Coordinated Forwarding and Caching in Content Centric Networks

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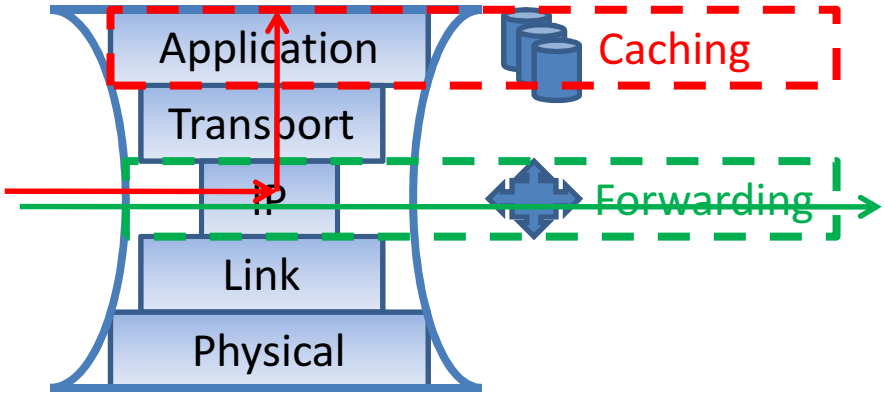
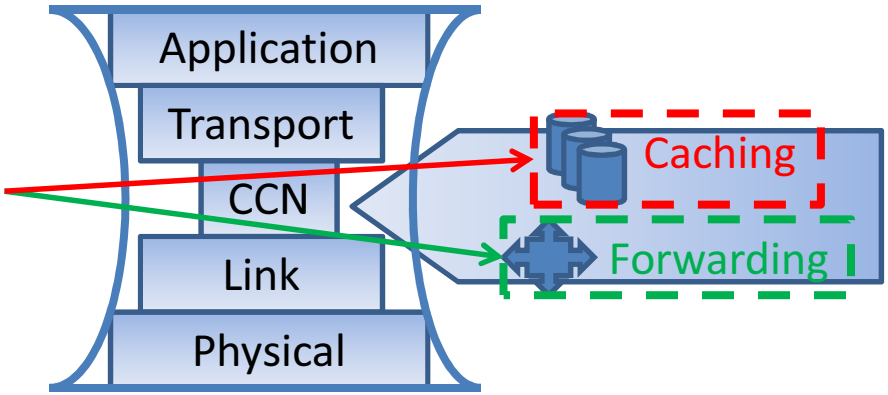
Forwarding & Caching in CCN

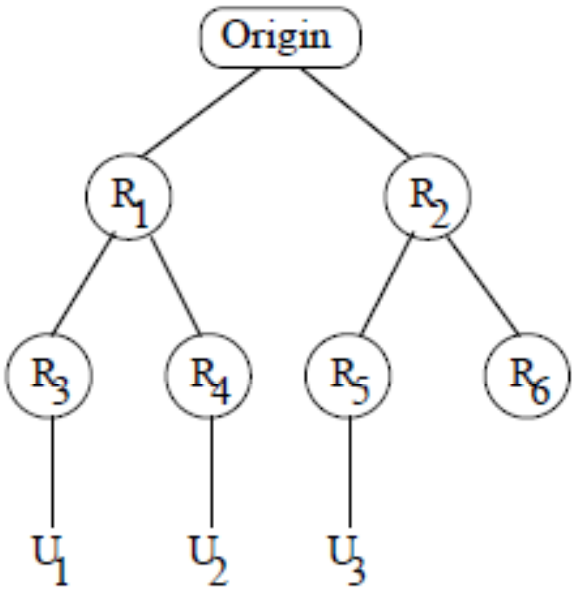


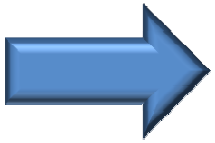
- Forwarding & Caching
  - Occurs at different layers
  - Unaware of each other
  - Mutual interactions: No

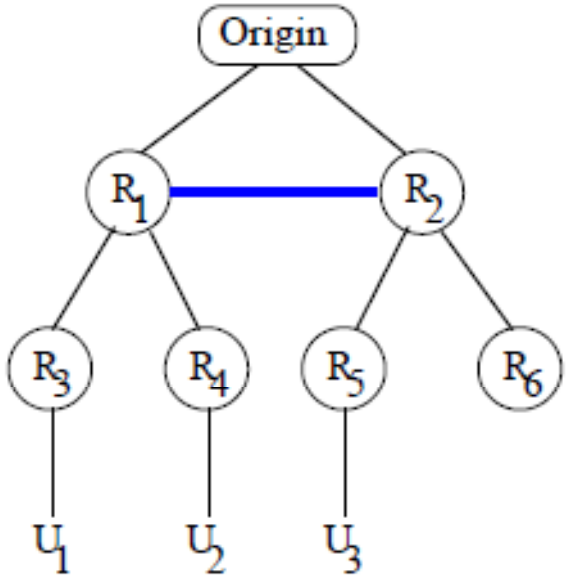


- Forwarding & Caching
  - Occurs at **same** layers
  - **Aware** of each other
  - Mutual interactions: **Yes**
- Let Forwarding & Caching be ***coordinated!***

