A Native Content Discovery Mechanism for NDN

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Outline

- Content discovery
- Opportunistic Off-path Content Discovery
- Forwarding Strategies
- Results
- Future Work &Conclusions

Content Discovery

Content Discovery

- **Goal: Retrieve a nearby (ideally the nearest!) copy of the content**
  - Difficult to achieve without significant ``**overhead**'' in practice
- **Why?**
  - Placement of Data into the Content Stores happens frequently
- **What does NDN/CCN do?**
  - Route Interests to content origins
  - Search content opportunistically ***on-path*** (i.e., along the default path)
- Existing Solutions for Content Discovery:
  - **Opportunistic on-path**
  - **Coordinated off-path**

Content Discovery

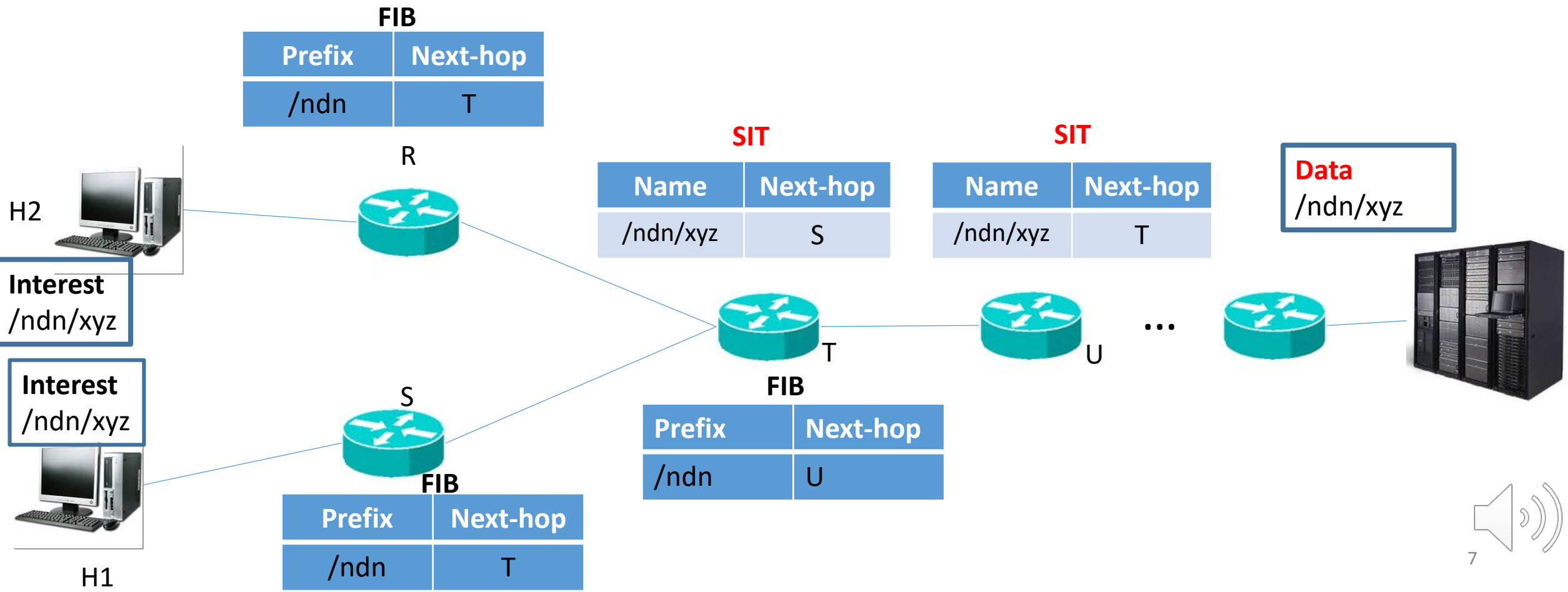
- **Opportunistic on-path:** *limited gain, without overhead*
- **Coordinated off-path:** *coordination and communication overhead*
  - ***Using control plane:*** *Advertise content names*
  - ***Using a function:*** *A Hash function determines the placement and routing*
  - *…*

- **What do we propose?**
  - **integrate an "opportunistic off-path content discovery mechanism" to the existing Interest/Data processing pipeline of NDN**
    - With minimal changes to NDN packet processing
    - Without introducing excessive overhead

