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A splitting-after-merging approach to multi-FIB compression and fast refactoring in virtual routers

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Key words: Virtual routers, Merging, Splitting, Compress, Fast Refactoring

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Introduction

- virtual routers have multiple virtual instances coexisting on a physical router platform, and each instance retains its own forwarding information base (FIB). memory scalability suffers from the limited on-chip memory.
- we present a splitting-after-merging approach to improve the memory efficiency and offer an ideal split position to achieve system refactoring.
- 14 real-world routing data sets show that our approach needs only a unibit trie holding 134 188 nodes, while the original number of nodes is 4 569 133

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Splitting-after-merging approach

Idx	Prefix	Next hop
P1	0	N1
P2	10	N2
P3	1010	N3

Idx	Prefix	Next hop
P4	000	N2
P5	1000	N4
P6	10001	N5

Idx	Prefix	Next hop
P7	11001	N2
P8	0110	N6

FIB1

FIB2

FIB3

Idx	Prefix	Next hop
P1	000	N1
P2	0010	N2
P3	001010	N3
P4	01000	N2
P5	011000	N4
P6	0110001	N5
P7	1011001	N2
P8	100110	N6

Fig. 1 Three FIBs merging into one with the added identification number

Lookup: 1010 001*

FIB

Idx	Prefix	Next hop
P1	000	N1
P2	0010	N2
P3	0010 10	N3
P4	0100 0	N2
P5	0110 00	N4
P6	0110 001	N5
P7	1011 001	N2
P8	1001 10	N6

Idx	Prefix	Next hop
P1	000	N1
P2	0010	N2
P3	0010	N3
P4	0100	N2
P5	0110	N4
P6	0110	N5
P7	1011	N2
P8	1001	N6

Idx	Prefix	Next hop
P1	Ø	N1
P2	Ø	N2
P3	10	N3
P4	0	N2
P5	00	N4
P6	001	N5
P7	001	N2
P8	10	N6

on-chip

FIB1

Idx	Prefix	Next hop
P1	000	N1
P2	0010	N2

FIB2

Idx	Prefix	Set	Next hop
G1	0	{P4}	{N2}
G2	00	{P5}	{N4}
G3	10	{P3, P8}	{N3, N6}
G4	001	{P6, P7}	{N2, N5}

Fig. 2 Splitting the merged FIB into two FIBs

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Prefix splitting

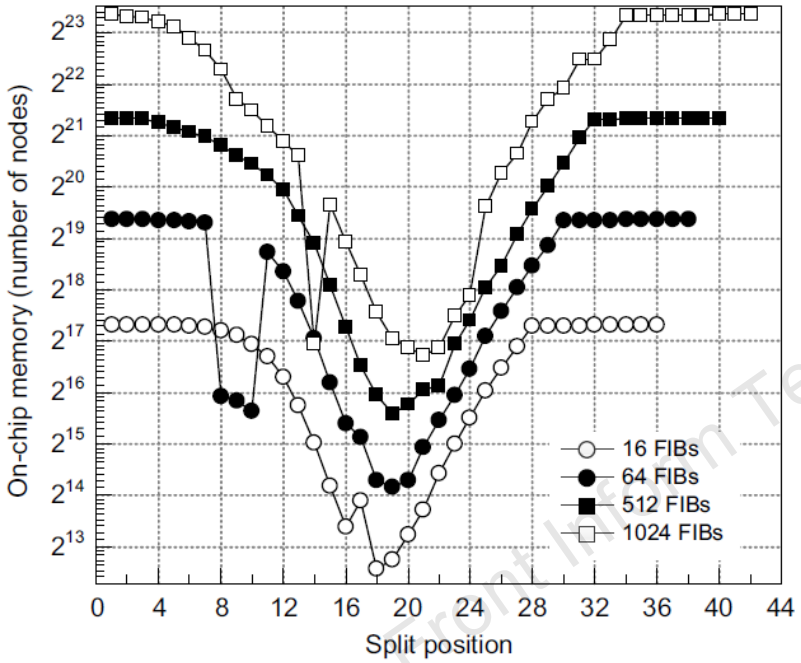


Fig. 3 The trend of on-chip memory varying with split position and the number of FIBs

