On the Prefix Granularity Problem in NDN Adaptive Forwarding

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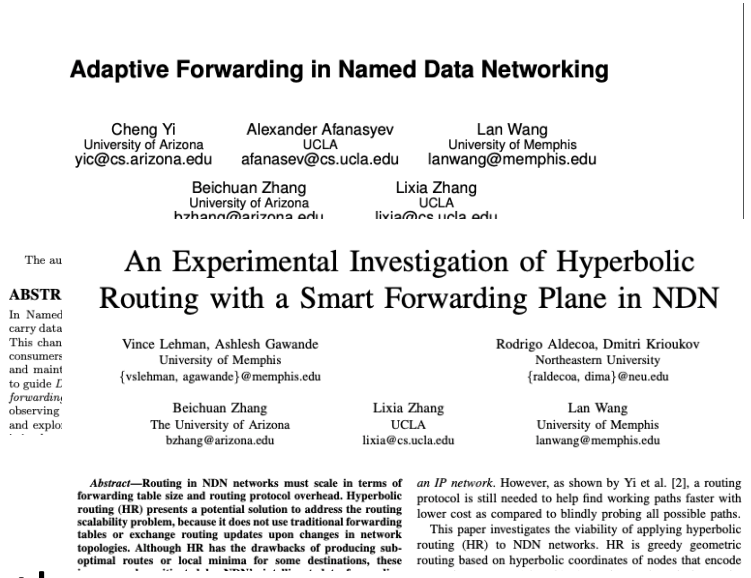
NDN Adaptive Forwarding

- IP forwarding is stateless and has no adaptability
  - Link failure, congestion, prefix hijack
- NDN forwarding is stateful and has adaptability
  - Observe past data retrieval measurement on multiple paths
  - and use it to improve forwarding decisions for future Interests
- Because of
  - Interest-Data exchange model
  - and States



Adaptive Forwarding in Named Data Networking

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An Experimental Investigation of Hyperbolic Routing with a Smart Forwarding Plane in NDN

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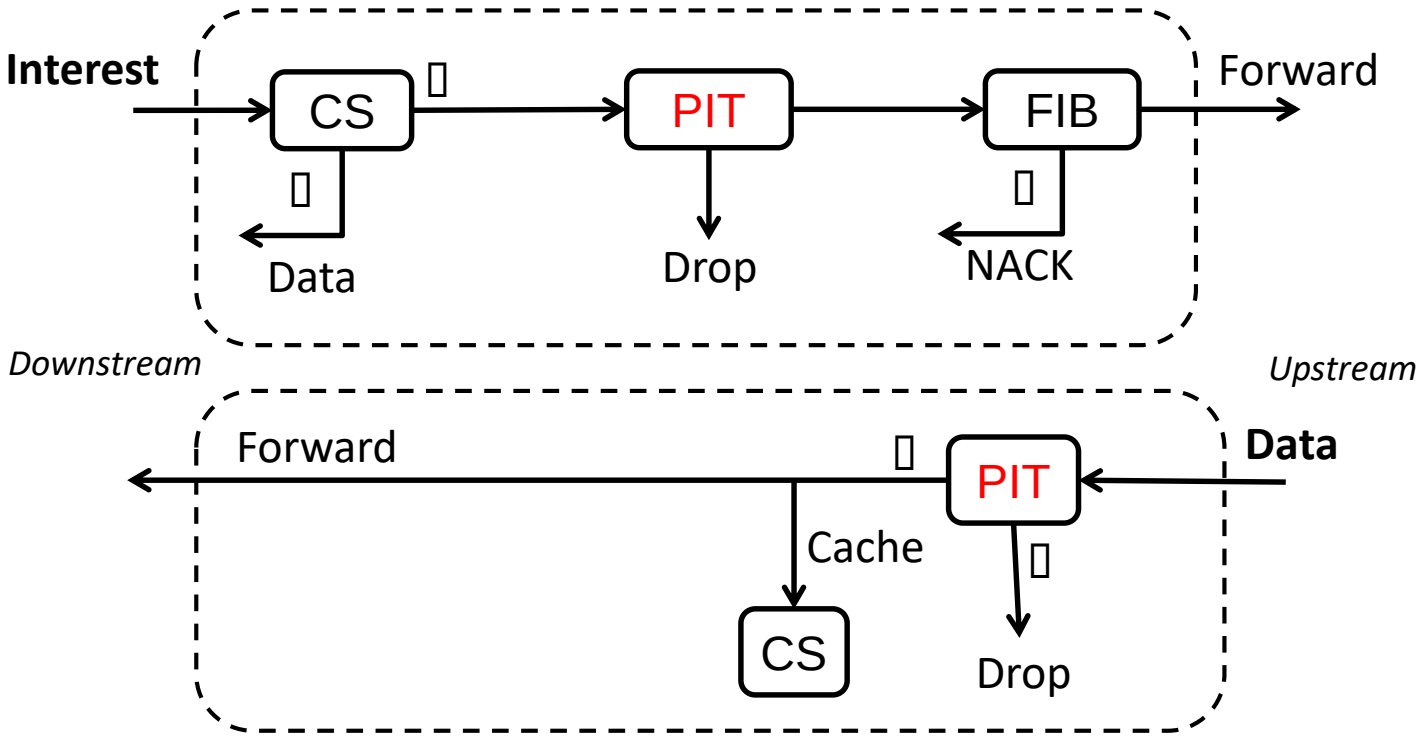
***Abstract*—Routing in NDN networks must scale in terms of forwarding table size and routing protocol overhead. Hyperbolic routing (HR) presents a potential solution to address the routing scalability problem, because it does not use traditional forwarding tables or exchange routing updates upon changes in network topologies. Although HR has the drawbacks of producing sub-optimal routes or local minima for some destinations, these** *an IP network*. However, as shown by Yi et al. [2], a routing protocol is still needed to help find working paths faster with lower cost as compared to blindly probing all possible paths.

