High Speed Route Lookup for Variable-Length IP Address

Wanli Zhang, Xiangyang Gong, Ye Tian, Jifan Tang

Beijing University of Posts and Telecommunications

Background

IP addresses are facing more and more problems

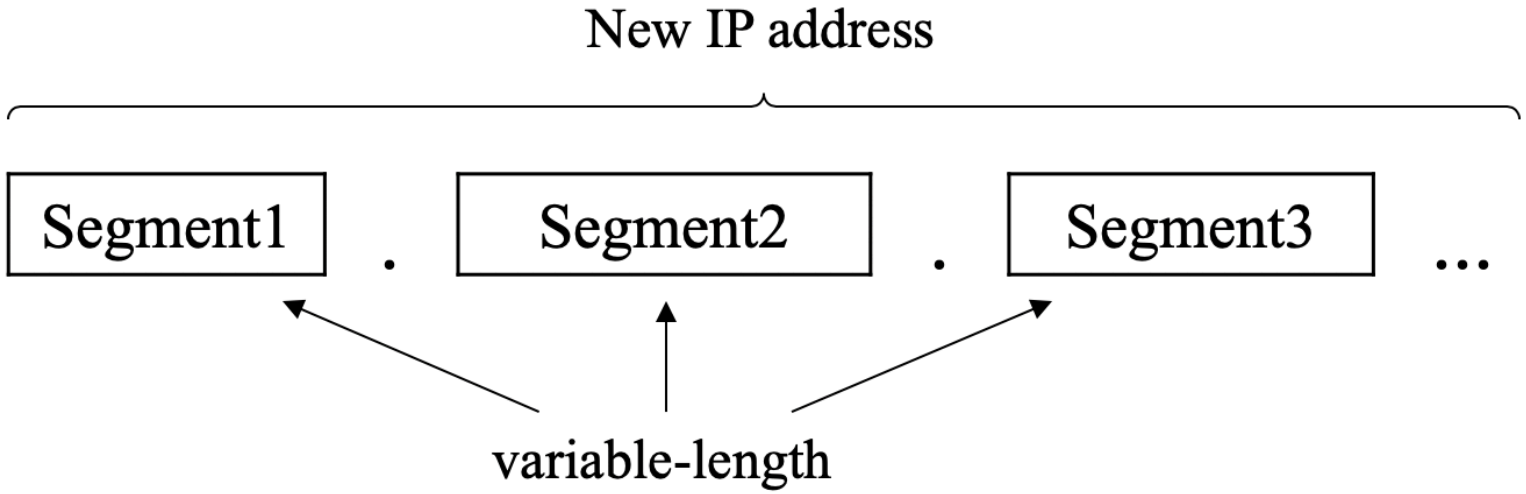
- Address exhaustion
- Low packet efficiency
- Low flexibility

Why?

- Fixed-length design

New IP

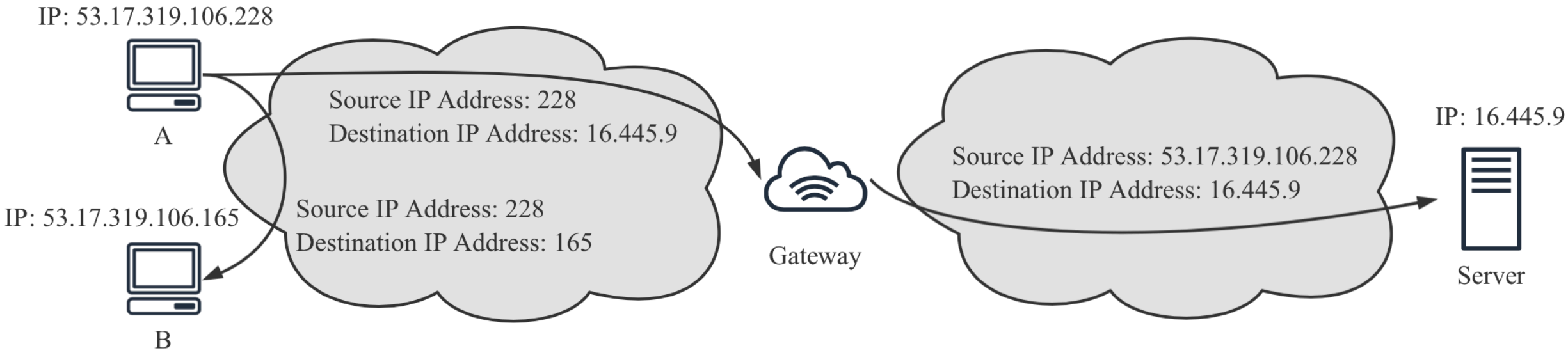
- Variable-length and structured addresses
- Address space smoothly expands



