Comparing Alternative Approaches for Networking of Named Objects in the Future Internet

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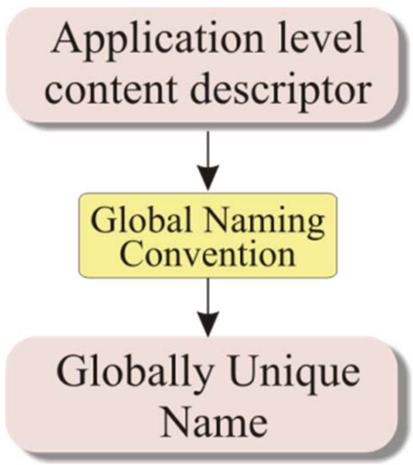
Motivation

- Increasing consensus on:
  - Rethinking Internet design around named data
  - Separating naming & addressing functionalities
- But implementation details under a lot of debate:
  - How to name content and hosts ?
  - Whether to route directly on names ?
  - How integrated should caching and CDNs be ?
  - ...

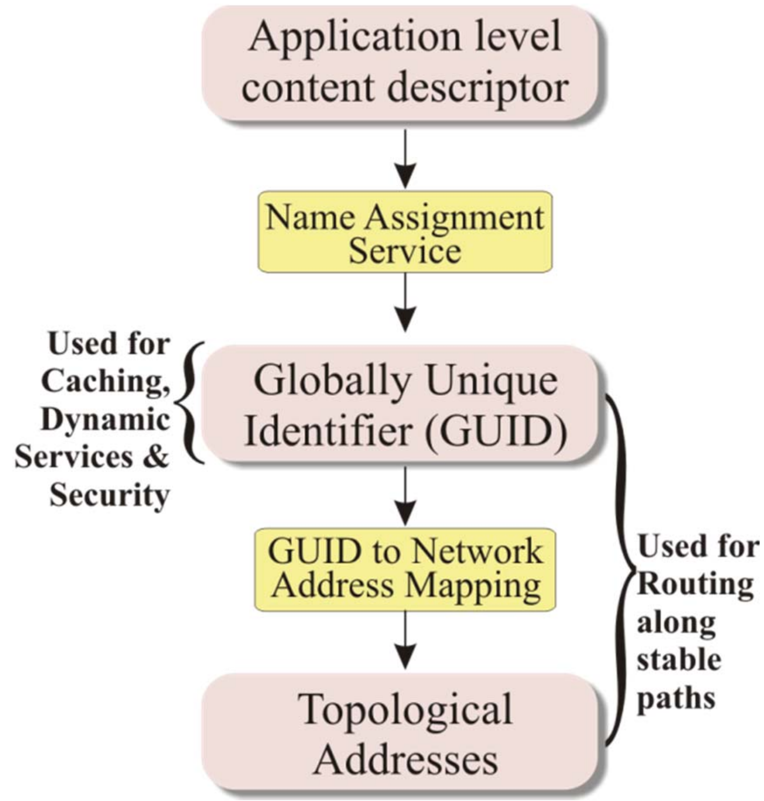
This work: Comparing two major naming and layering approaches through big picture analysis and back-of-the-envelope numbers

Layering Alternatives



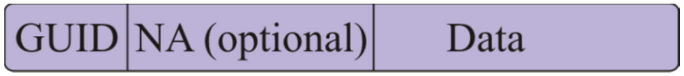
CCN Approach:

- Hierarchical names
- Used for routing packets
- Used for caching at routers



Hybrid GUID-Name (HGN) Approach:

- Use flat GUIDs for caching
- Use topological addresses for routing



CCN & HGN Routing/forwarding

- Using an instance of HGN routing, as per the design in the MobilityFirst project[1]

CCN Routing

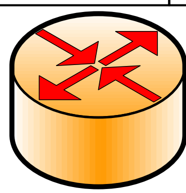
Name-based Interest forwarding

Name-forwarding table

Name	Face
/winlab/vids/	1

Cache

Name	Content
/winlab/video1/	Video File

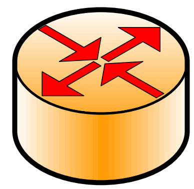


HGN Routing

GUID –based forwarding (slow path)

GUID-Address Mapping

GUID	NA
xz1756..	Net 1194



Cache

GUID	Content
x1122	Video File

Routing Table

Dest NA	Path
Net 123	Net1,Net2, ..