A Motivating Example



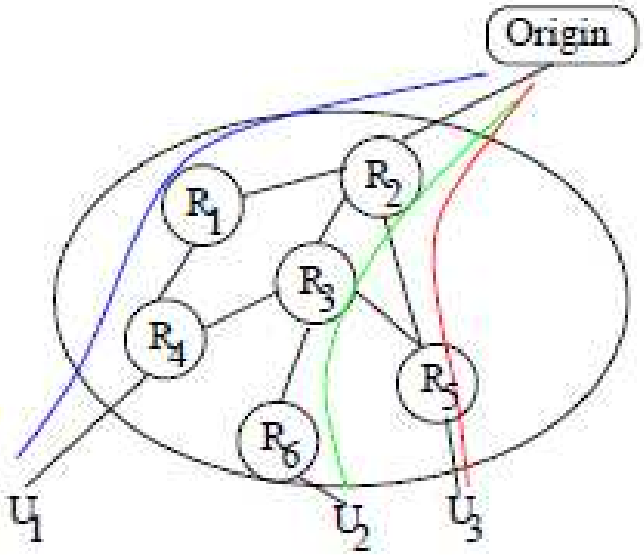


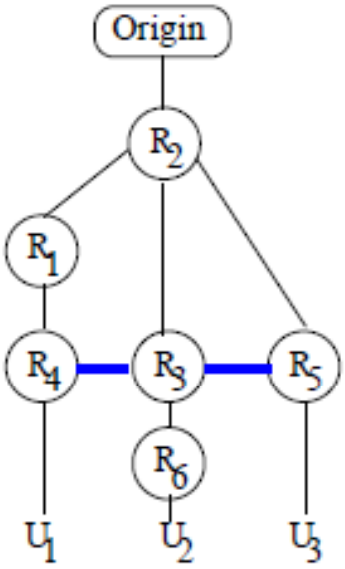


- Routing tree is a simplified view of the network, missing important details

- Routing "mesh" is a more realistic view of the network, disclosing more details

A Motivating Example (*cont'd*)





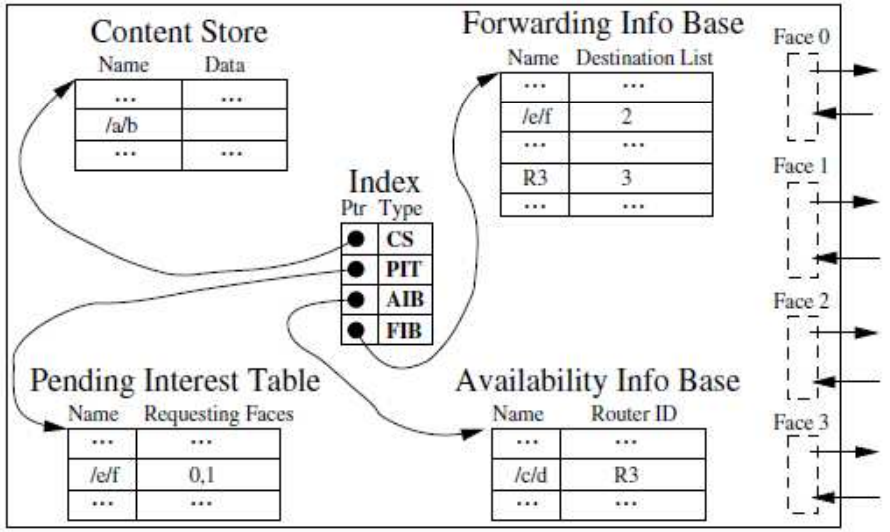
- Intradomain topology is more like a mesh
- In mesh-like topologies, "horizontal" links could be leveraged to allow caching-aware routing