- 1.2.3.4.5

New IP Communication

- Short address
- Long address

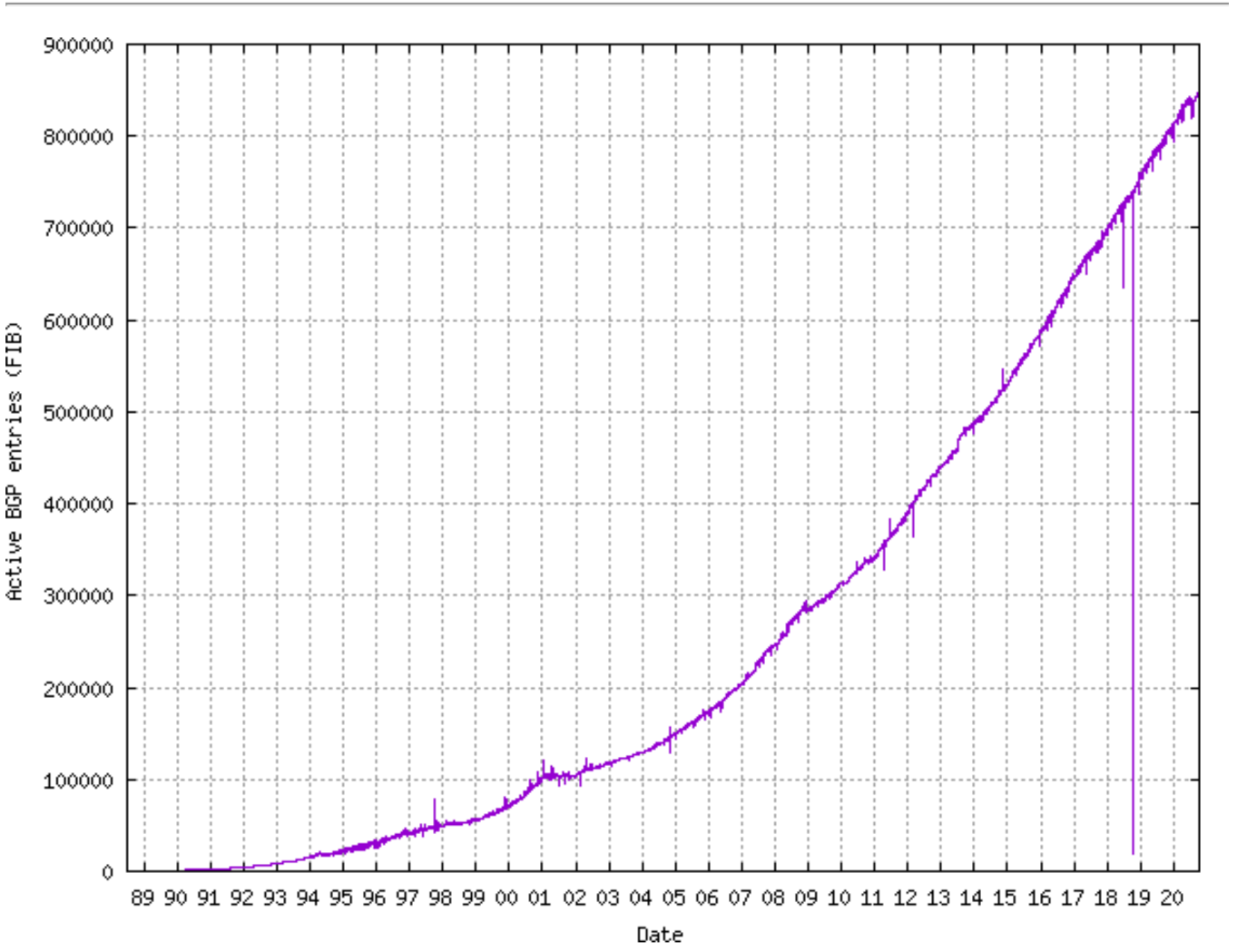


Contribution 1

Analogy with IPv4

- Large address space:
  - $2^{32} \approx 4 * 10^9$
- Small routing table:
  - $9 * 10^5$