Opportunistic Off-path Content Discovery

Opportunistic off-path Content Discovery

- **Satisfied Interest Table (SIT): Caches** trails of Data packets



Forwarding Strategies with FIB & SIT

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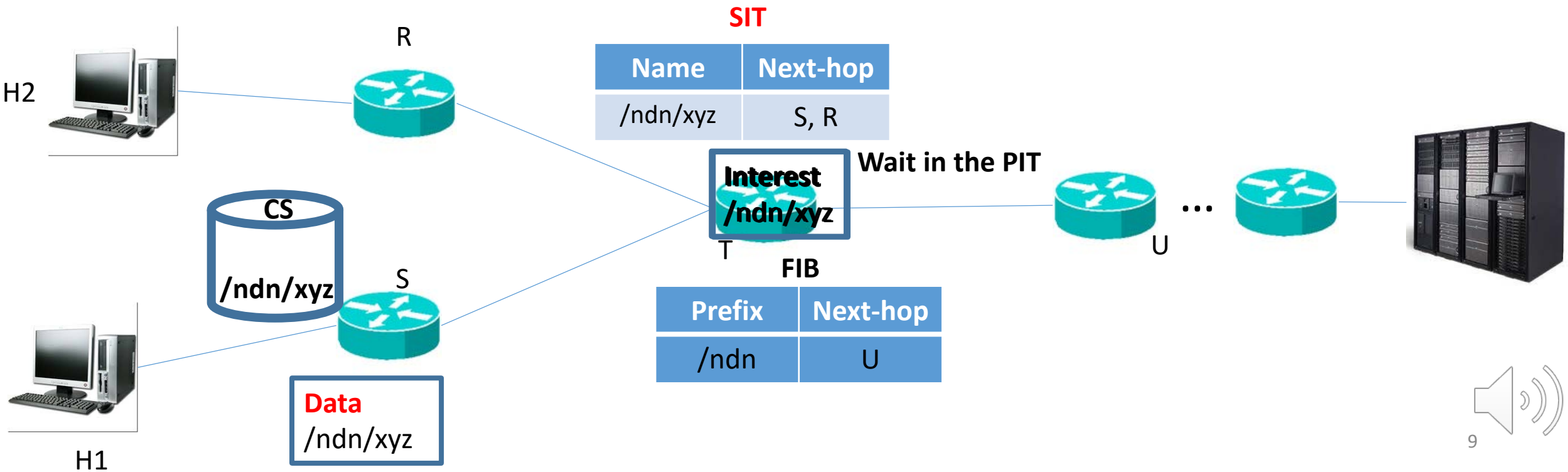
- **Breadcrumb**