This paper investigates the viability of applying hyperbolic routing (HR) to NDN networks. HR is greedy geometric routing based on hyperbolic coordinates of nodes that encode

NDN Adaptive Forwarding



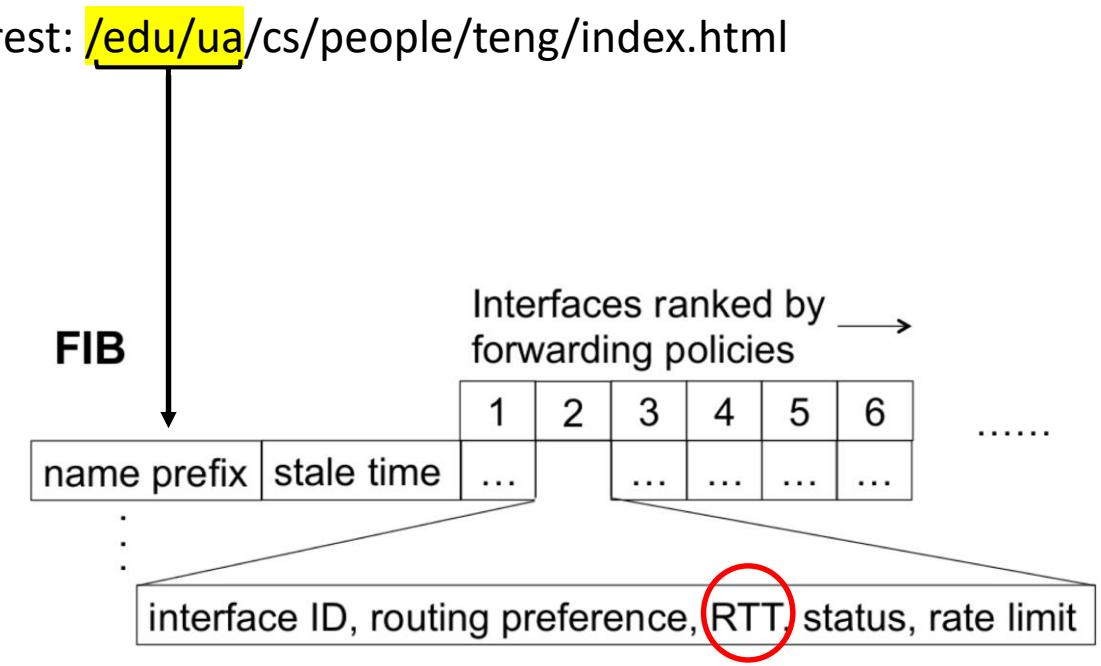
lookup miss lookup hit

The Prefix Granularity Problem

- NDN adaptive forwarding assumes that *Interest Routing Locality*
  - is influenced by the length of common name prefix
- Interests sharing a longer name prefix are more likely to take the same forwarding path
- Problem: which name prefix length should be used to record path performance measurements?
  - The longer the name prefix, the better Interest Routing locality
  - However, the fewer Interests will be covered, the bigger FIB
- We define it as the ***Prefix Granularity Problem***