Coordinating Caching & Forwarding

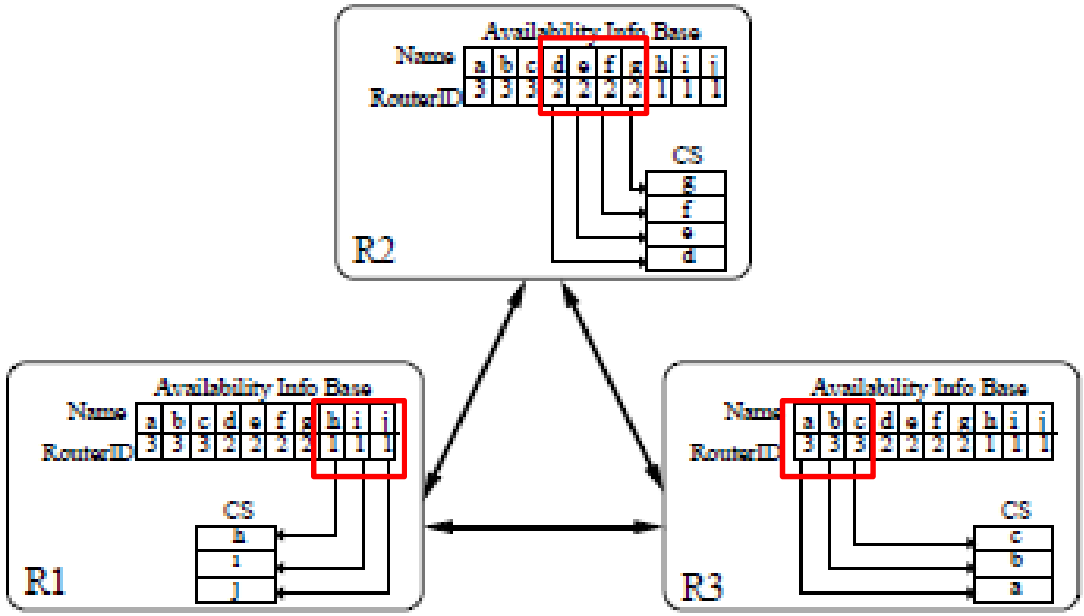
- Key ideas
  - Let Interest drive where data should be temporarily cached (on the fly)
  - Make such availability information (temporarily cache) accessible by all routers
    - Network-wide OSPF-like announcement does NOT work!
  - Address inconsistencies of interest-driven caching
  - Dual-segment, self-adaptive algorithm to improve efficiency of content store

Coordinating Caching & Forwarding

- FIB consists of
  - Name-based routing
    - which face(s) should be used to reach a given content
  - Infrastructure routing
    - which face(s) should be used to reach a given router
- Availability Info Base
  - Which router(s) a given content is supposed to be available from
- FIB and AIB could be merged