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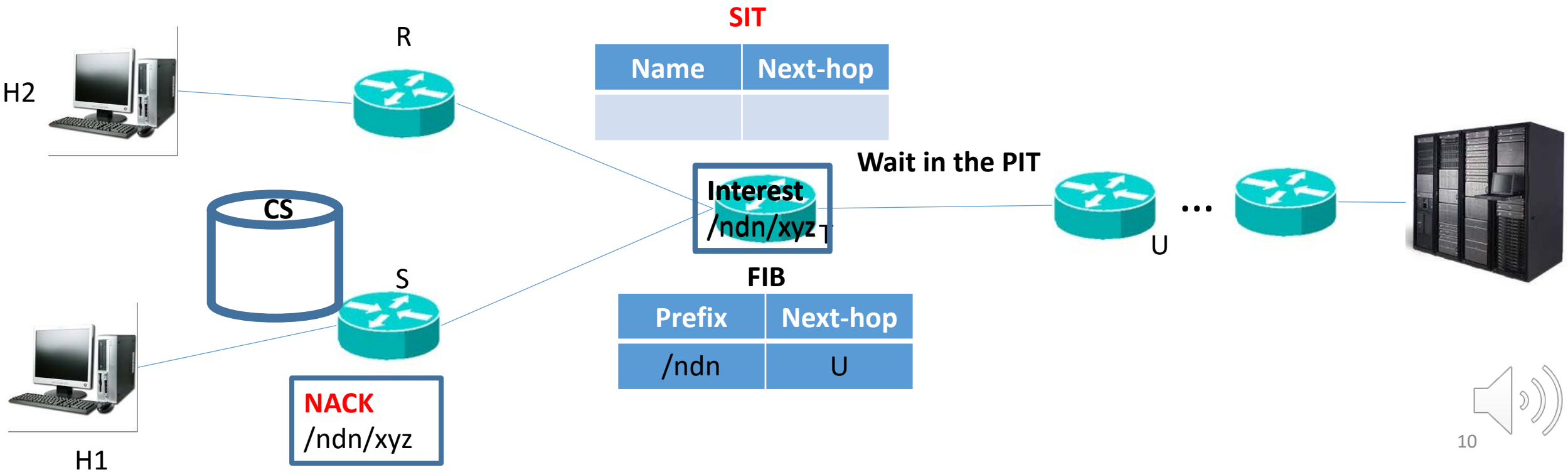
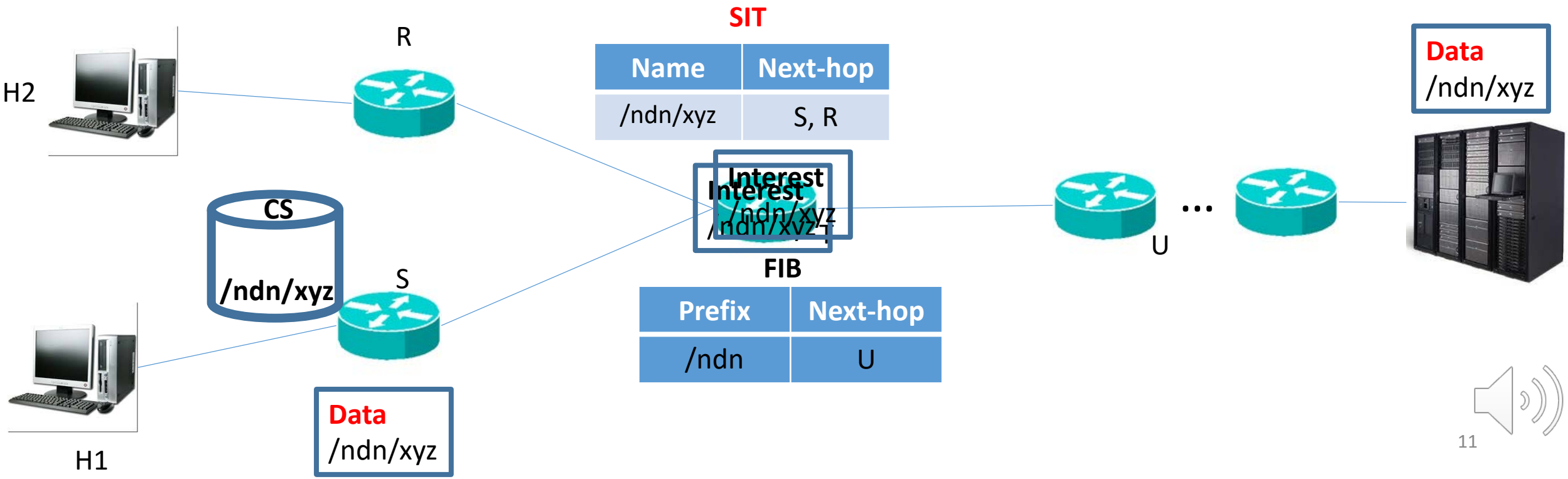


