Content Discovery and Delivery in MobilityFirst

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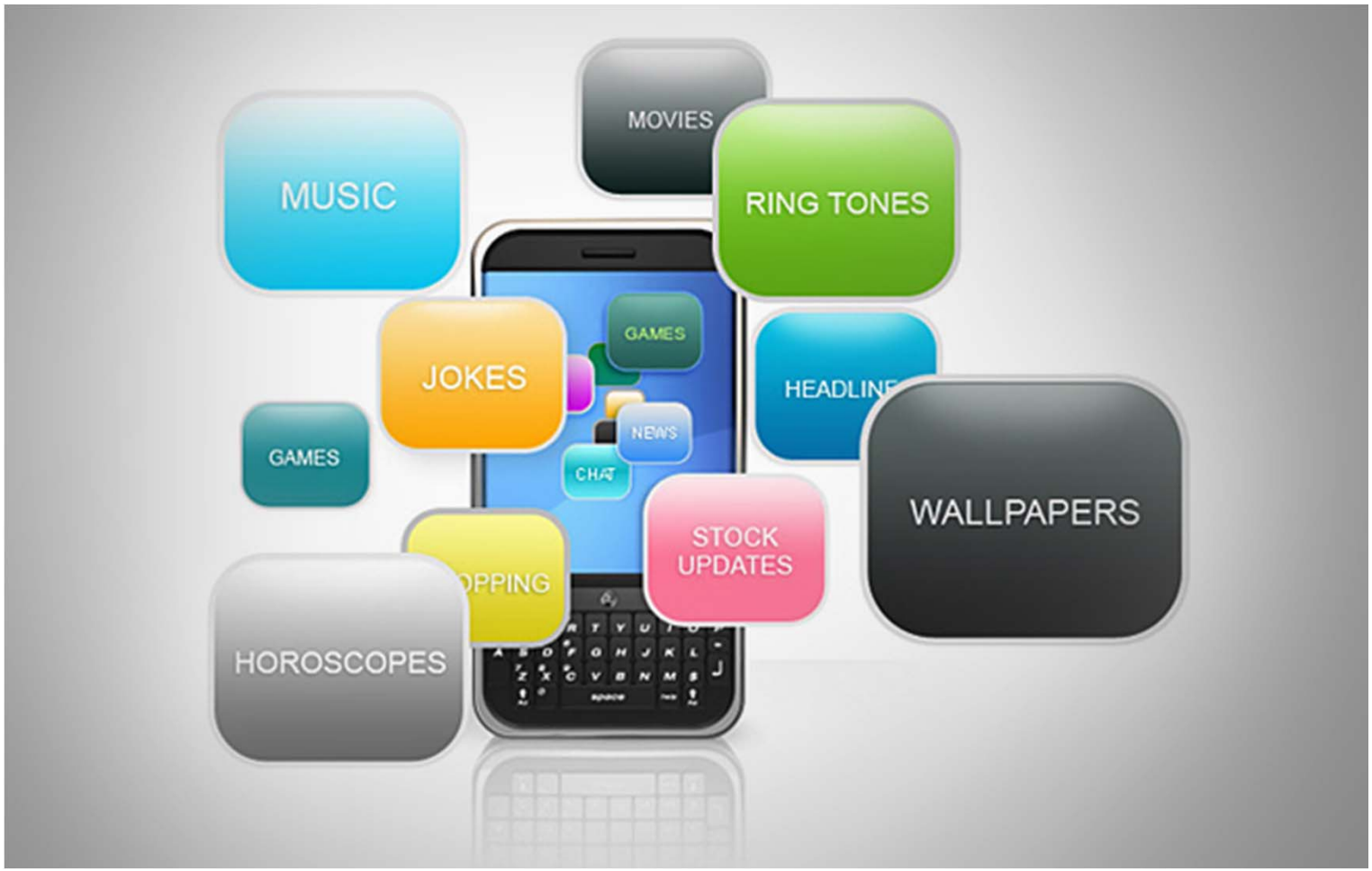
Content Statistics on Today's Internet

- **YouTube**
  - **60 hours of video are uploaded every minute**
  - **Over 4 billion videos are viewed a day**
- **Netflix**
  - **23 millions of Netflix streaming subscribers**
- **Pandora**
  - **Number of archived titles: 30,504 (3/27/2012)**
  - **Number of archived files: 140,891,755**
  - **4th most popular iphone app**
    - **A new listener every two seconds**

Mobile Data Usage Forecast

- **Mobile data [Cisco Visual Networking Index]**
  - **Global mobile data traffic grew 2.3 fold in 2011**
    - **More than doubling for the fourth year in a row**
  - **By the end of 2012, the number of mobile-connected devices will exceed the number of people on earth.**
- **Mobile cloud traffic**
  - **Mainly medium**
  - **Mobile cloud traffic will grow 28 fold from 2011 to 2016, will account for 71% (7.6 exabyets / month) of total mobile data traffic in 2016**