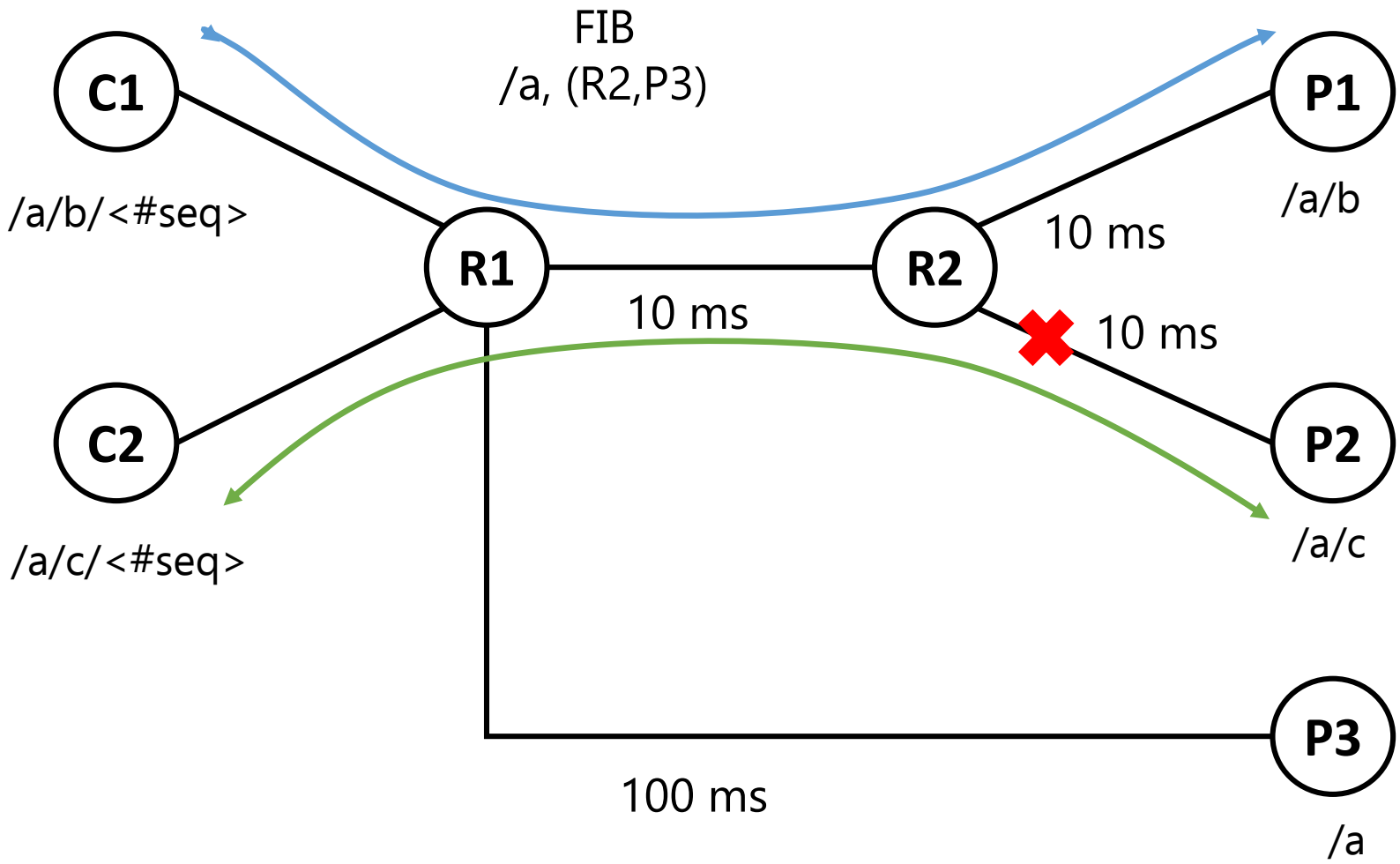
Existing Solutions

- Existing designs use a **static** name prefix to record measurements



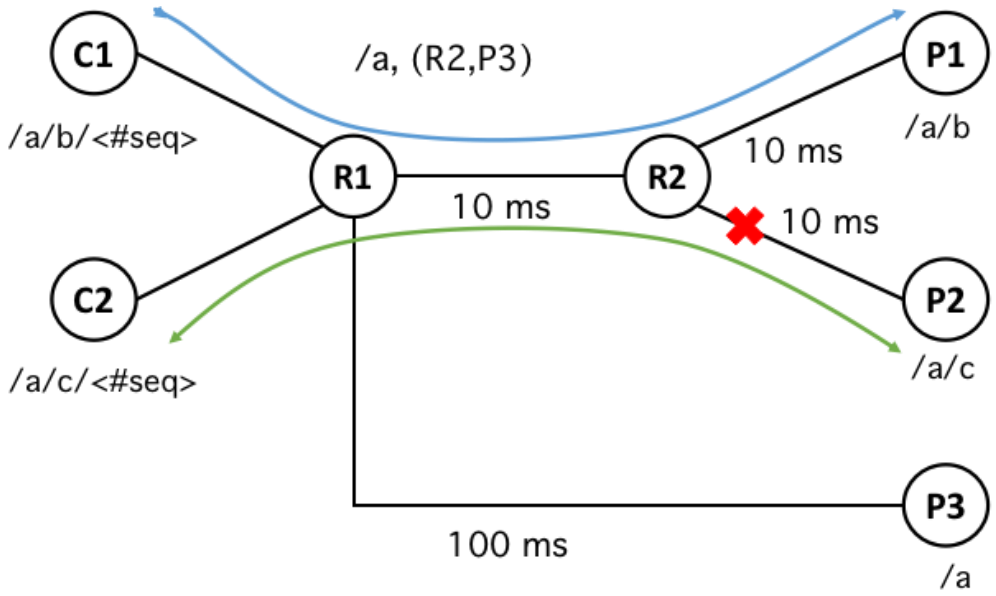
The Limits of Existing Designs

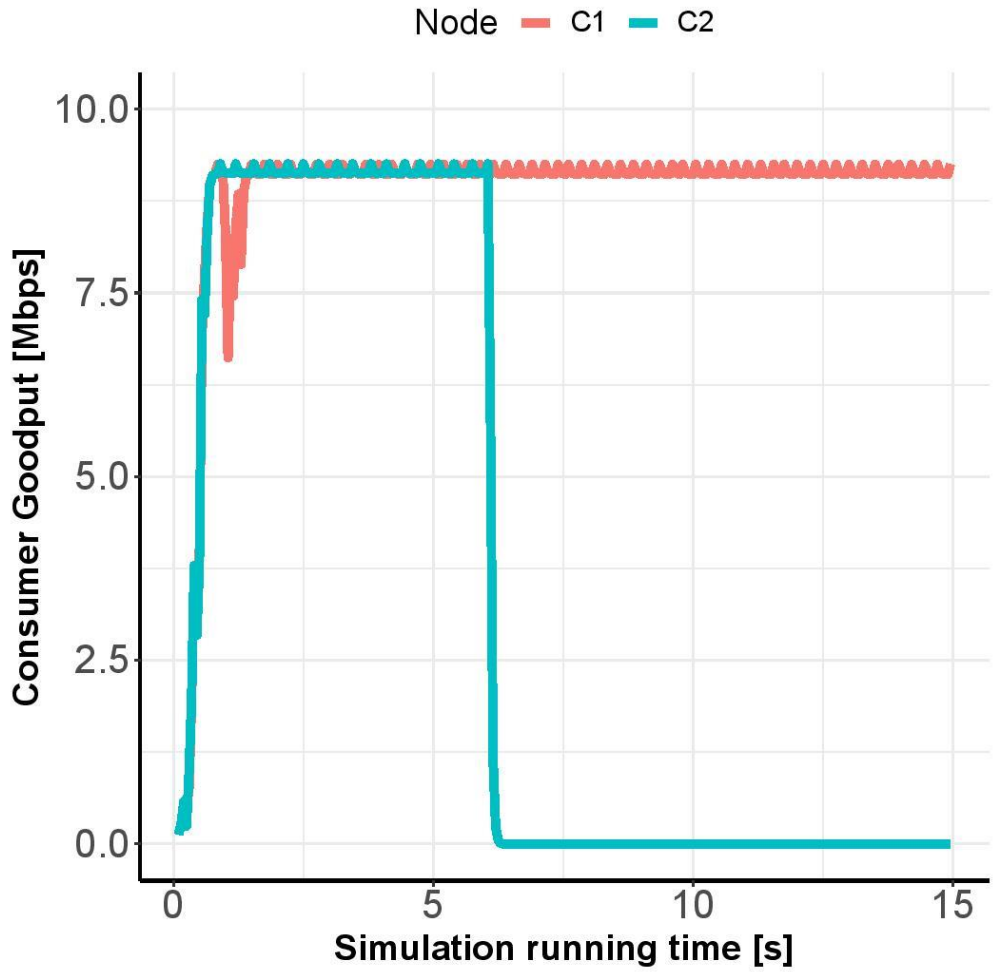
- Existing designs cannot handle partial network failures