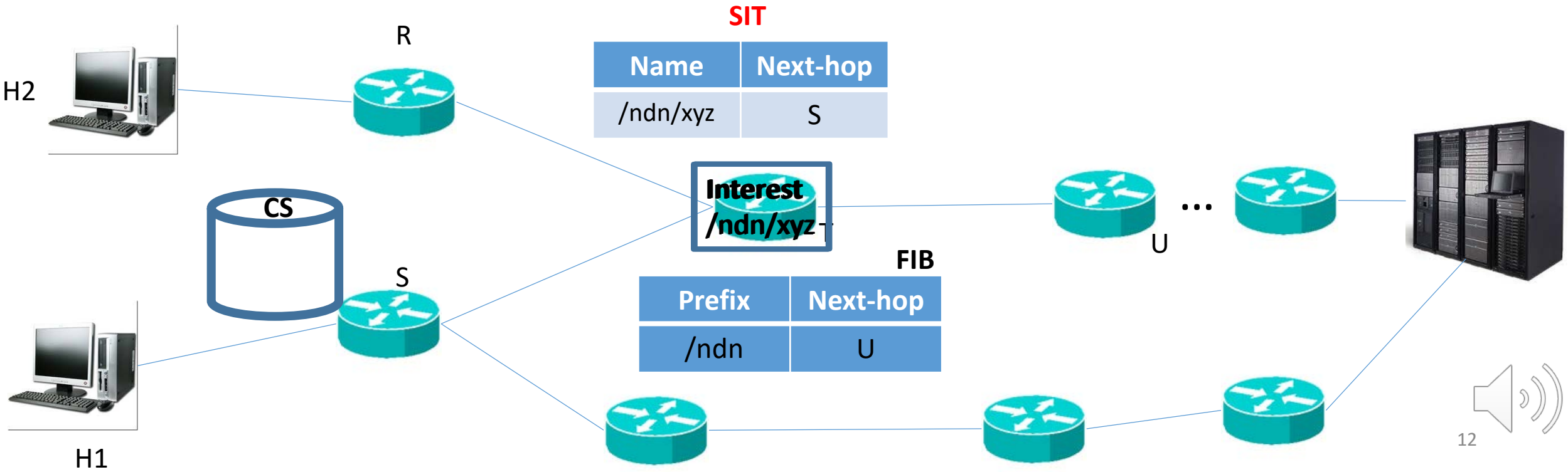
Forwarding Strategies with FIB & SIT

- **Multicast**



Forwarding Strategies with FIB & SIT

- **Multicast:** Once forwarded downstream, an Interest follows a single SIT trail
- **Forwarding Strategy:** **Pick the freshest matching SIT entry**



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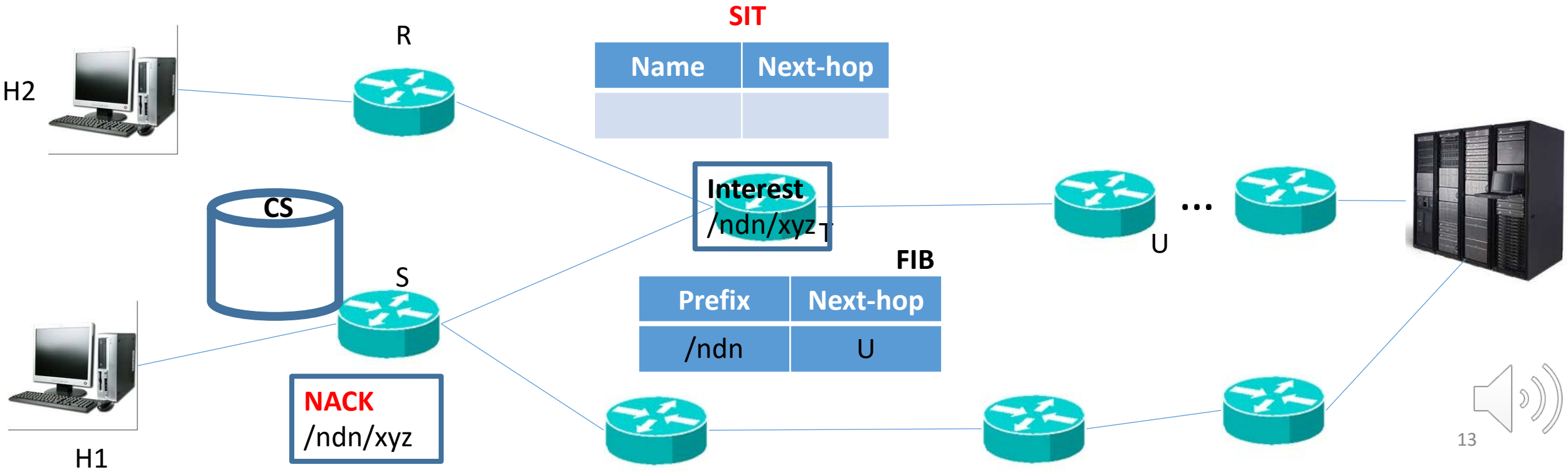
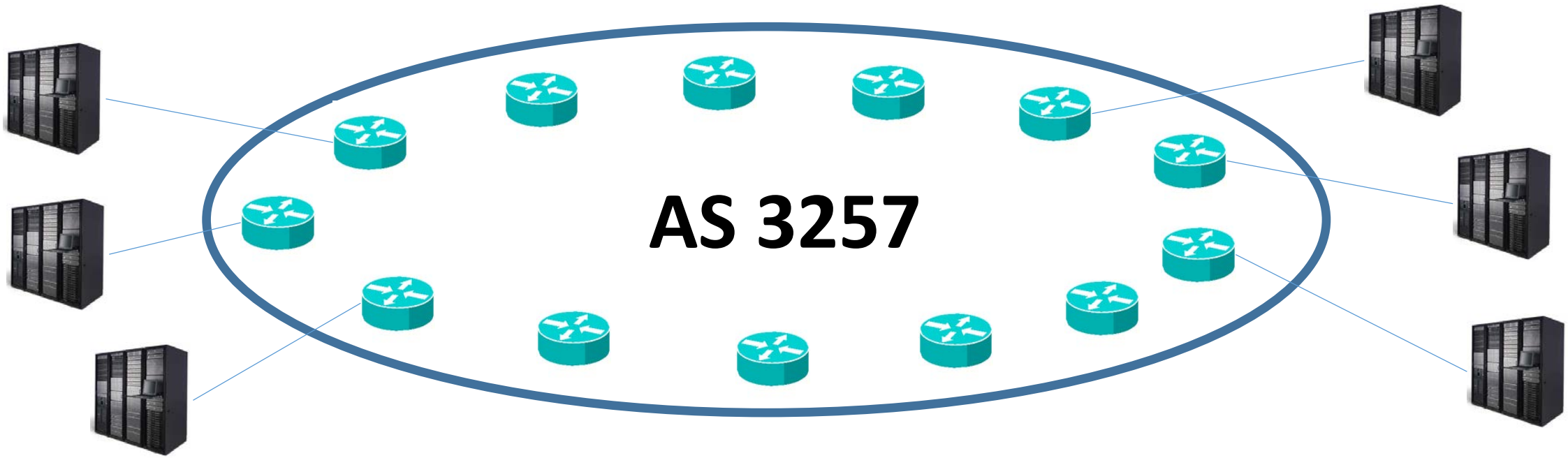