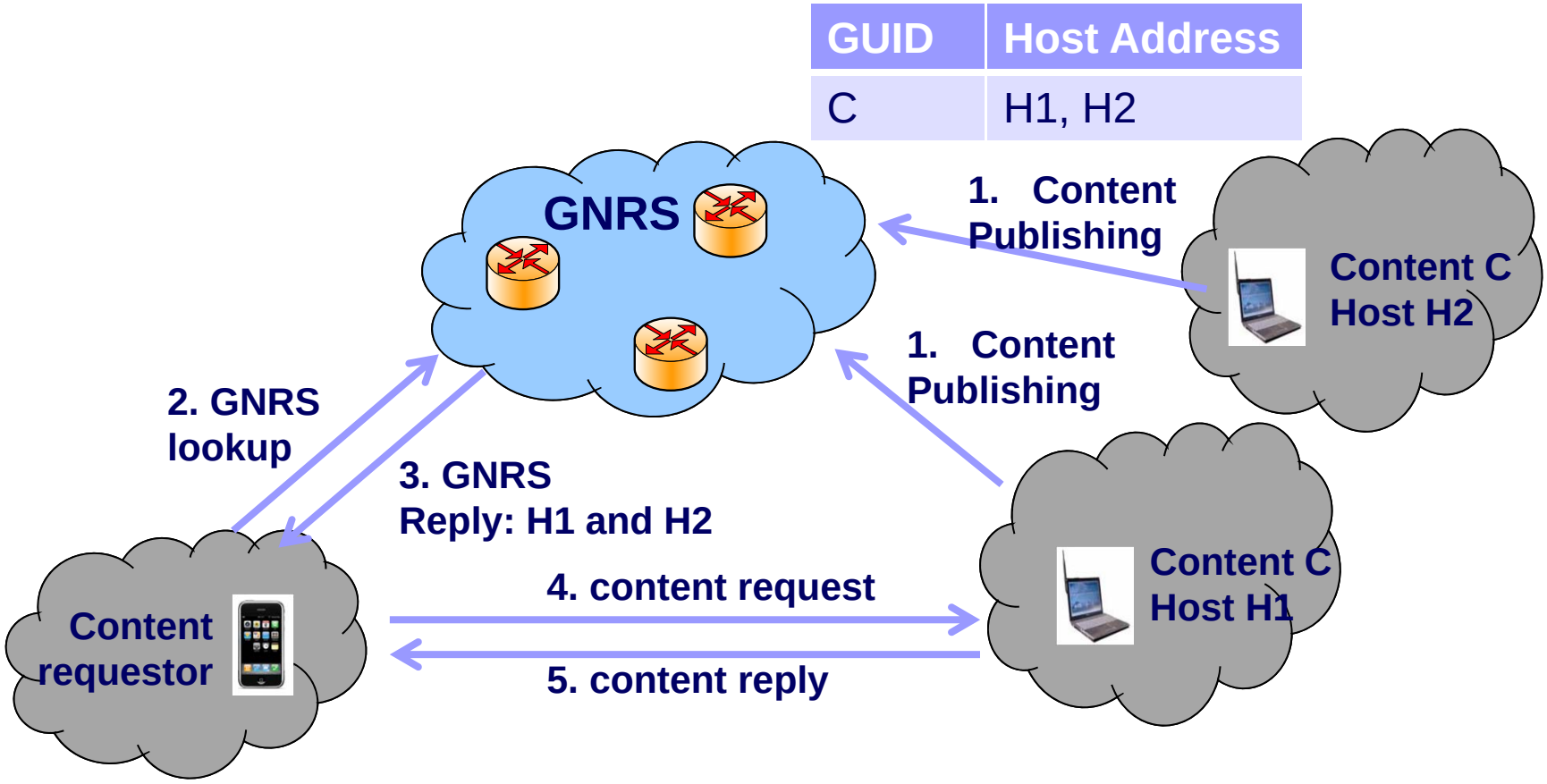
Supporting Content in Future Internet



Content Services in MobilityFirst

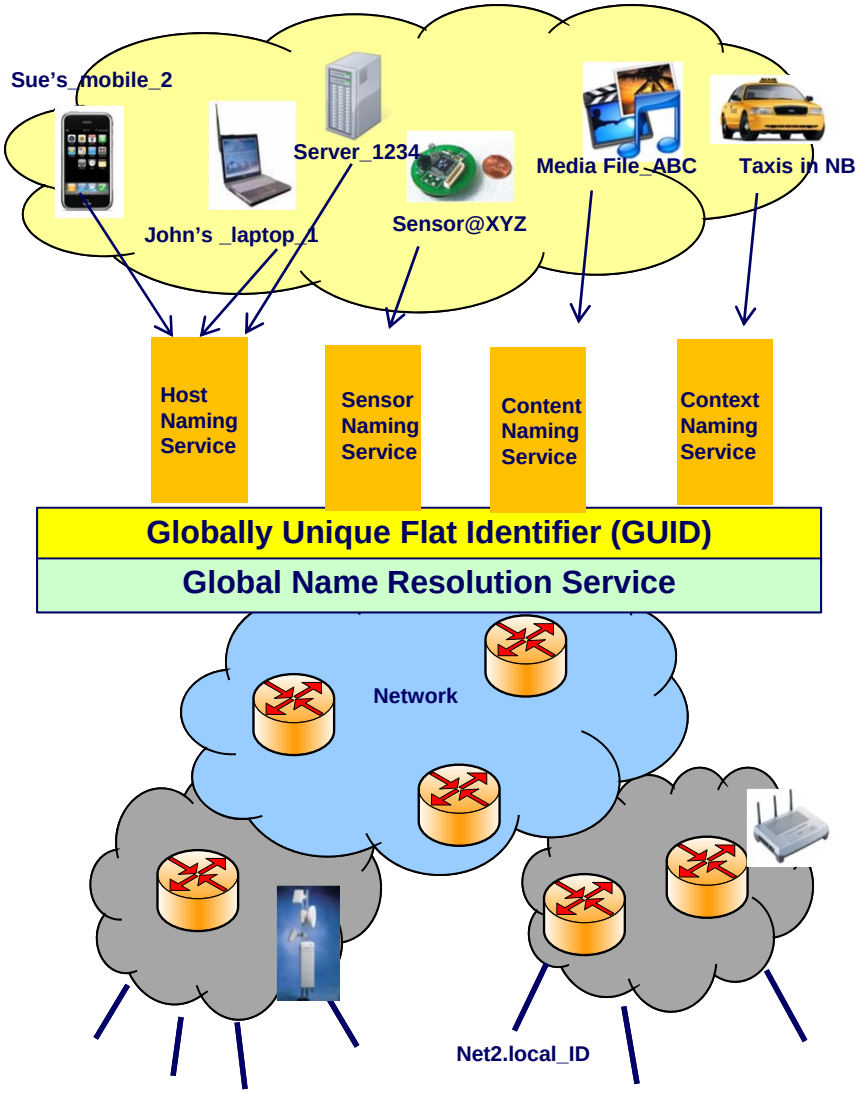
- **Scalable, Flat Content Name Space**
  - **human readable name → flat globally unique identifiers (GUID)**
- **Efficient Content Discovery**
  - **Content GUID → Content Location**
  - **GNRS: dynamic binding between GUID and locations**
- **Reliable Content Transport**
  - **hop-by-hop storage-aware transport scheme**

Content Discovery/Delivery Illustration



Content Naming

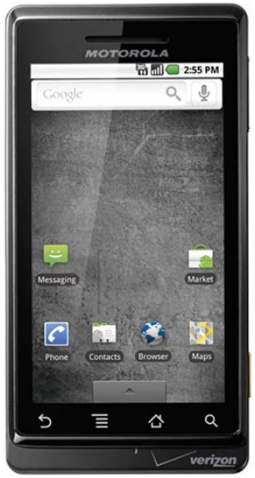
- Each content has a human-readable name (HRN) and a globally unique ID (GUID)
  - Many existing work on creating HRNs
- GUIDs are flat, randomly generated bits (possibly from public key), without any semantic structure
  - ~ 160 bits
- Name assignment service (NAS): domain-specific service
  - Translating HRNs to GUIDs



Content Discovery Through GNRS

- **Global Name Resolution Service (GNRS)**
  - **Stores all the (GUID → NA) mappings**
  - **NAs can be any host or cache that has the content**