Network Address Based Routing (fast path)

[1] MobilityFirst Future Internet Architecture Project, http://mobilityfirst.winlab.rutgers.edu/

Comparison Points

- Routing Table Size
- Routing Update Overhead
- Infrastructure Requirements

- Use Case Scenarios:
  - Content Retrieval
  - Unicast Push/Pull
  - Mobile Receivers/Senders

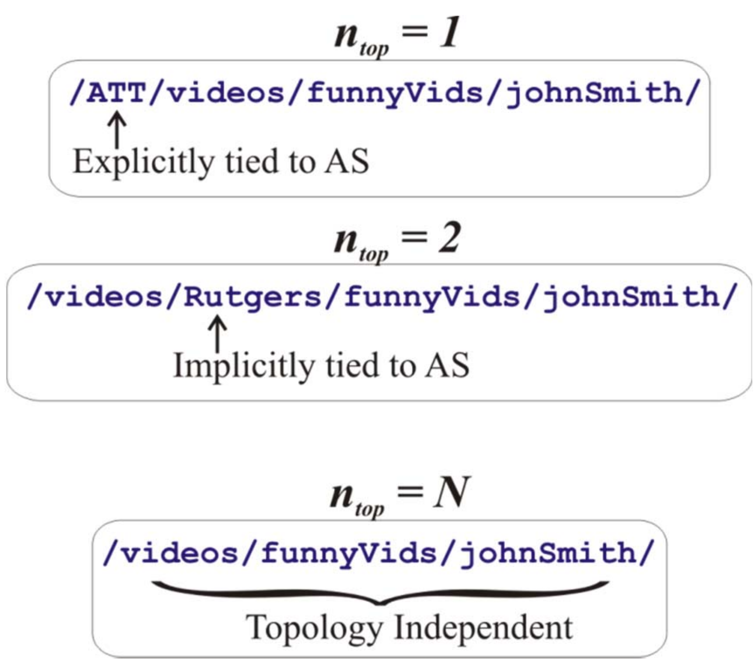
Routing Table Size

- **HGN:** Routing decoupled from the content names
  - Can be designed to contain network specific prefix
  - Thus routing table bounded by no. of networks

- **CCN**: Name based routing
  - Routing table size depends on name aggregation
  - Which depends on mapping between the naming tree and the topological structure of the network

A simple naming abstraction

- N levels of hierarchy; prefix at level i having l_i sub-level prefixes.
- Define $n_{top} \in \{1,2,\ldots,N\}$ which indicates the prefix level below which the naming tree starts being influenced by the network topology