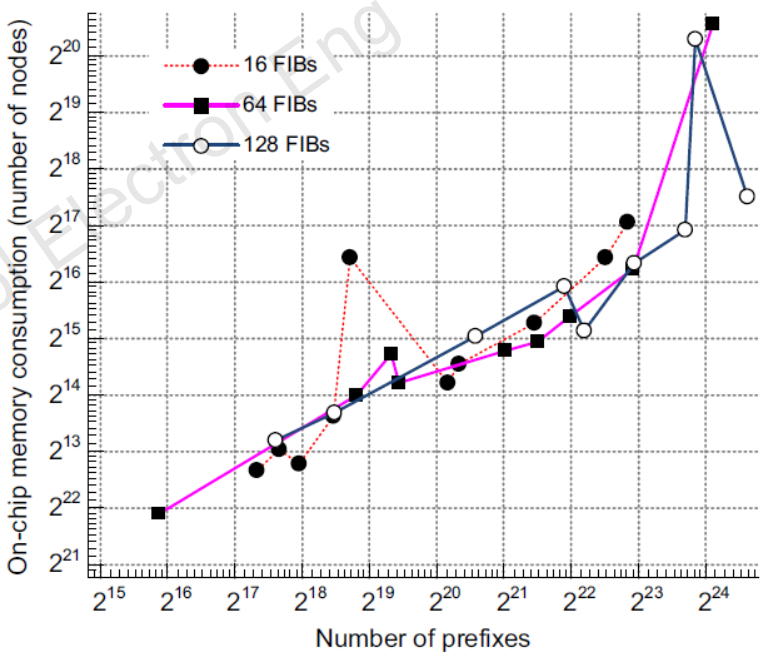


Fig. 4 The trend of on-chip memory varying with the number of FIBs (the split position is chosen as 18)

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Mechanism for fast rebuilding