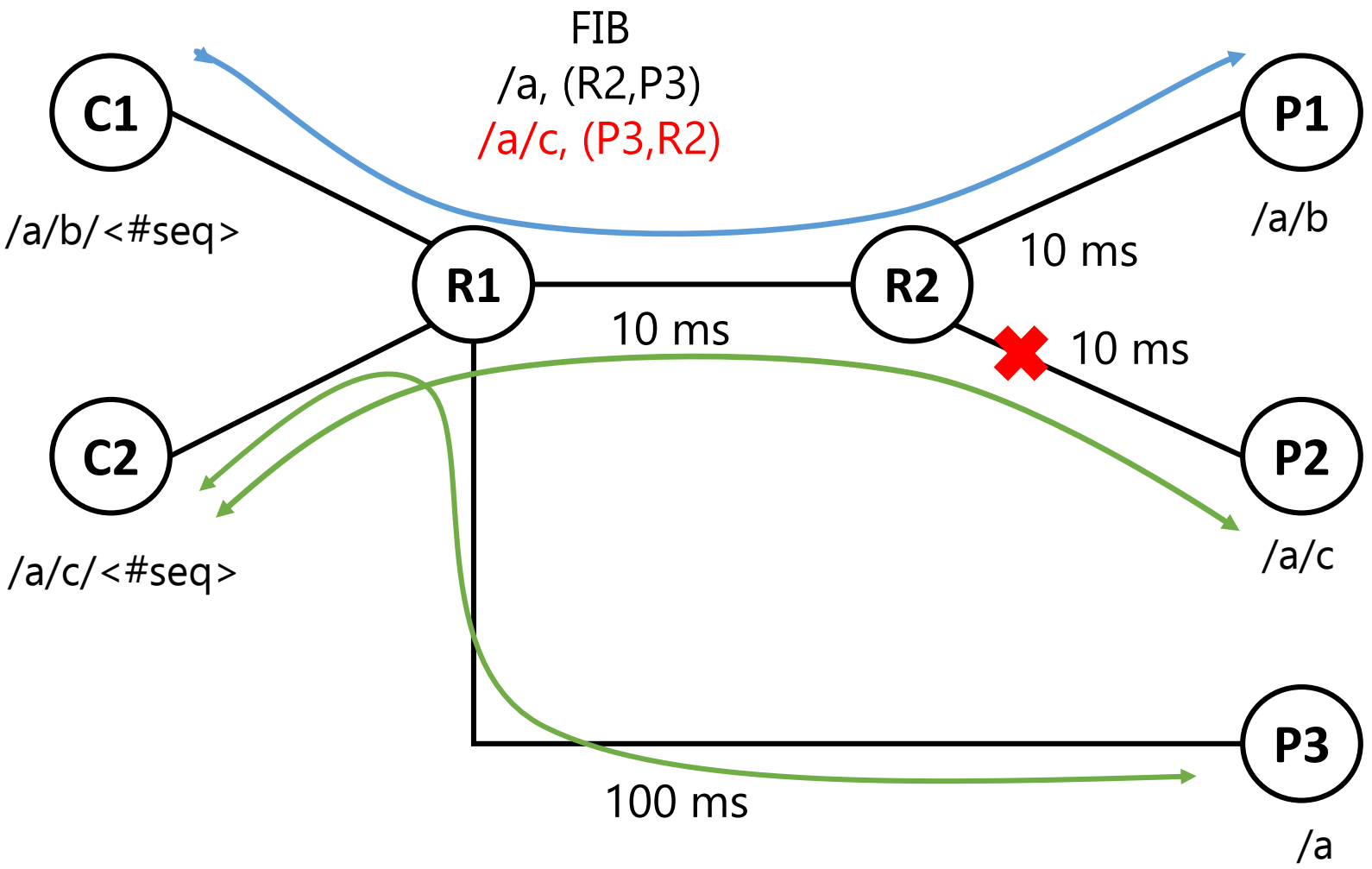
Simulation Results

- The scenario is simulated in ndnSIM



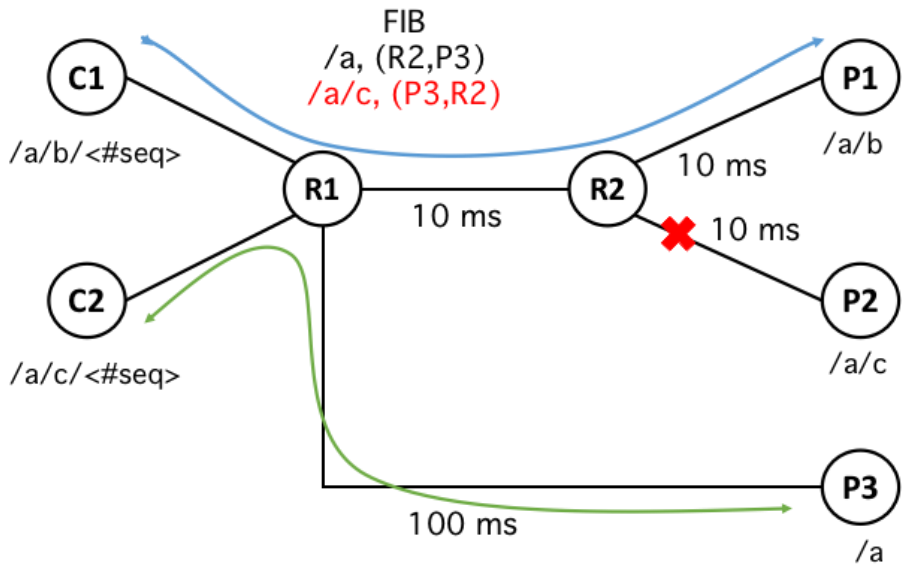


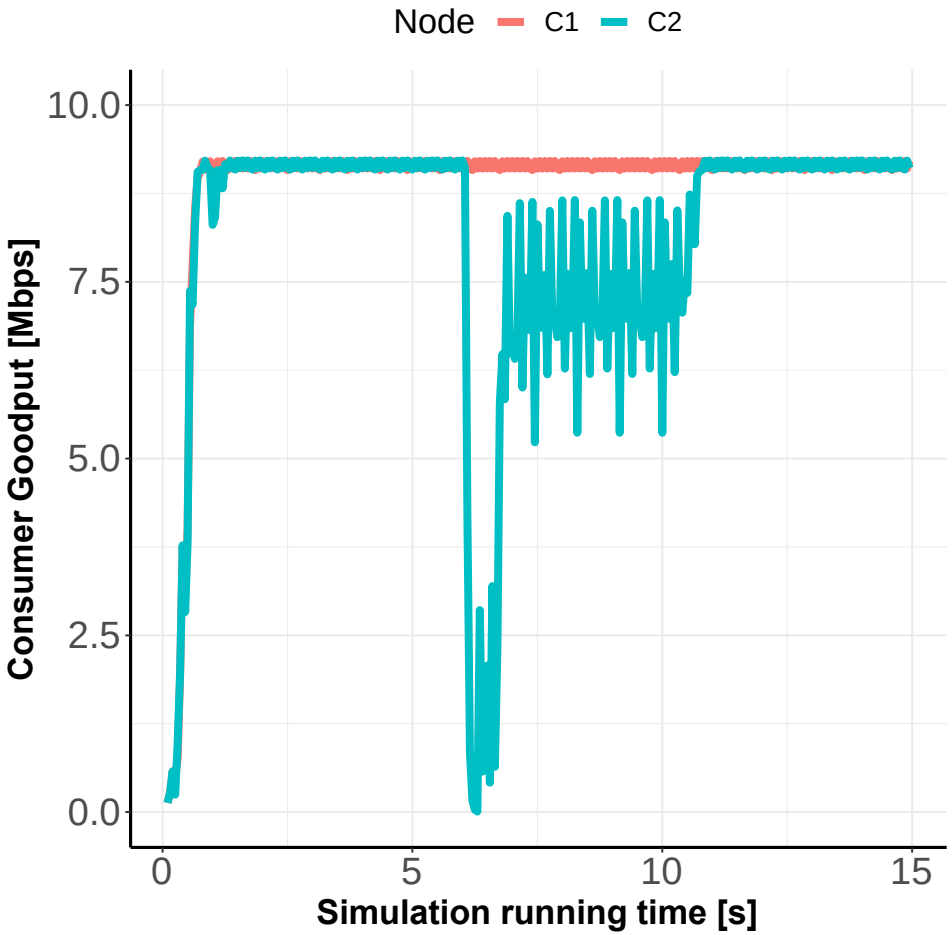
Dynamic FIB Expanding



Simulation Results

- The scenario is simulated in ndnSIM



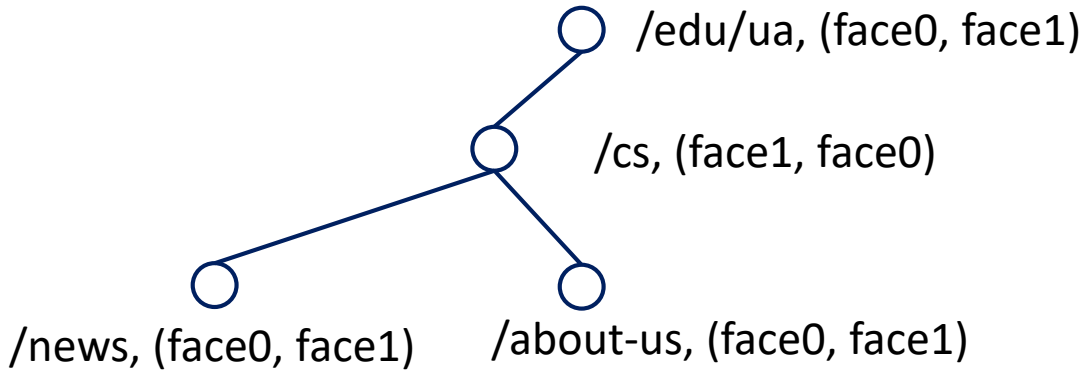


Dynamic FIB Expanding

- When to trigger FIB expanding:
  - when a new ranking of next hops is observed
- How to do FIB expanding?
  - Three different algorithms
- How to evaluate a FIB expanding algorithm?
  - Two metrics
- How to control/optimize FIB expanding?
  - Dynamic FIB collapsing mechanisms