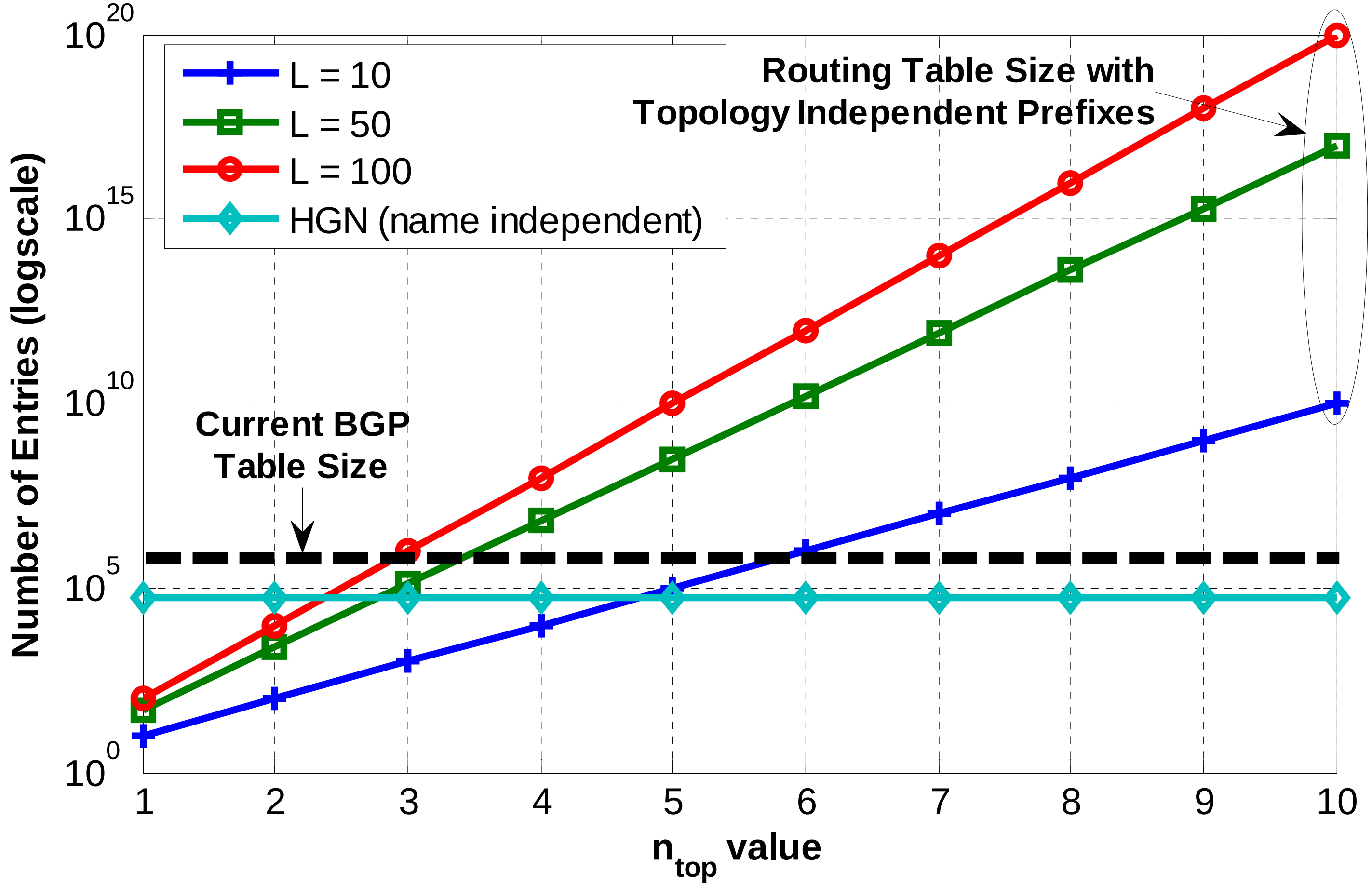


$n_{top} = j \Rightarrow$ prefix aggregation at level j

$\Rightarrow$ Routing table size $\propto \prod_{i=1}^{j} l_i$

Let's assume $l_i = L$, for all i

Routing Table Size



Key message: Hierarchy in name reduces the table size only when the name prefixes have some degree of dependence on the physical network topology.

Routing Update Overhead

- HGN: Network reachability through routing protocol and content reachability through GNRS
  – content additions/deletions and changes in its hosting location do not effect the network

- CCN: Content movement is reflected in the routing
  – content movements are propagated to maintain reachability