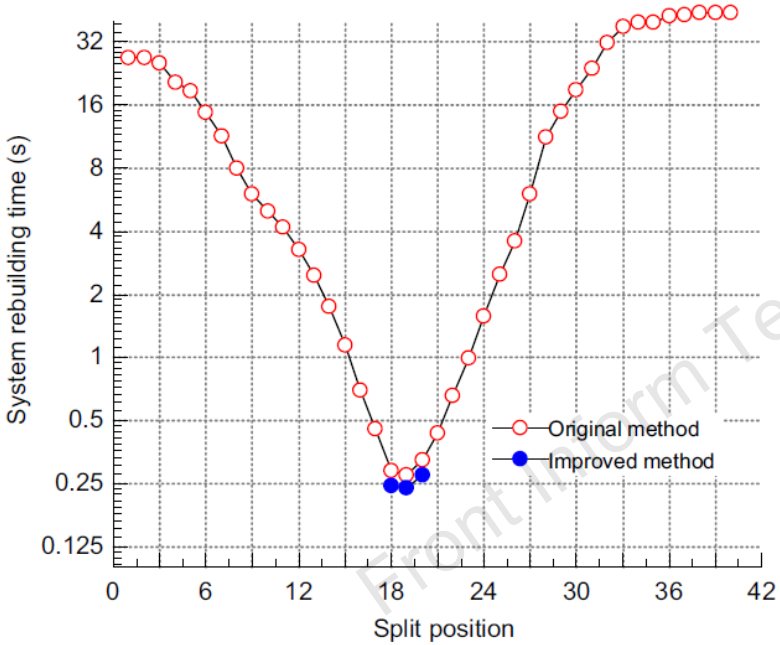


Fig. 6 Time efficiency of the two strategies of systen rebuilding

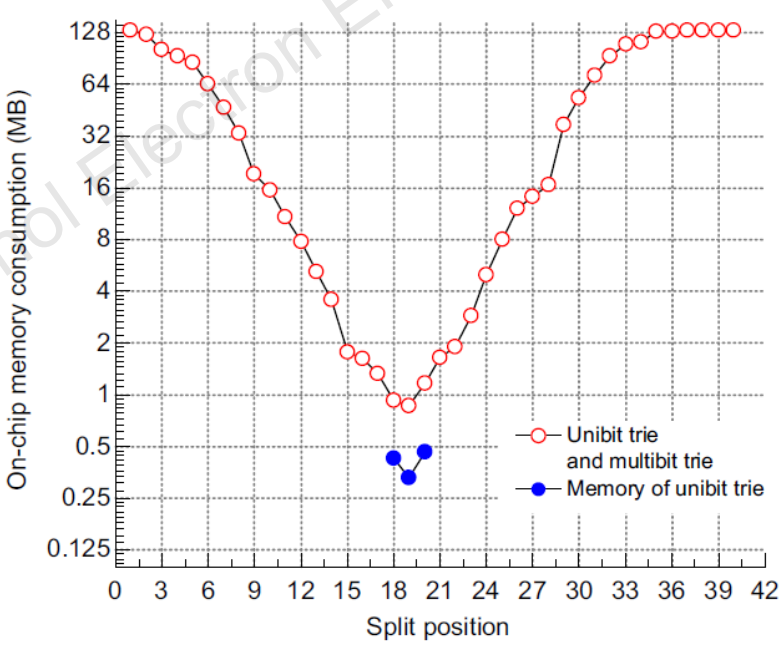


Fig. 7 Memory efficiency of the two strategies of system rebuilding

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Evaluation experiments

Table 1 Routing data set

Router	Location	Collected time	Collected number
Rrc00	RIPE NCC, Amsterdam	2001-04 to 2015-05	22
Rrc01	LINX, London	2001-10 to 2015-04	20
Rrc02	SFINX, Paris	2006-12 to 2008-10	3
Rrc03	AMS-IX, Amsterdam	2001-12 to 2015-05	22
Rrc04	CIXP, Geneva	2001-12 to 2015-05	21
Rrc05	VIX, Vienna	2002-12 to 2015-05	19
Rrc06	Otemachi, Japan	2001-12 to 2015-05	19
Rrc07	Stockholm, Sweden	2002-12 to 2015-05	21
Rrc08	San Jose (CA), USA	2002-12 to 2004-01	5
Rrc09	Zurich, Switzerland	2003-05 to 2004-01	5
Rrc10	Milan, Italy	2004-12 to 2015-04	17
Rrc11	New York (NY), USA	2004-12 to 2015-05	19
Rrc12	Frankfurt, Germany	2004-12 to 2015-05	20
Rrc13	Moscow, Russia	2005-12 to 2015-05	17
Rrc14	Palo Alto, USA	2006-10 to 2015-05	15
Rrc15	Sao Paulo, Brazil	2005-12 to 2015-05	15
Rrc16	Miami, USA	2006-12 to 2012-03	8

Total number of data sets collected: 272
Total number of prefixes collected: 89 122 790

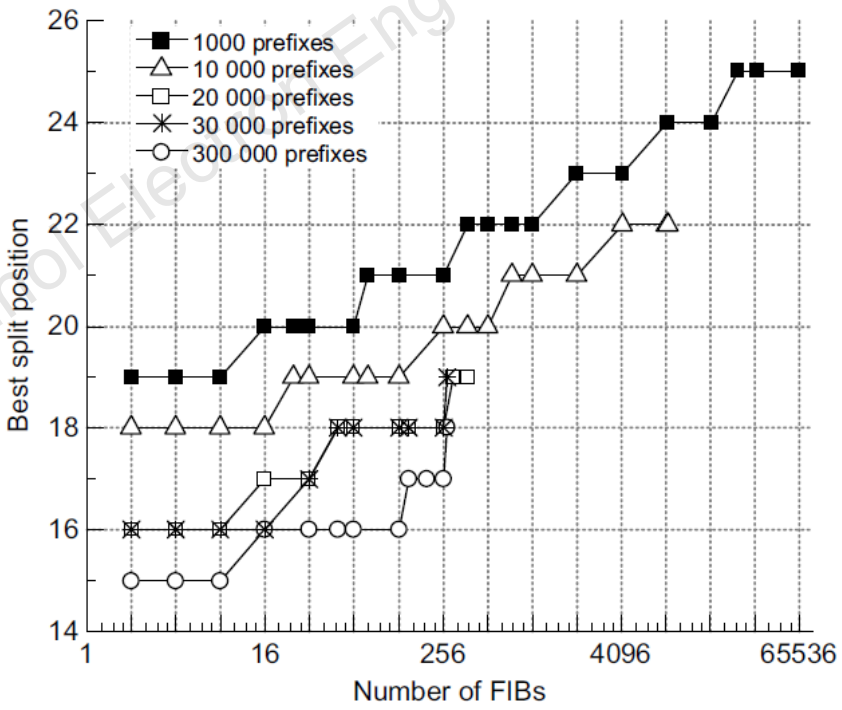
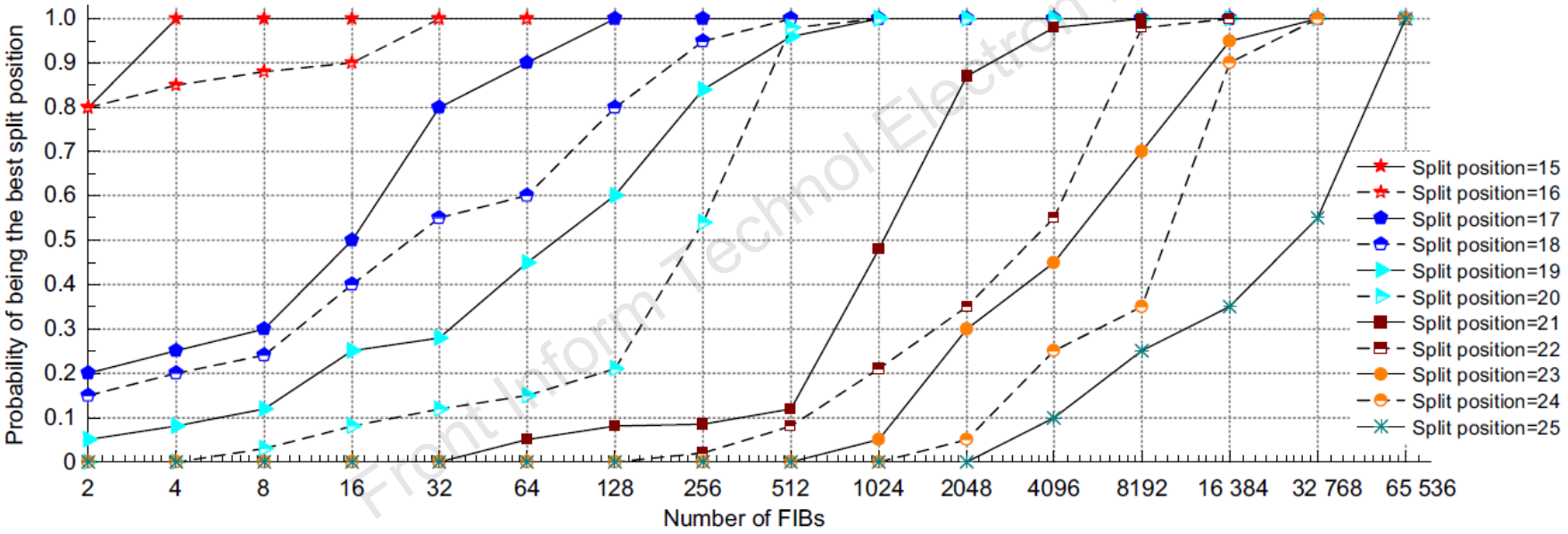