The Top-down FIB Expanding Algorithm

FIB Name Tree



Path Ranking Observation

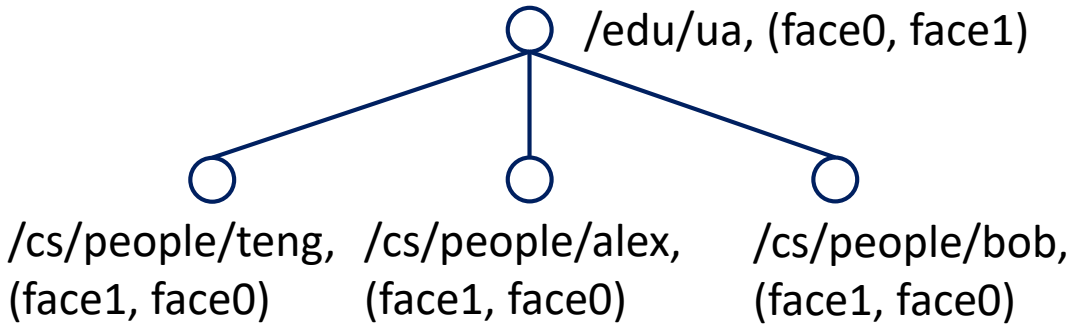
Interest/Data: /edu/ua/cs/people/teng/index.html
(face1, face0)

Interest/Data: /edu/ua/cs/news/index.html
(face0, face1)

Interest/Data: /edu/ua/cs/about-us/index.html
(face0, face1)

The Bottom-up FIB Expanding Algorithm

FIB Name Tree



Path Ranking Observation

Interest/Data: /edu/ua/cs/people/teng/index.html
(face1, face0)

Interest/Data: /edu/ua/cs/people/alex/index.html
(face1, face0)

Interest/Data: /edu/ua/cs/people/bob/index.html
(face1, face0)

Find the Shortest Name Prefix with the Solo Route Ranking (SS)

FIB Name Tree

/edu/ua, (face0, face1)

/cs/people/, (face1, face0)

Path Ranking Observation

Interest/Data: /edu/ua/cs/news/index.html
(face0, face1)

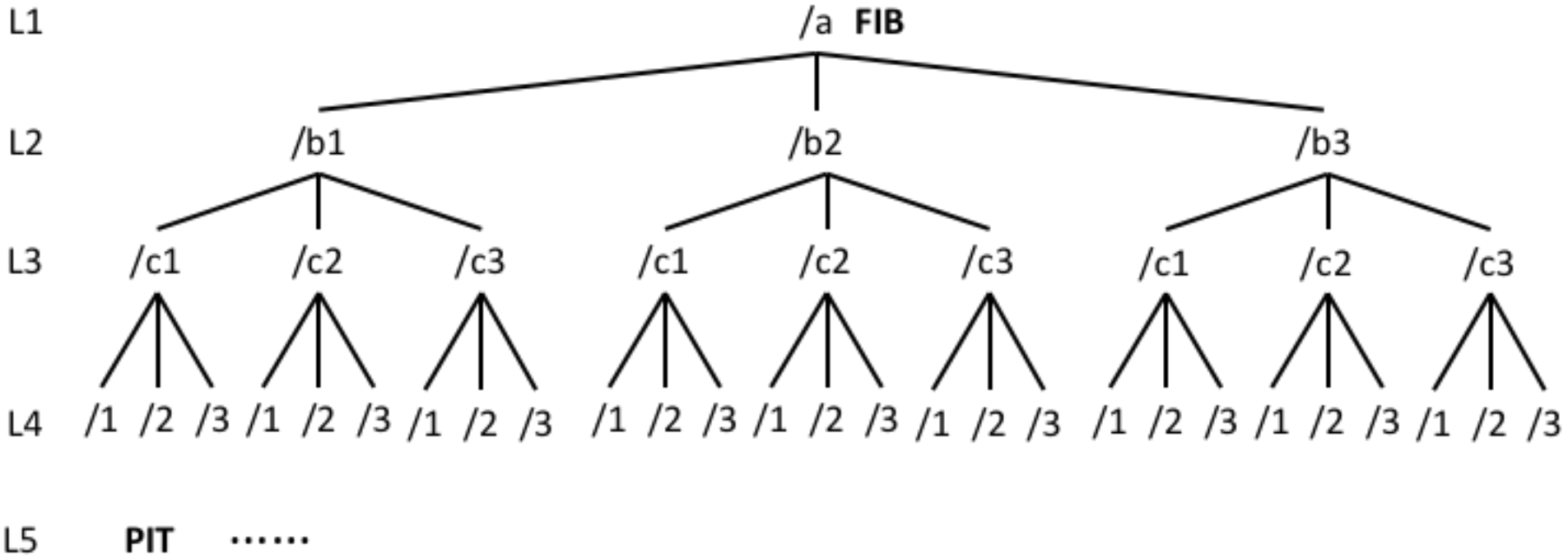
Interest/Data: /edu/ua/cs/people/teng/index.html
(face1, face0)