GUID	NA(s)
0010011..1	44.32.1.153

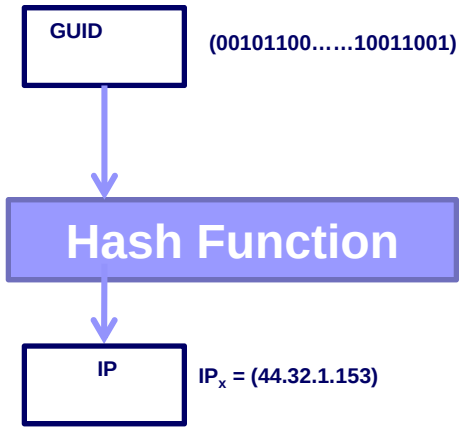


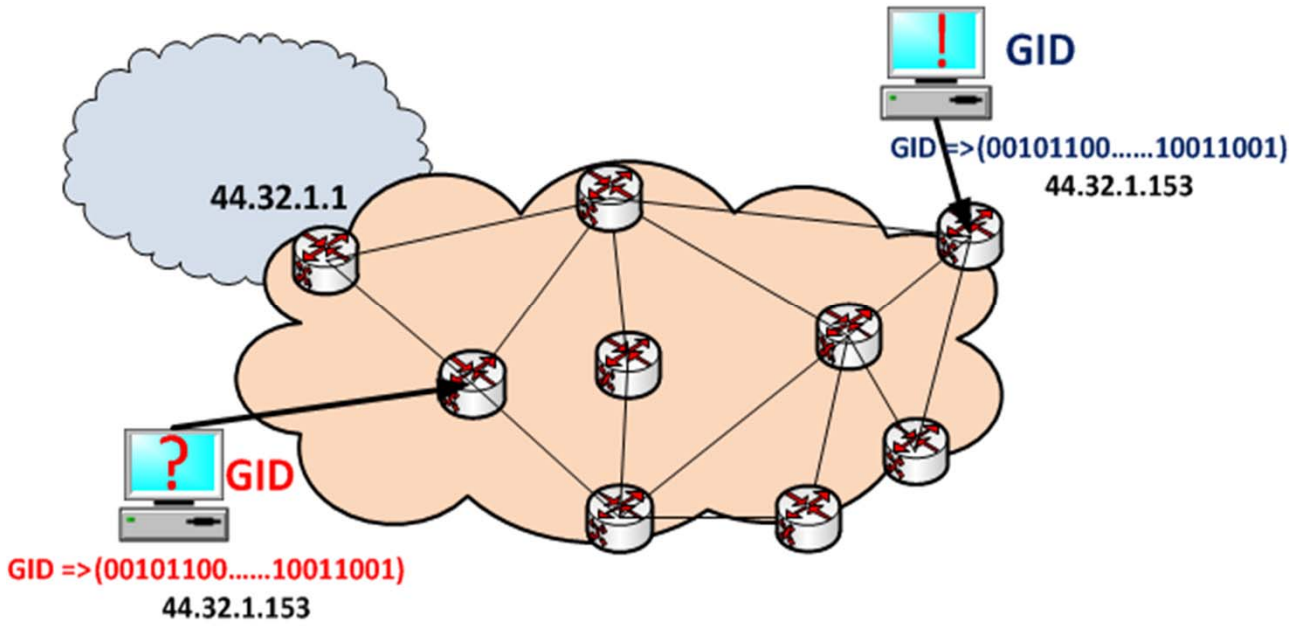
Content GUID lookup (GUID)

Content Network Address (NA)

Global Name Resolutions Service (GNRS)

A Shared-Hosting GNRS through Direct Map (D-Map)