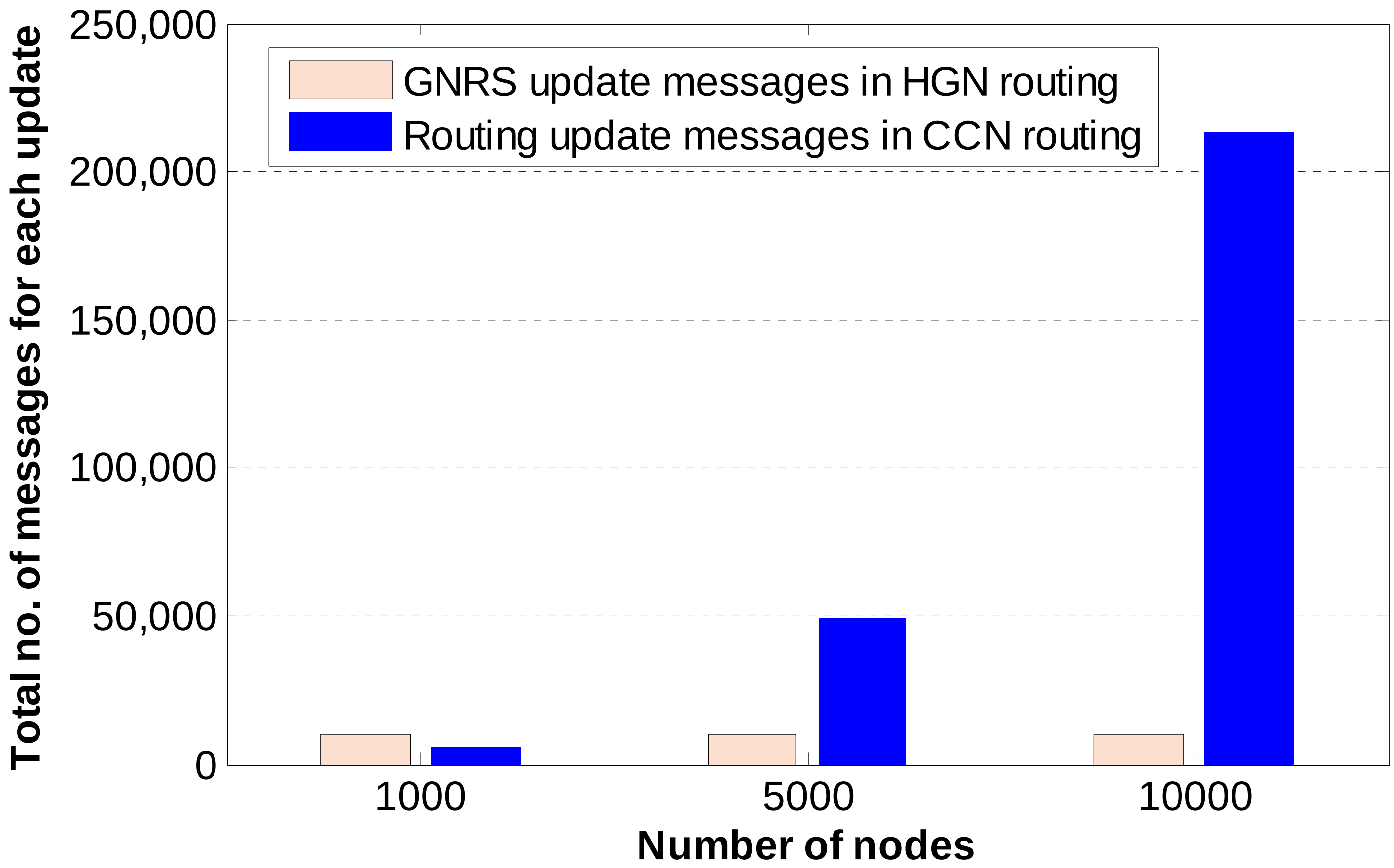
How much is the *routing* overhead for changes in *content* ?

Update overhead study

- Using AS-level topology generator and BGP simulator[2]
  - generates realistic topologies with 3 kinds of nodes: tier-1 (T), mid-level (M), customer (C)
  - 3 simulations with total nodes *A = {1K, 5K, 10K}*
- Event under consideration:
  - Withdraw a name prefix
  - Wait for table convergence
  - Re-announce the prefix from another network
- Metric: Total number of name update messages passed between all nodes

[2] A. Elmokashfi, A. Kvalbein, and C. Dovrolis, "On the Scalability of BGP: The Role of Topology Growth," IEEE Journal on Selected Areas in Comm., vol. 28, no. 8, 2010

Total no. of update messages



Name based routing could burden the network with large number of updates when there is dynamism in where the content is advertised from