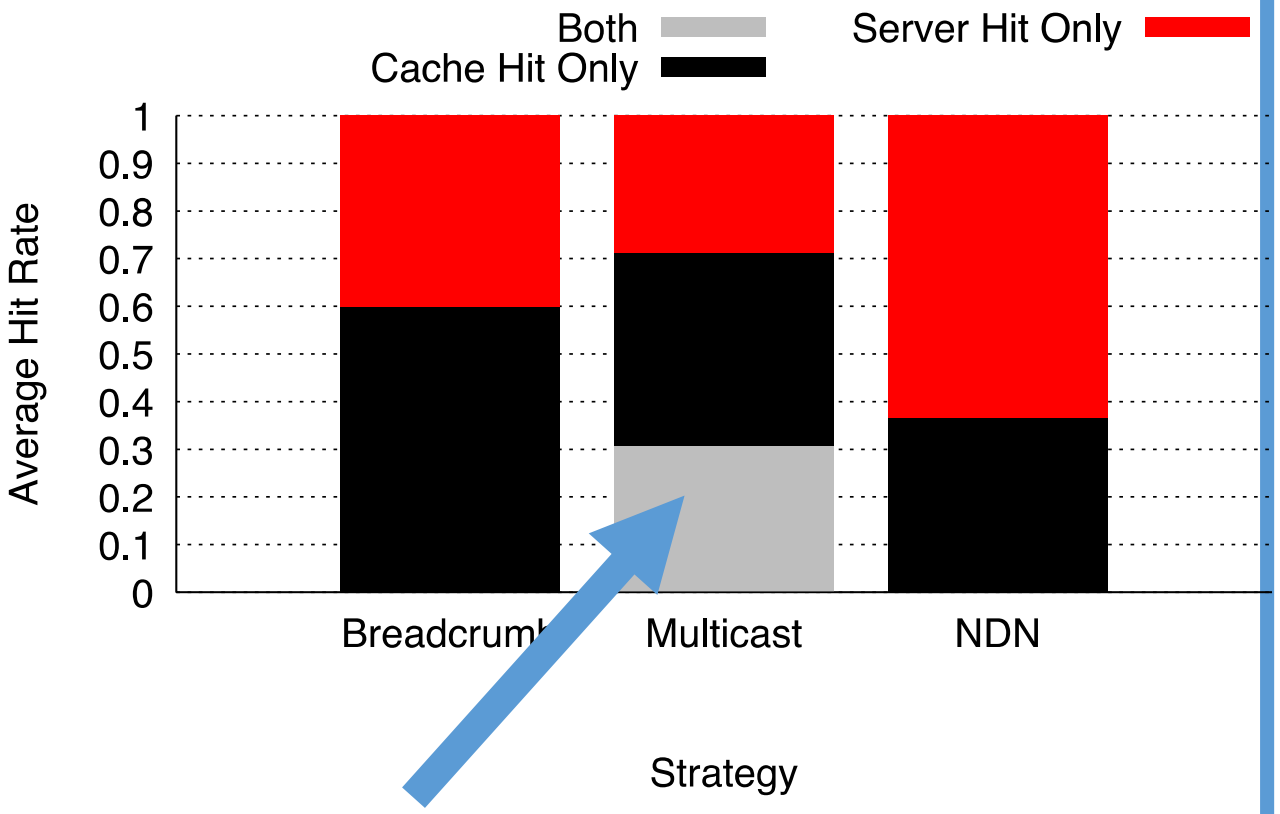
Results - Multicast and Breadcrumb Strategies