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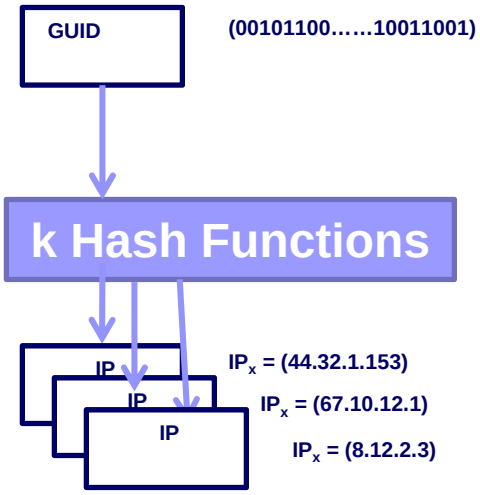
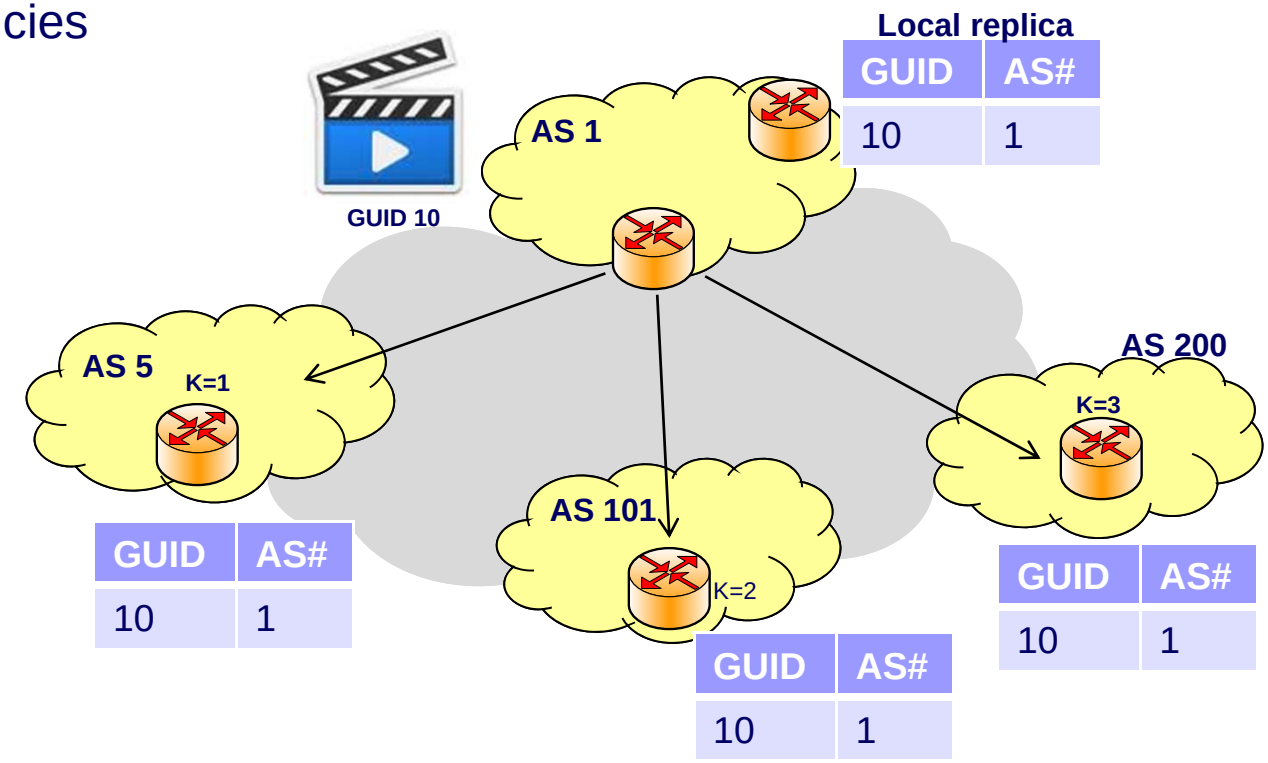
- Strictly 1-overlay-hop lookup
- No extra routing requirement (e.g. utilize current BGP)

Content Discovery: Mapping Replication

- Every mapping is replicated at K random locations
- Lookups can choose closest among K mappings. Much reduced lookup latencies
- Keeping a local copy within the source AS
- LNRS vs GNRS