Fig. 8 The trends of the best split position

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Evaluation experiments



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Fig. 9 The cumulative distribution of the ideal split position

Evaluation experiments

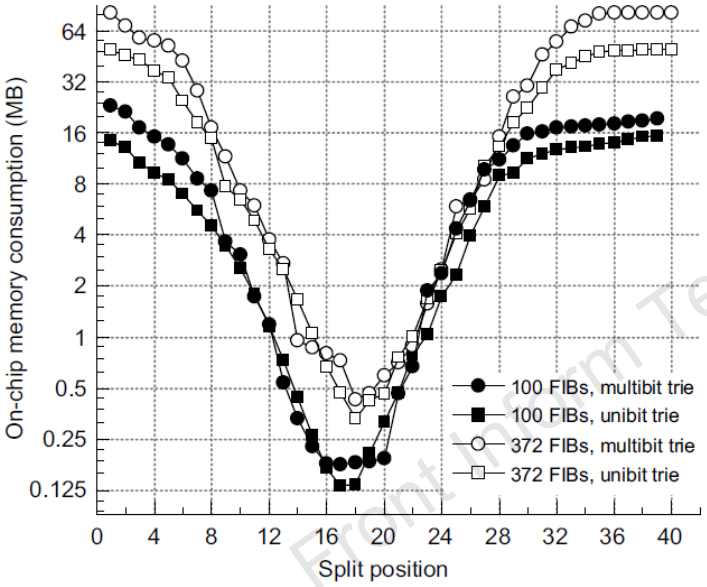


Fig. 10 The best split position of unibit and multibit tries

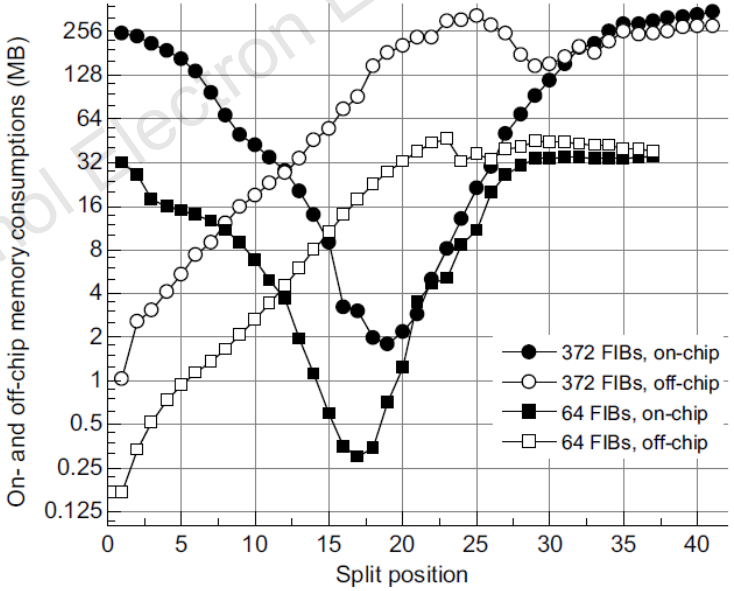


Fig. 11 On- and off-chip memory consumptions

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Conclusions

- We introduced an identity number to each prefix based on the number of FIBs and split the merged trie by using the splitting-after merging approach, which is memory efficient and supports fast update.
- The cumulative distribution of the ideal split position can help predict the best split position, which will shorten the detection time and accelerate the system rebuilding process

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