Results- Settings

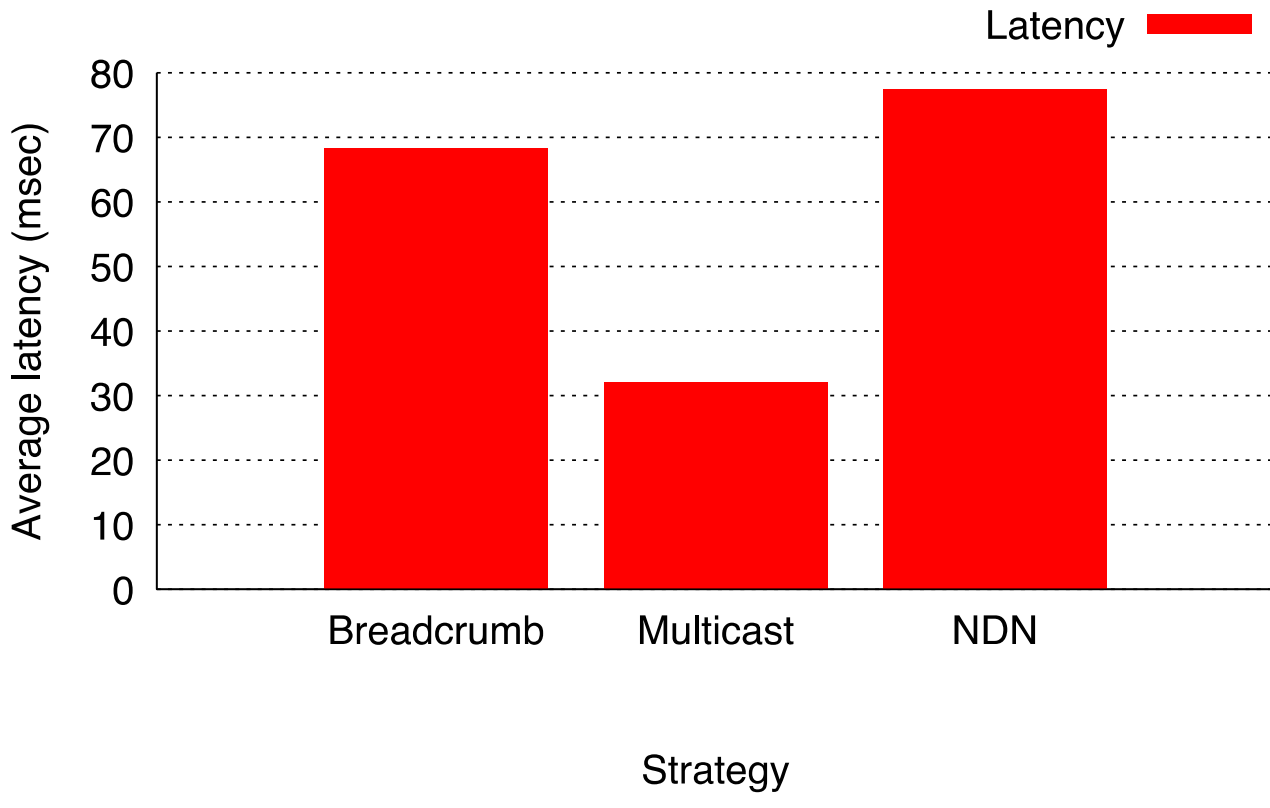
- **Topology**: Rocketfuel ISP topology
- **Content Providers**: Attached to 16 egress nodes are randomly chosen
- **Link Latencies:** Penalty for leaving ISP network: extra **50-100 msec**
- **Network Cache Capacity**: %80 of content can be cached in the network
- **Request Rate**: 100 Requests/sec (origins selected randomly)
- **Popularity Distribution**: Zipf Parameter 0.7
- **Experiment Duration:** 1 Hour warm-up and 3 hours of experiment