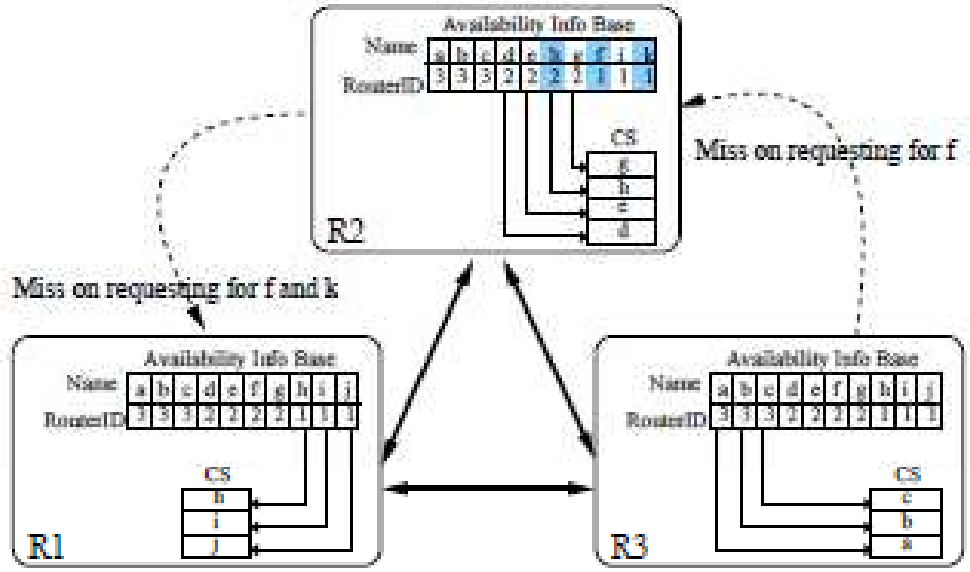


Leverage Content Popularity Info



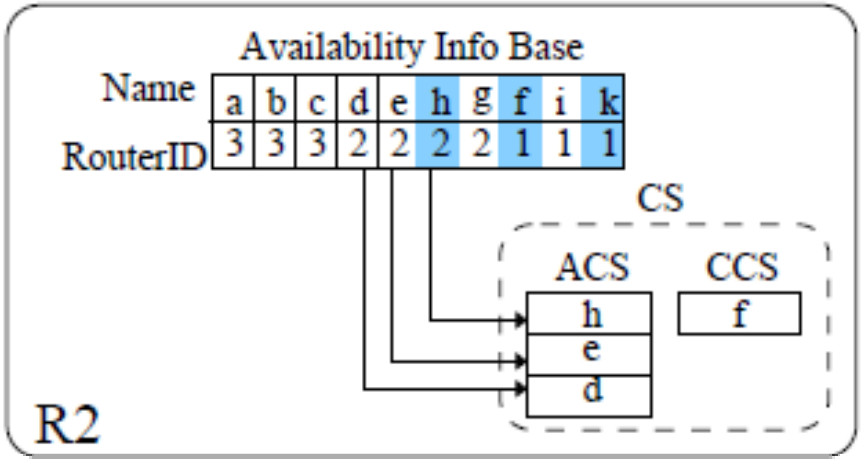
- Assume that all routers share content popularity information
  - Will cope with inconsistencies later
- Each router can decide what content it should cache locally
  - Store ranking sequence in “Availability Info Base” (AIB)
  - Chose the set of content that have the minimum “cost” in the ranking sequence, fill up its content store (optimality proof in the paper)
    - Cost information is available through OSPF announcements

Handle Inconsistency



- Inconsistent popularity can lead to inefficiency
  - R2's actual popularity is different from R3's
    - R3 thinks R2 has content f, but actually R2 does not!

Handle Consistency (*cont'd*)



- Divide the content store into two parts
  - Part 1 corresponds to normal popularity ranking
  - Part 2 corresponds to "abnormal" inconsistent popularity ranking
    - ACS Misses on requests forwarded from peer routers suggest that a content be abnormal
- Design two-segment, self-adaptive algorithm to dynamically adjust the boundary between ACS/CCS
  - See our paper for details

Summary

- Consider cache availability in forwarding in CCN
  - Which maximally leverages in-network cache capability
- Extend router architecture to support coordinated forwarding and caching
- Dual-segment algorithm for optimizing the effectiveness

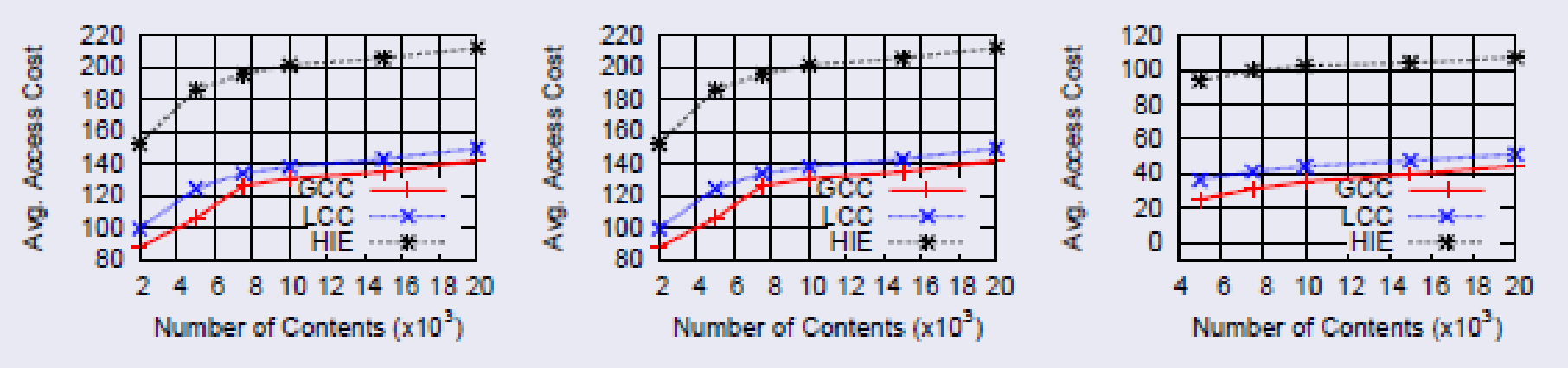
Thank You!

