port Q
ld2	port Q
ld3	port Q
ld3:ld4	port A

The routing tables are stored in TCAM

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 9

Trend of FQDN

← Increase of FQDN

Increase of number of routers ↓

2nd level routers 3rd level routers Total routers

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 10

Utilization & Aggregation

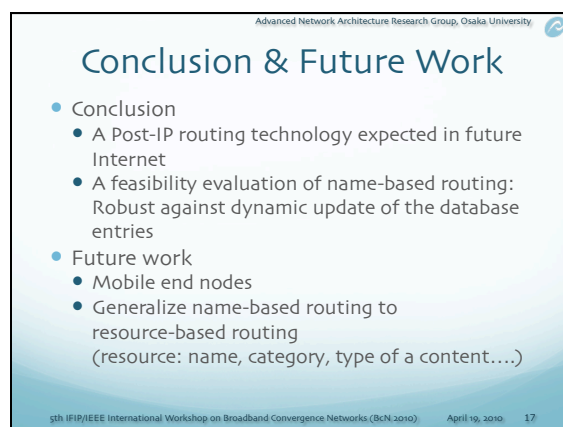
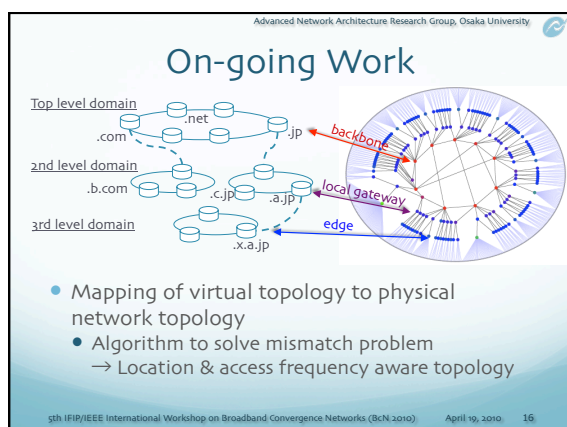
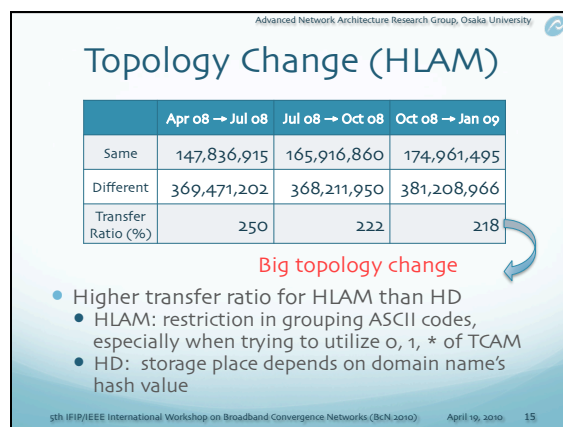
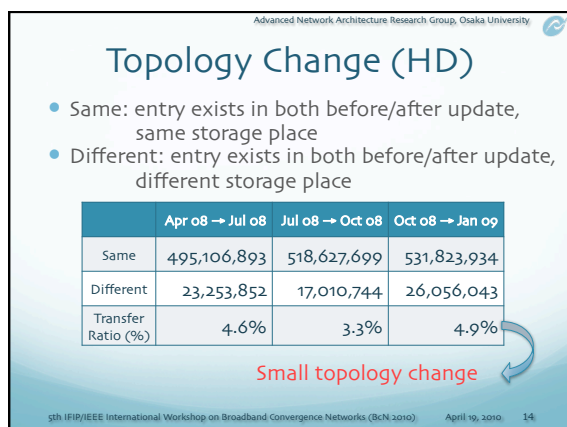
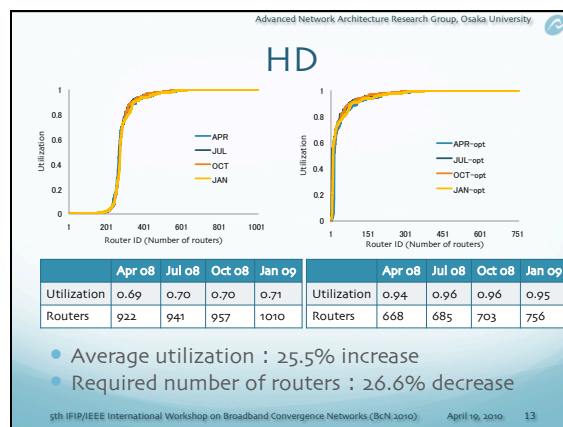
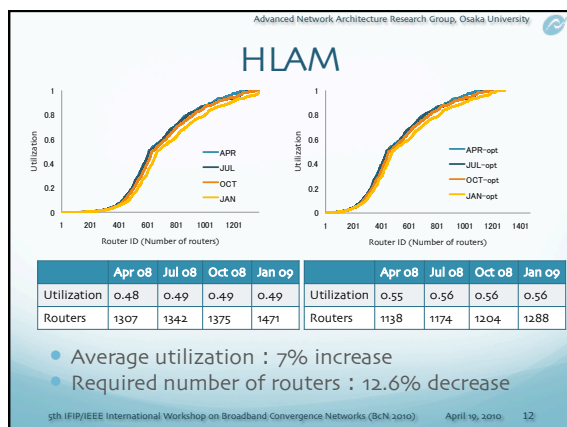
Threshold: maximum allowed memory
Utilization: actual memory used


$$= \frac{\text{number of entries in a router} \times 180 \text{ bits}}{\text{router memory size}}$$

(router memory size is assumed as ten 18 Mbit TCAM per one router)

- HLAM: Store domain names with small database size to a router
ac, ad, ae, aero, af, ag, ai, al, am, an, ao → 1100001 110****
- HD: Store domain names with same hash value to a router
H(osaka-u) = 1000 (mod 16)
H(renesas) = 1000 (mod 16) } ID# 1000

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 11



Advanced Network Architecture Research Group, Osaka University 

Thank you!

Haesung Hwang
h-hwang@ist.osaka-u.ac.jp

5th IFIP/IEEE International Workshop on Broadband Convergence Networks (BcN 2010) April 19, 2010 18