Active BGP entries (FIB)



Plot Range: 30-Jun-1988 1430 to 09-Oct-2020 0109

www.cidr-report.org

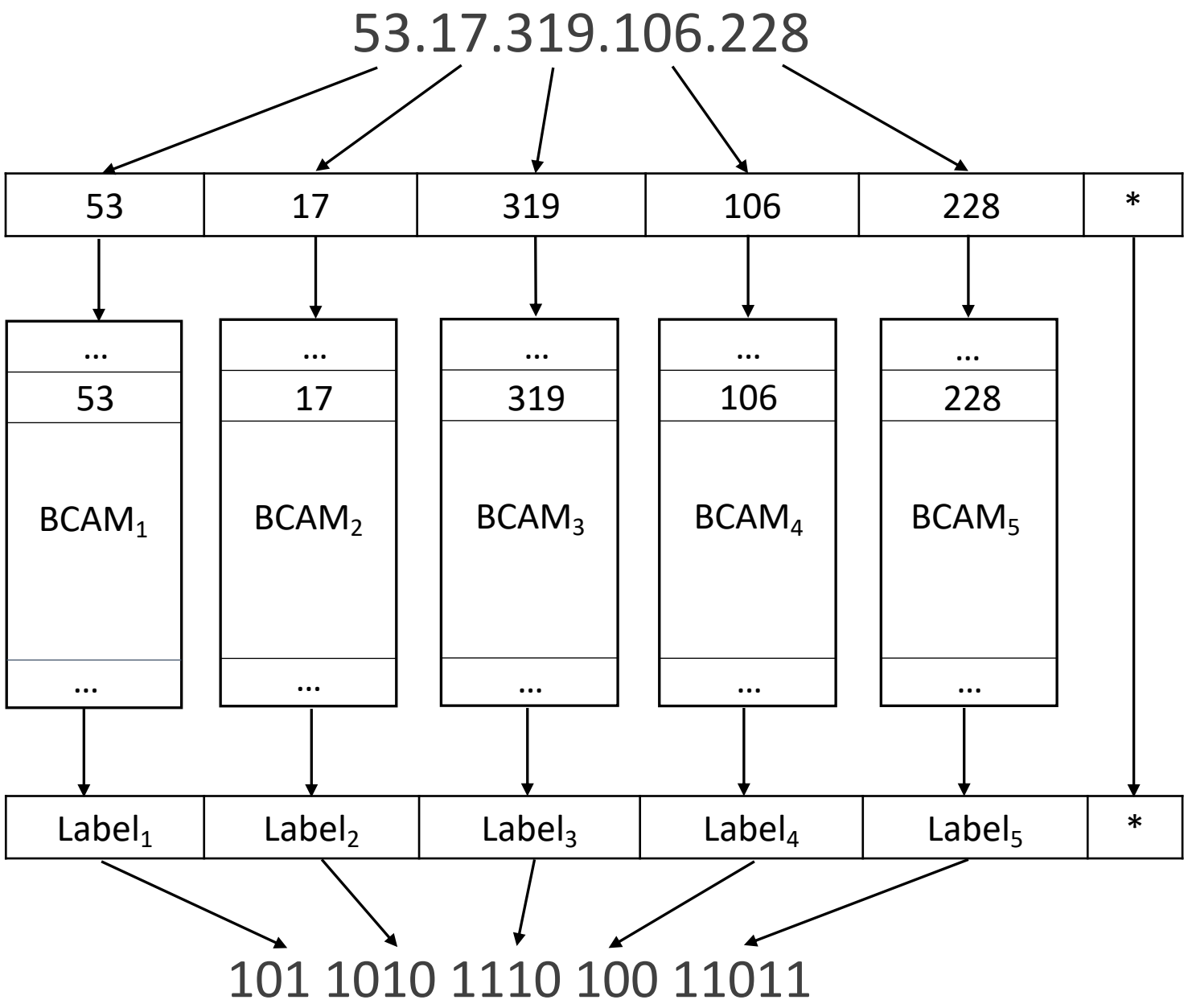
Contribution 1

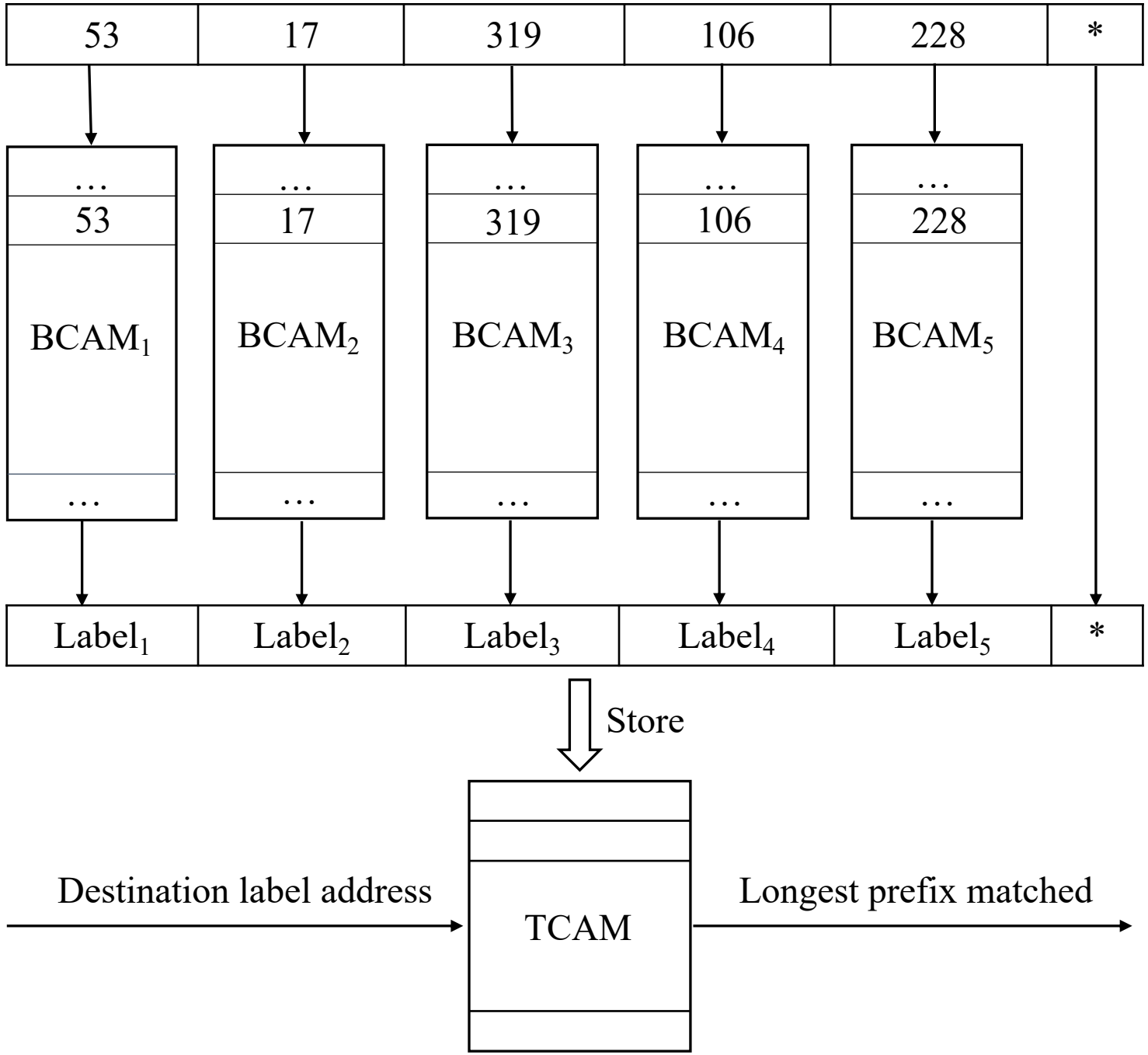
New IP Address

- Structured design
- Assign IP based on geographic location

New IP can aggregate better

- BCAMs: Map each segment of New IP to a shorter segment
- TCAMs: Longest prefix matching