Evaluation Model

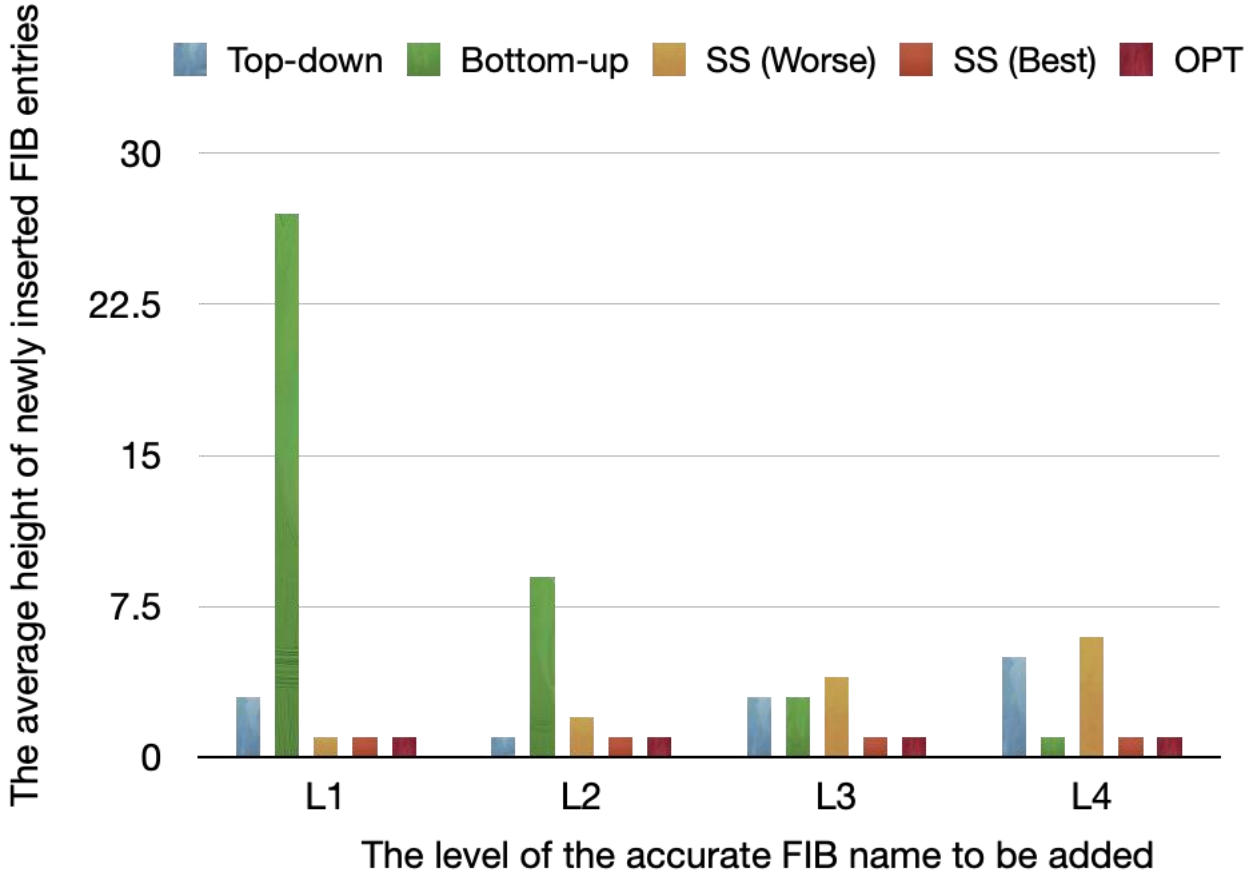
- Given a FIB name tree, an “accurate” FIB expanding name prefix, and a sequence of observed data names with route ranking
  - how many new FIB names are inserted
  - the length of newly inserted FIB names

Evaluation Details

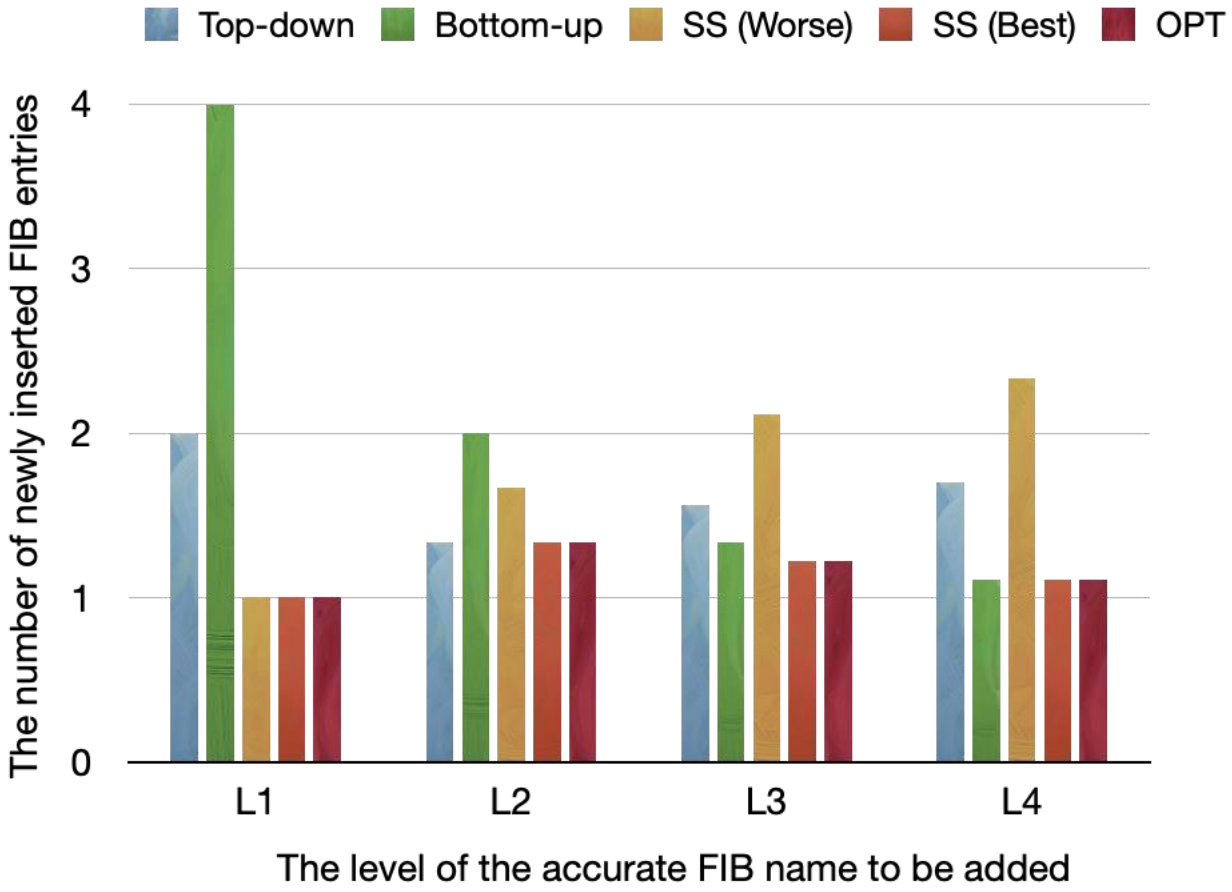
- Use 5-length 3-out-degree name tree
- Generate one “accurate” name prefix at different levels
- Randomly generate a sequence of data name and observed route ranking