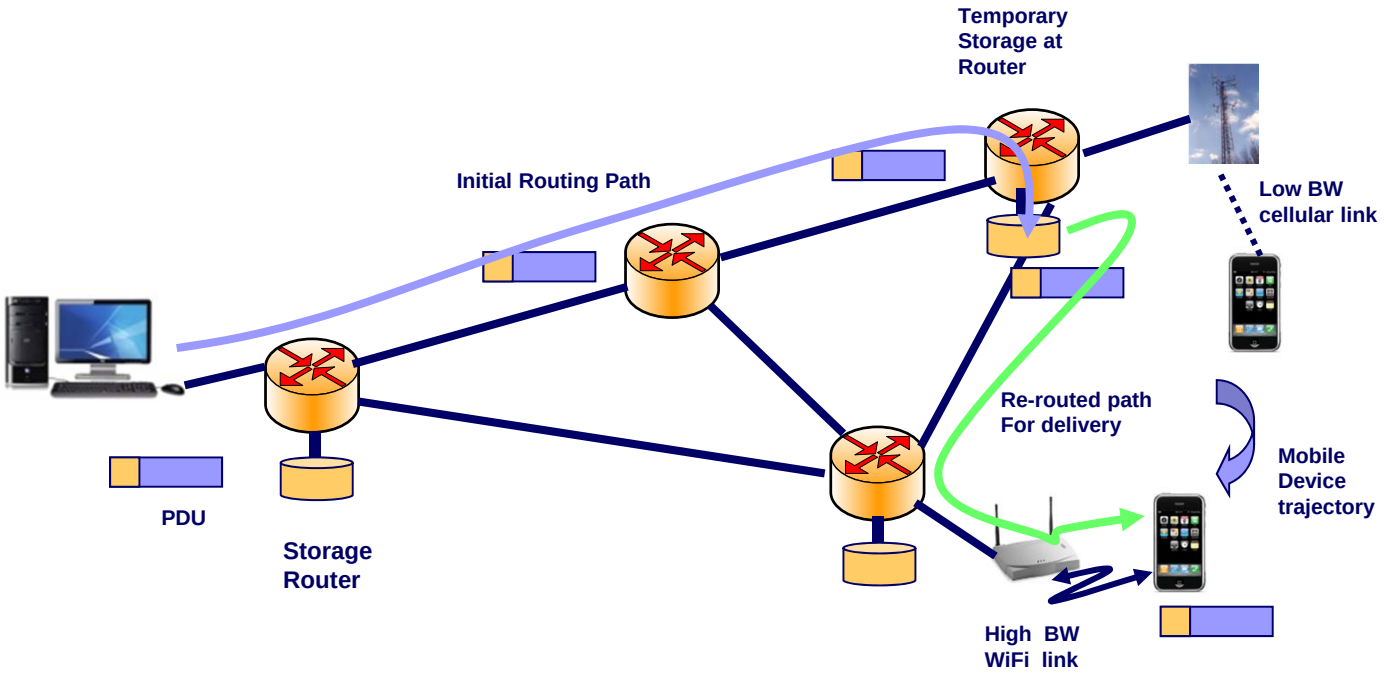


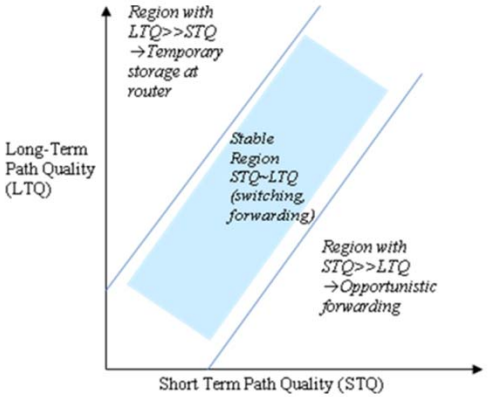


Content Routing: Storage-Aware Routing

- Storage aware routing exploits in-network storage to deal with varying wireless link quality and disconnection

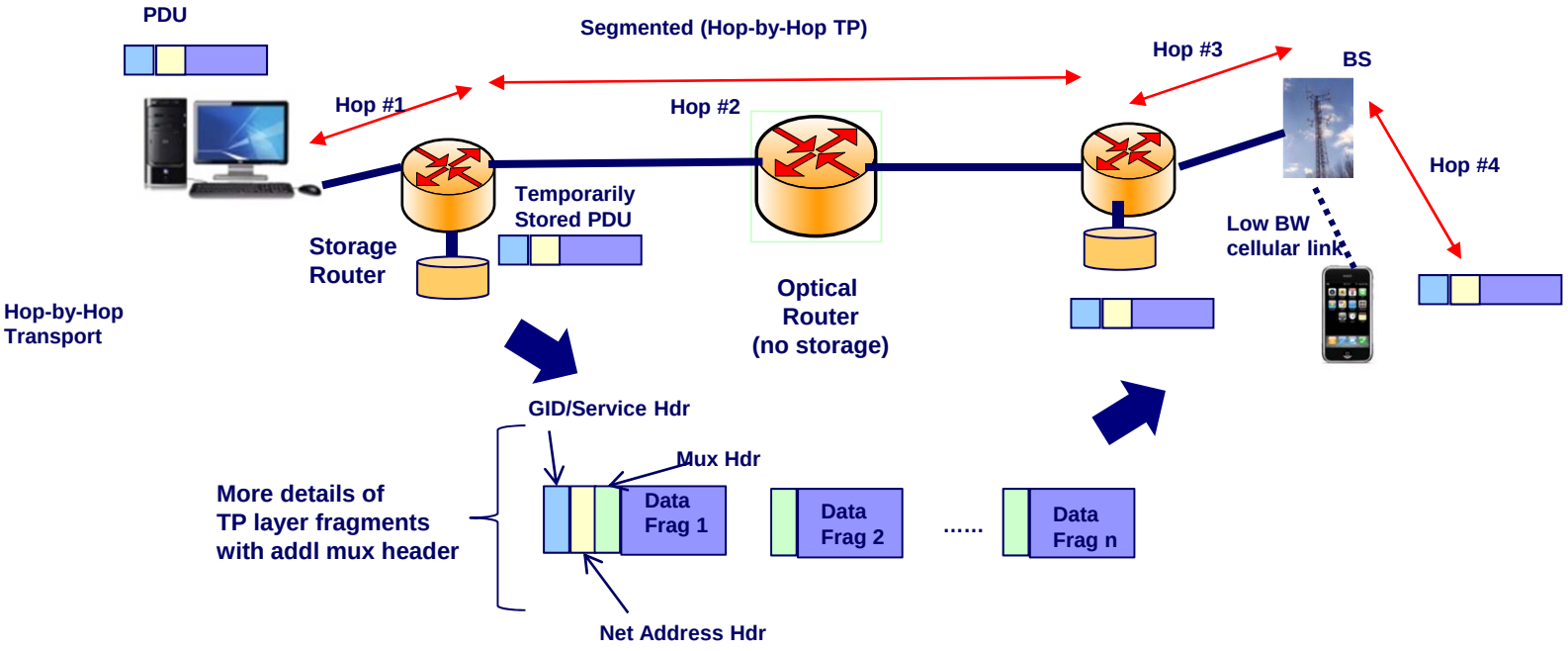
- Routing algorithm seamlessly adapts from switching (good path) to store-and-forward (poor link BW/disconnected)