53.17.319.106.228
53
17
319
106
228
*
...
53
17
319
106
228
BCAM1
BCAM2
BCAM3
BCAM4
BCAM5
...
Label1
Label2
Label3
Label4
Label5
*
101 1010 1110 100 11011


53
17
319
106
228
*
…
53
17
319
106
228
BCAM1
BCAM2
BCAM3
BCAM4
BCAM5
Label1
Label2
Label3
Label4
Label5
*
Store
Destination label address
TCAM
Longest prefix matched

Contribution 2

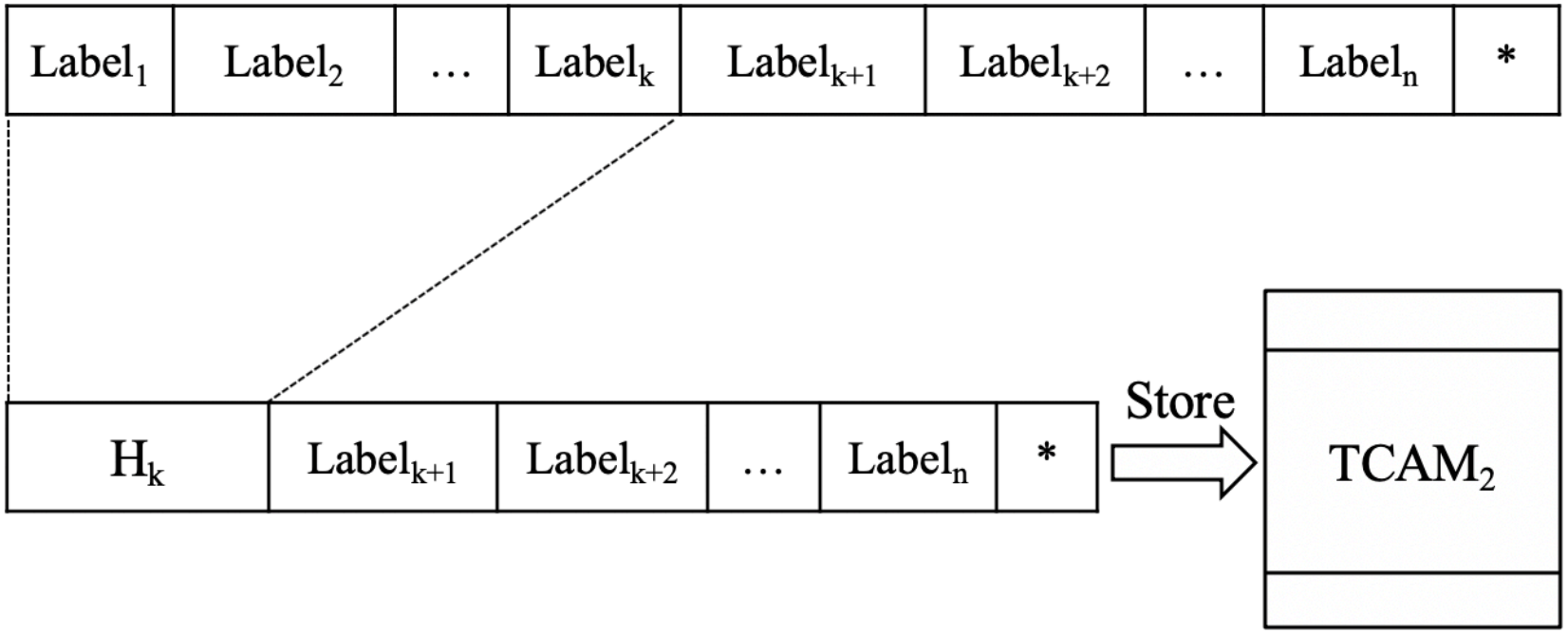
Contribution 1

- ☐ TCAM width should be more than the longest address length
- ☐ Waste TCAM storage space

- ✓ Most addresses are much shorter than the longest address
- ✓ Long address shortening method
- ✓ Reduce TCAM storage space consumption