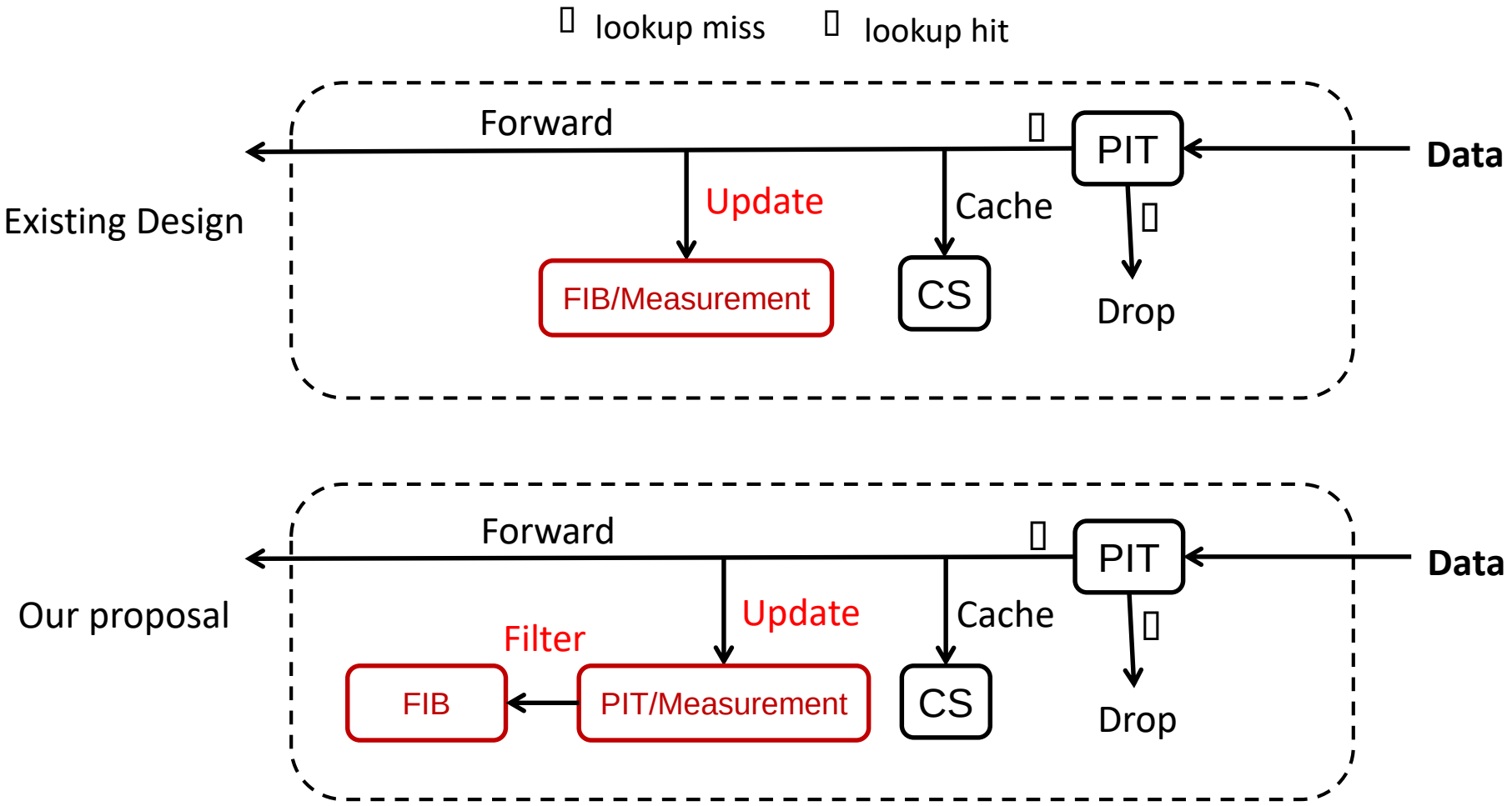
Metric 1: the Number of newly inserted FIB entries



Metric 2: the average height of the inserted FIB entries



Optimize NDN Adaptive Forwarding Processing



Summary

- The Prefix Granularity Problem:
  - To balance the trade-offs between Interest routing locality and FIB size
- Key ideas:
  - Dynamic FIB Expanding: disaggregating FIB names
  - Dynamic FIB Collapsing: aggregating FIB names
- Optimizing measurement management in Data processing to reduce FIB lookups.

Q/A

Thanks!