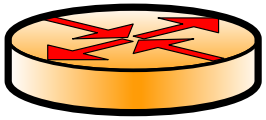
Content Transport: Segmented Transport

- Segment-by-segment transport between routers with storage, in contrast to end-to-end TCP used today
- Unit of transport (PDU) is a content file or max size fragment
- Hop TP provides improved throughput for time-varying wireless links, and also helps deal with disconnections
- Also supports content caching, location services, etc.

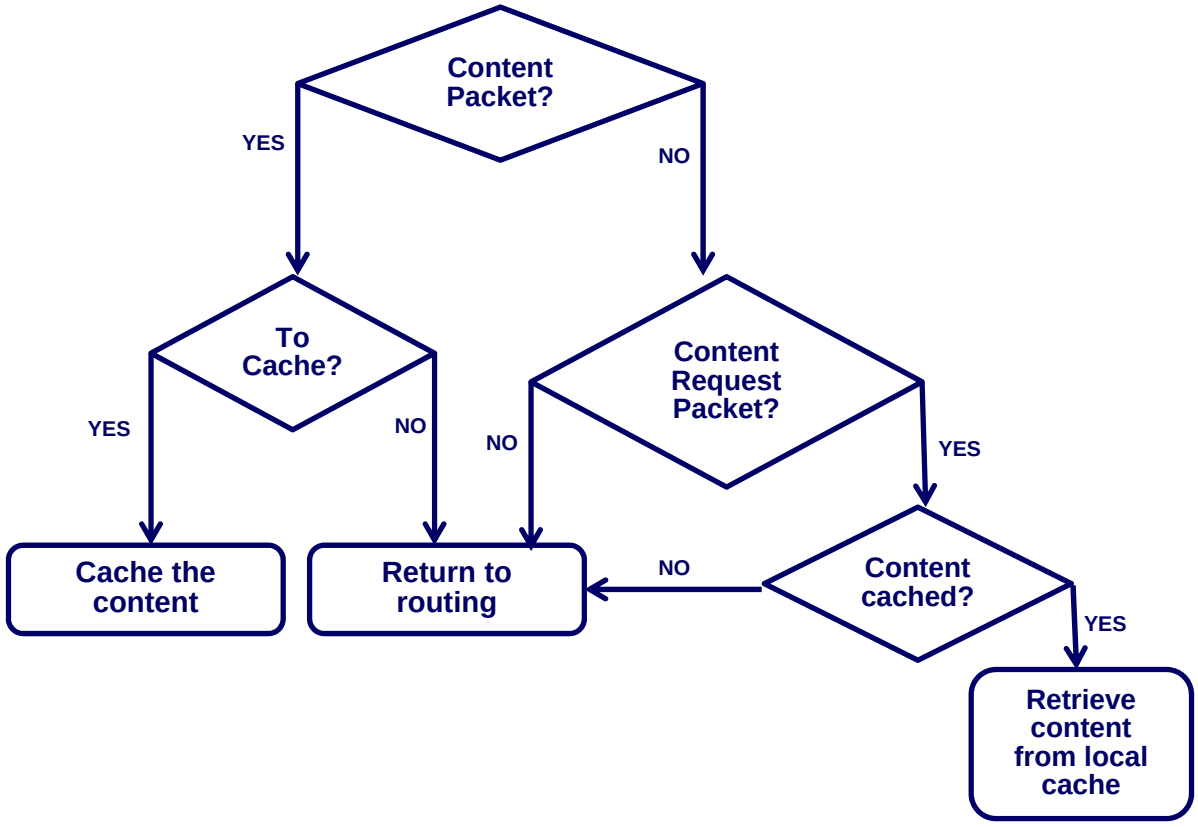


In-network Caching

- **Intermediate routers can choose to cache content files**
  - **Reduced retrieval latencies**