Results with Breadcrumb & Multicast



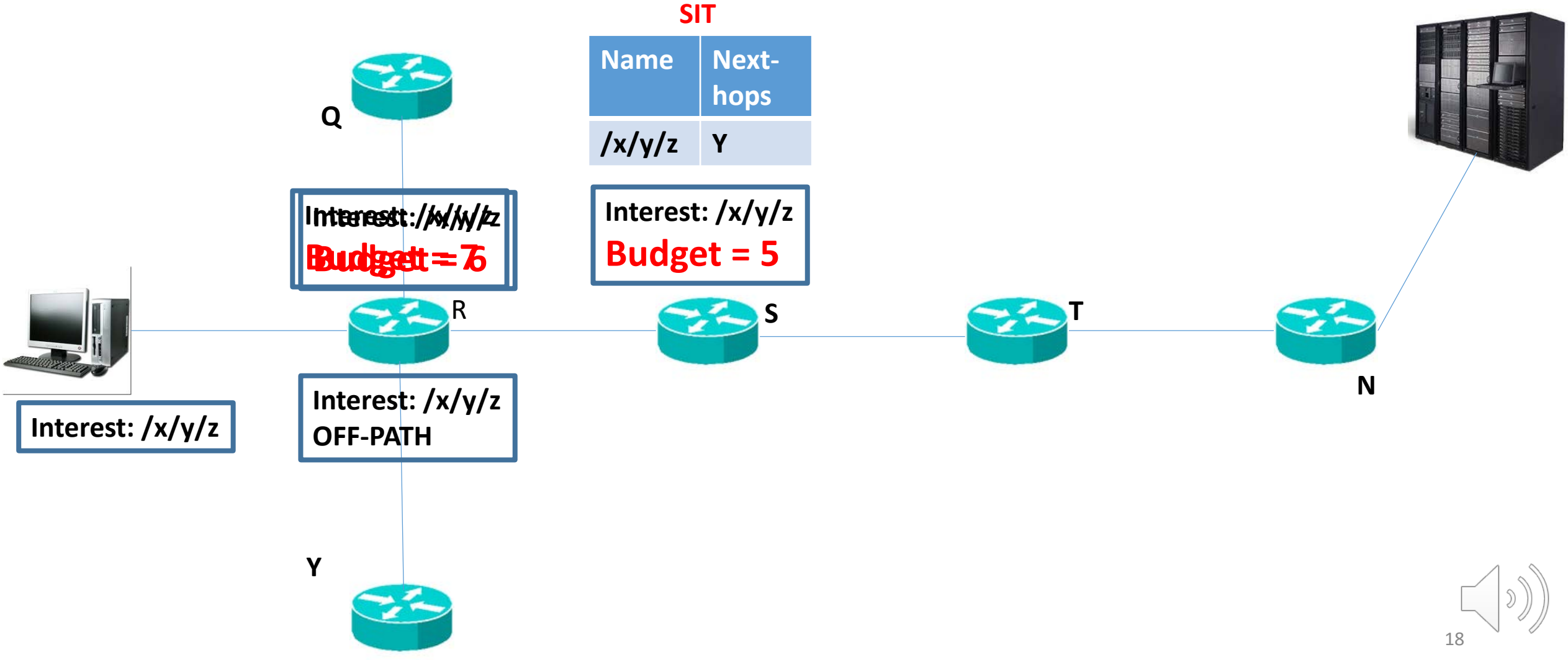
Overlap



Results

- **Modified Multicast Strategy:**
  - Each Interest is associated with a ***Forwarding Budget***
    - spend the budget on:
      - sending a copy upstream (following FIB)
      - sending a copy downstream (following SIT)
      - spend it on both
  - **Cost** of sending Interest upstream/downstream
    - **Static**: Deduct one unit per each copy sent downstream.
    - ***Dynamic*****:** Deduct variable amount per each copy sent downstream

Multicast with Forwarding Budget (Static)