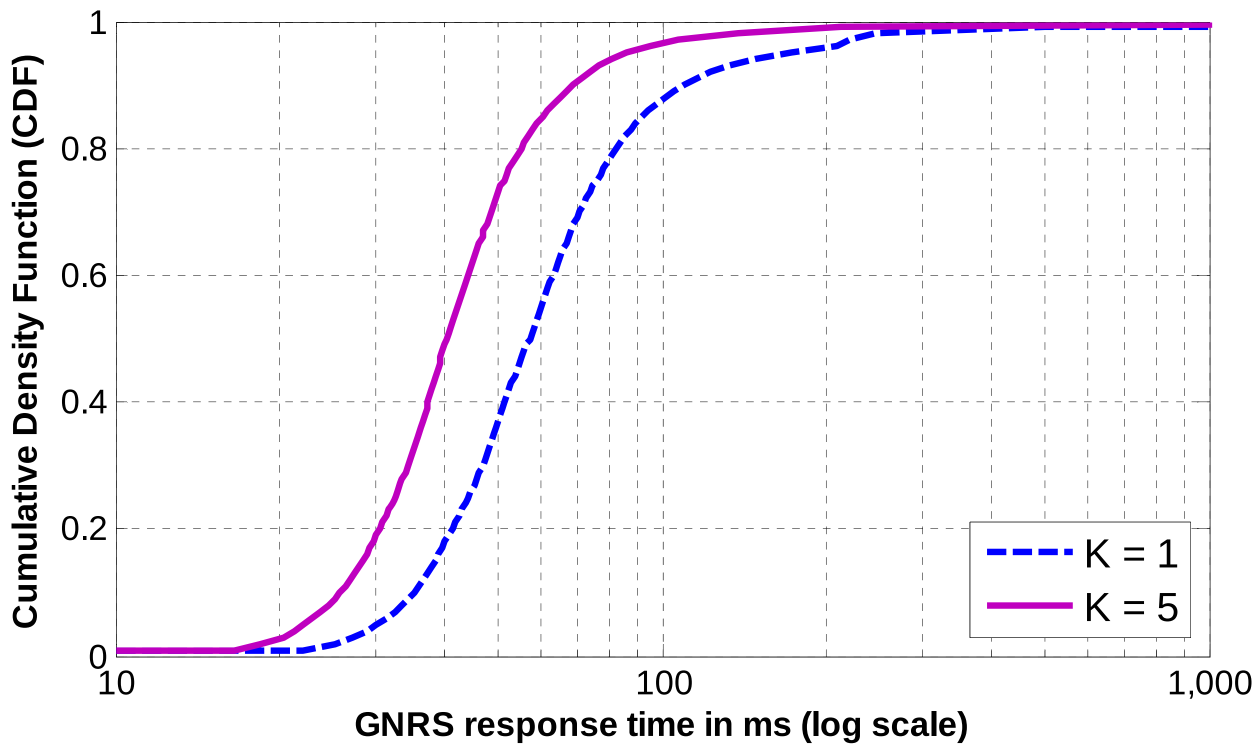
Infrastructure Requirements

- Scalability properties of HGN in terms of routing table & overhead comes at the cost of a global name resolution infrastructure
- The GUID → NA mapping incurs a resolution latency
  - how much is this latency ?
  - how can we make this small ?
- MobilityFirst approach[3]:
  - distribute the mapping between the routers
  - use a single-hop DHT to insert/query the mappings

[3] T. Vu et al., "DMap: A Shared Hosting Scheme for Dynamic Identifier to Locator Mappings in the Global Internet," in *Proceedings of ICDCS, 2012*

Name resolution response time

- Results from a large-scale measurement drive simulation
  - uses real inter-AS & intra-AS latencies measured through DIMES project
  - measures response times for 1 million queries sourced from randomly selected end-hosts distributed uniformly across all ASs.



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Conclusions

- While extremely efficient for content retrieval, the baseline CCN can suffer from scalability issues in terms of:
  - Routing table size
  - Update traffic overhead
  - Unicast push message overhead
  - Mobile source latency
- A hybrid approach with an additional level of indirection can mitigate some of the scaling challenges