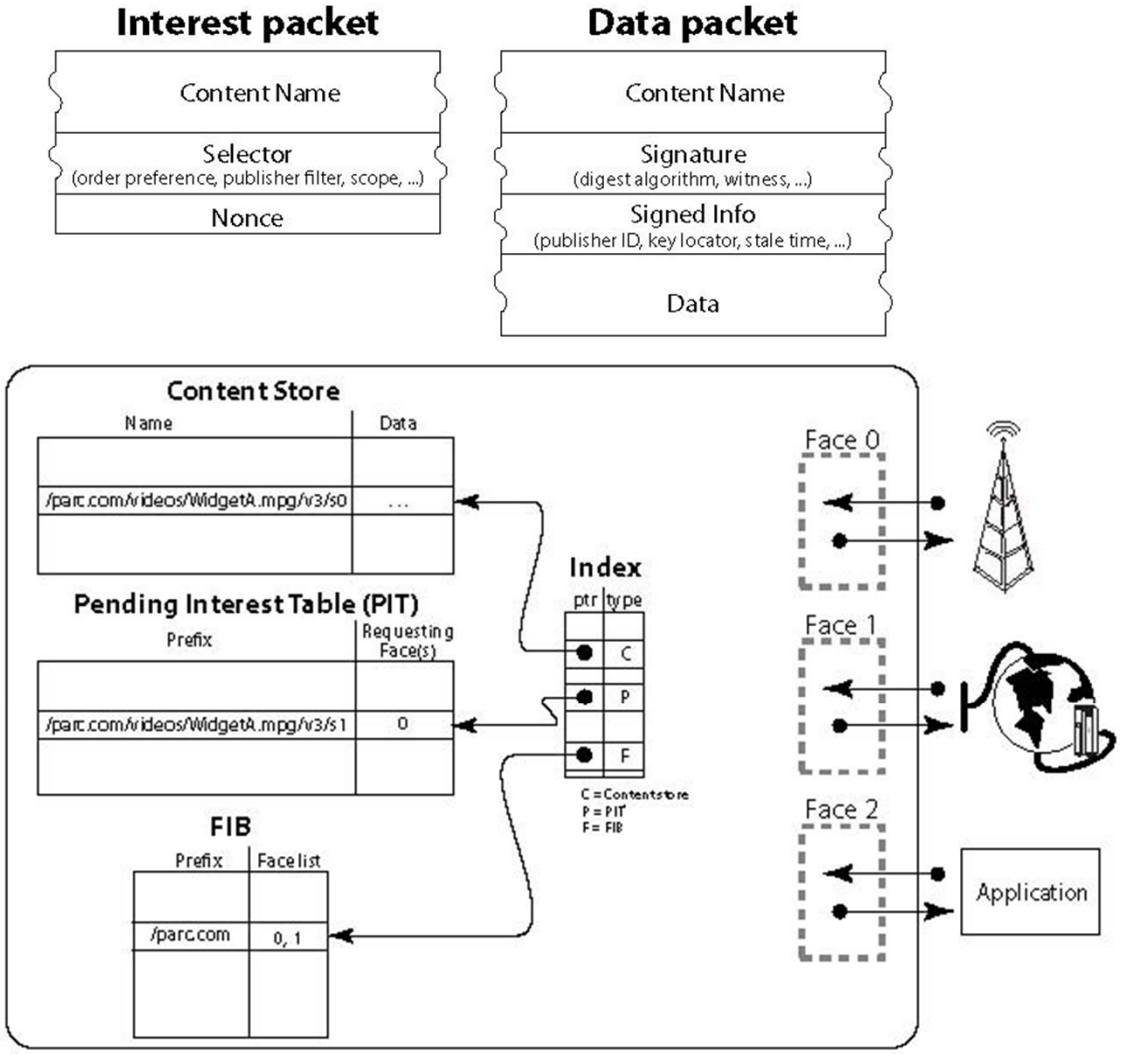


- **Many issues**
  - **Where to cache**
  - **What to cache**
  - **Caching overhead**



Comparison against NDN

- Hierarchical naming
  - /parc.com/videos/WidgetA.mpg
- Interest packets are routed according to FIB
- Data packets are routed by reversing the path of the interests



Comparison Against NDN

- Compared to NDN, our design offers the following benefits:
  - Much smaller routing table: our solution relies on existing routing table, while NDN's routing table may grow sub-linearly with number of contents
  - Much lower Update cost: our solution only needs to update K locations for an update, while NDN needs to update a large number of routing tables
  - Better Mobility Support: NDN routes data packets by reversing the interest path

Evaluation Plan

- **Four Use Cases**
  - **Use case I: downloading popular contents, e.g., movie or video**
  - **Use case II: peer-to-peer one-2-many delivery**
  - **Use case III: content download on the go**
  - **Use case IV: high density, dynamic content retrieval, e.g., stadium, commuting bus**

- **Two-step evaluation plan**
  - **Orbit prototyping**
  - **GENI evaluation**

Questions & Answers