Backup Slides

Evaluations

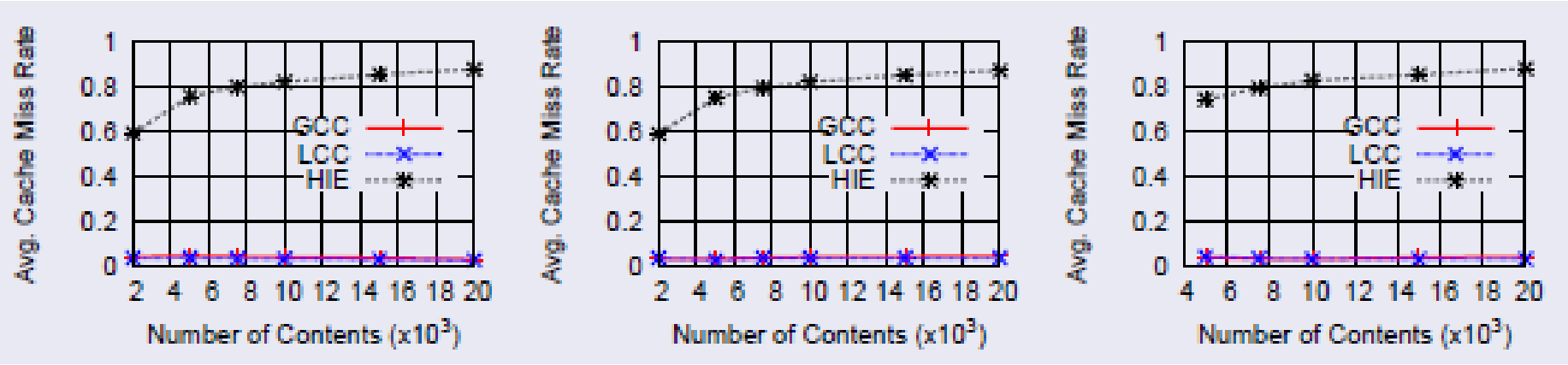
- Algorithms
  - Global coordinated caching (GCC)
  - Local coordinated caching (LCC), a localized version of GCC
  - Hierarchical coordinated caching (HIE)
- Methodology
  - Simulation on real network topologies
  - Topologies: Abilene, GEANT, CERNET
- Metrics
  - Average access cost
  - Miss ratio

Average Access Cost



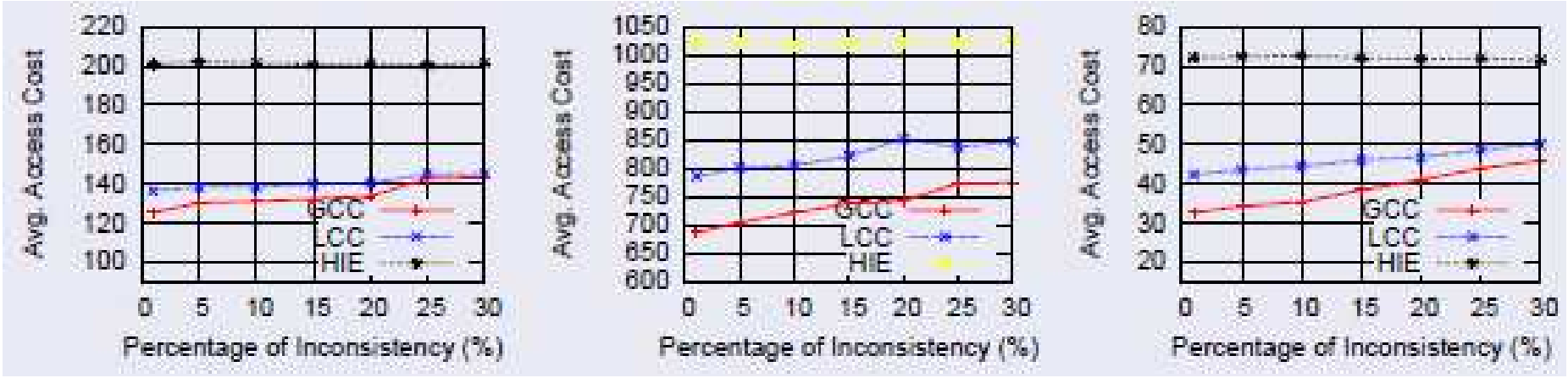
- GCC/LCC are significantly better than HIE
- LCC is very close to the performance of GCC
  - In practice, LCC incurs lower control overhead and thus is preferable

Average Miss Rate



- GCC/LCC's miss rates are significantly lower than HIE
- Miss rates of GCC/LCC have negligible differences
  - LCC is more preferable due to lower overhead

Impacts of Inconsistency



- Inconsistency has no impacts on HIE (of course no!)
- Average access cost by GCC/LCC increases gradually when inconsistency level increases
  - Increase in access cost is low