Long Address Shorten

- TCAM1: Stores short addresses
- TCAM2: Stores long addresses



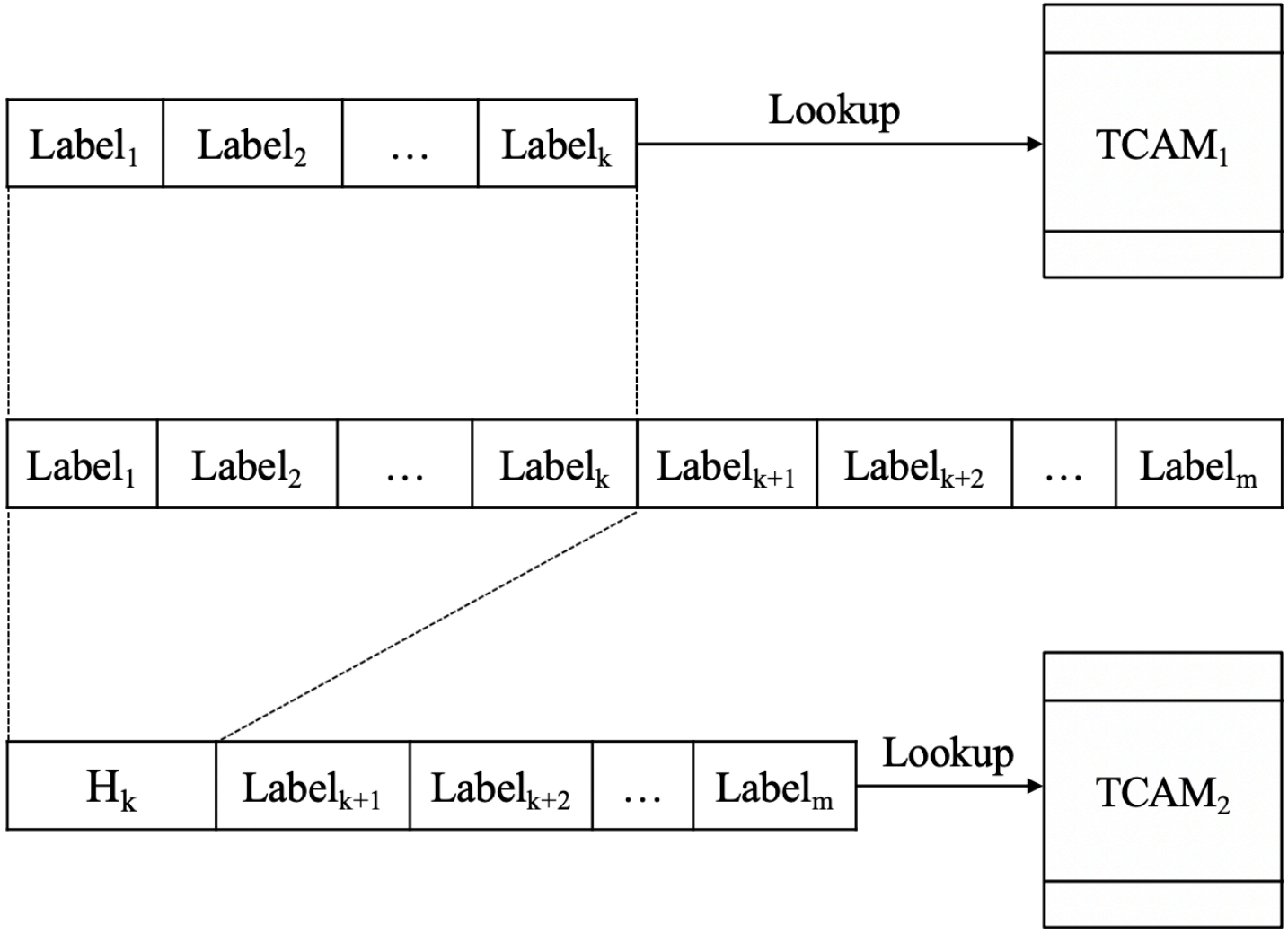
Long Address Shorten

Short addresses lookup

- Only TCAM1

Long addresses lookup

- TCAM1 and TCAM2



Evaluation

Lookup latency

- BCAM+TCAM: Two clock cycles
- ✓ Pipeline: One clock cycle

TCAM storage space consumption

- Random 1 million New IP address
- TCAM width for IPv6 : Always 128
- ✓ The router can choose appropriate TCAM width based on the size of its routing table.