Results - Multicast with Forwarding Budget

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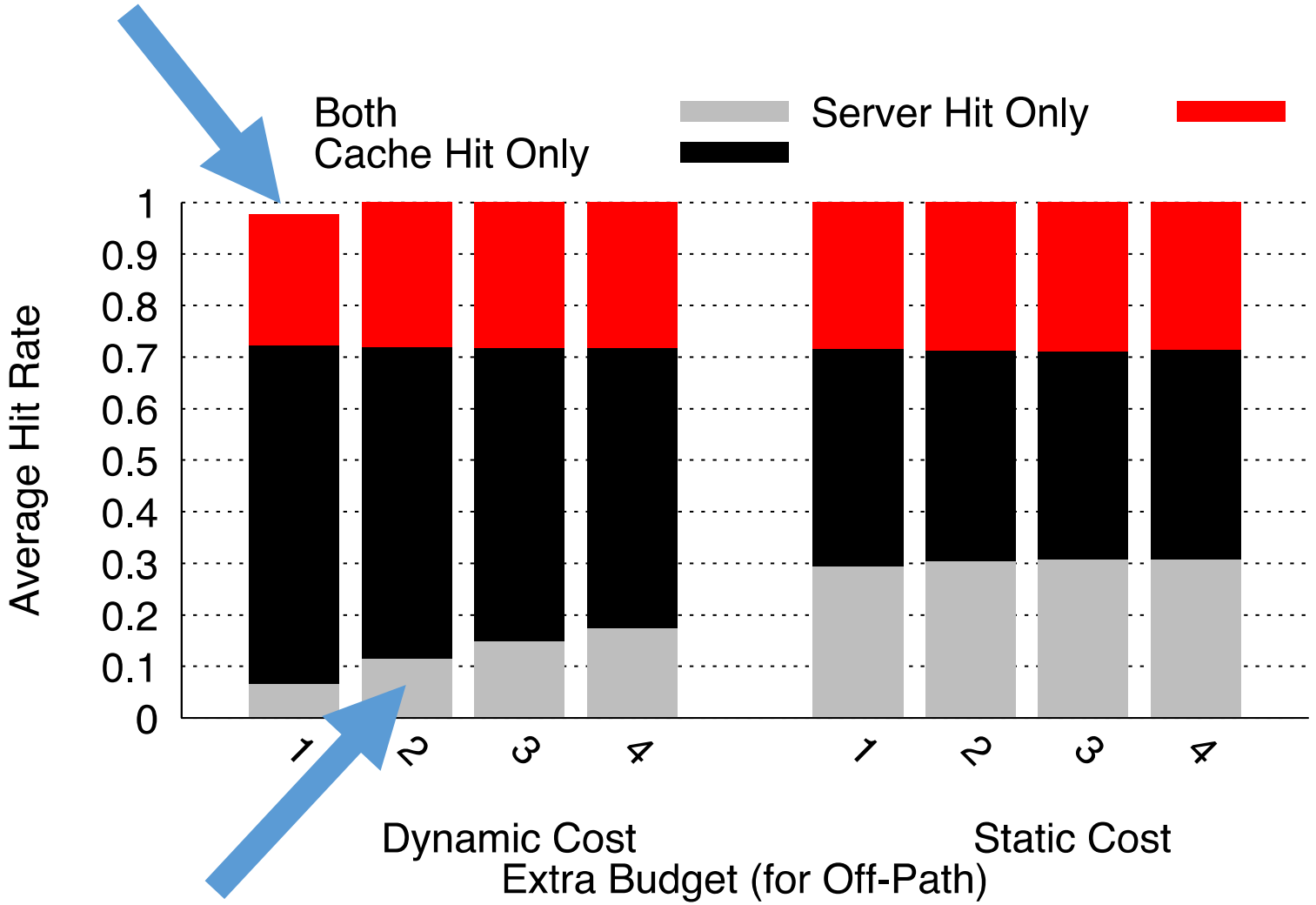
Satisfaction



Overlap

Conclusions

- Opportunistic content discovery using **SIT table**
  - Significant increase in the percentage of requests satisfied from the caches
- Forwarding strategies using SIT/FIB are introduced
  - Possible to limit the overhead with a Forwarding Budget and Dynamic Costs
  - Requires minimal changes to the packet processing of NDN
- Security
  - End-user/host caches are not exploited by the mechanism
  - *Exclude* field can be used to ignore matching SIT entries
  - Our scheme inherits the existing cache poisoning problems with NDN

Thank you!

Questions?