LEVER: Leveraging Routing Infrastructure for Routing Scalability, Mobility and Content Networking

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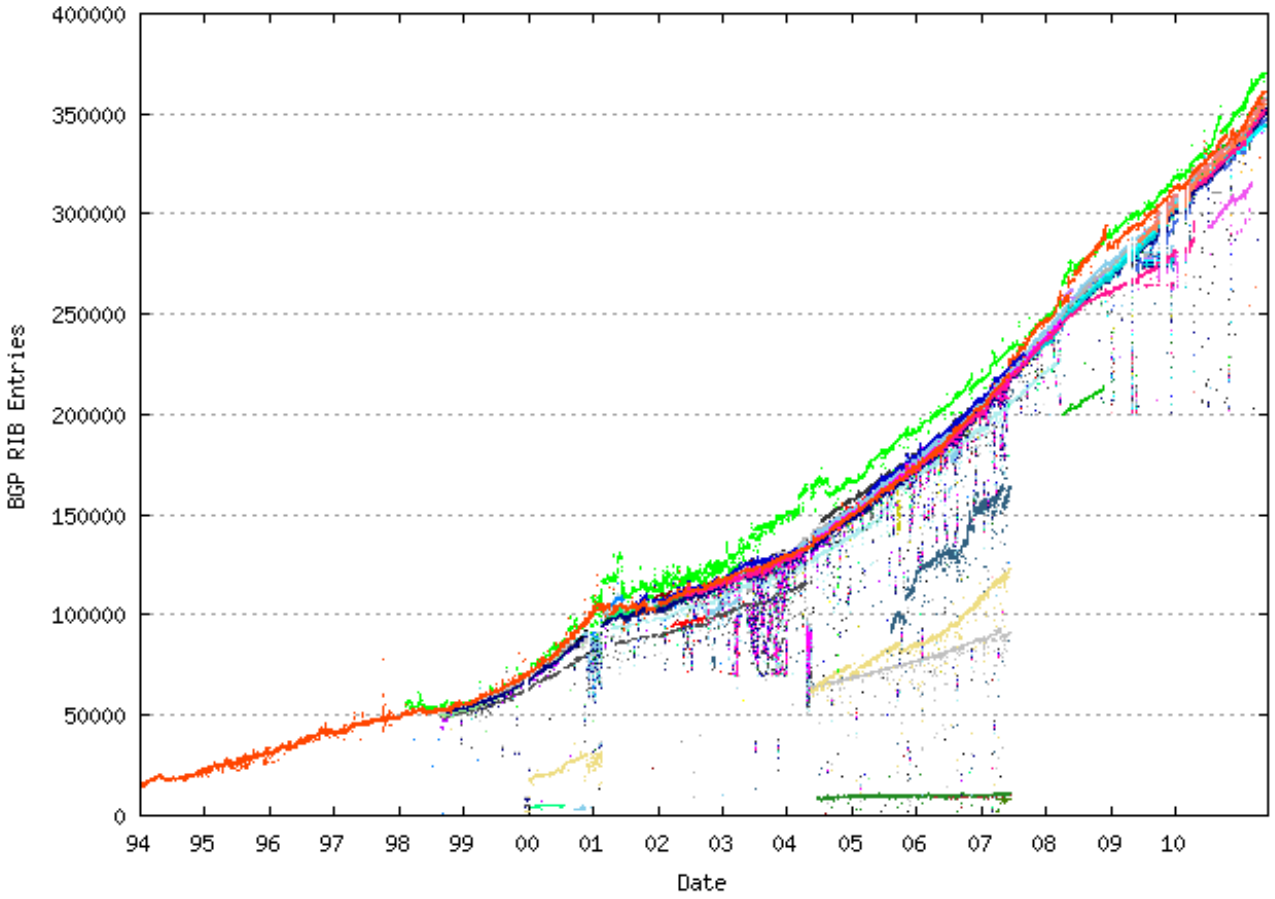
Routing scalability

- Number of IP prefixes



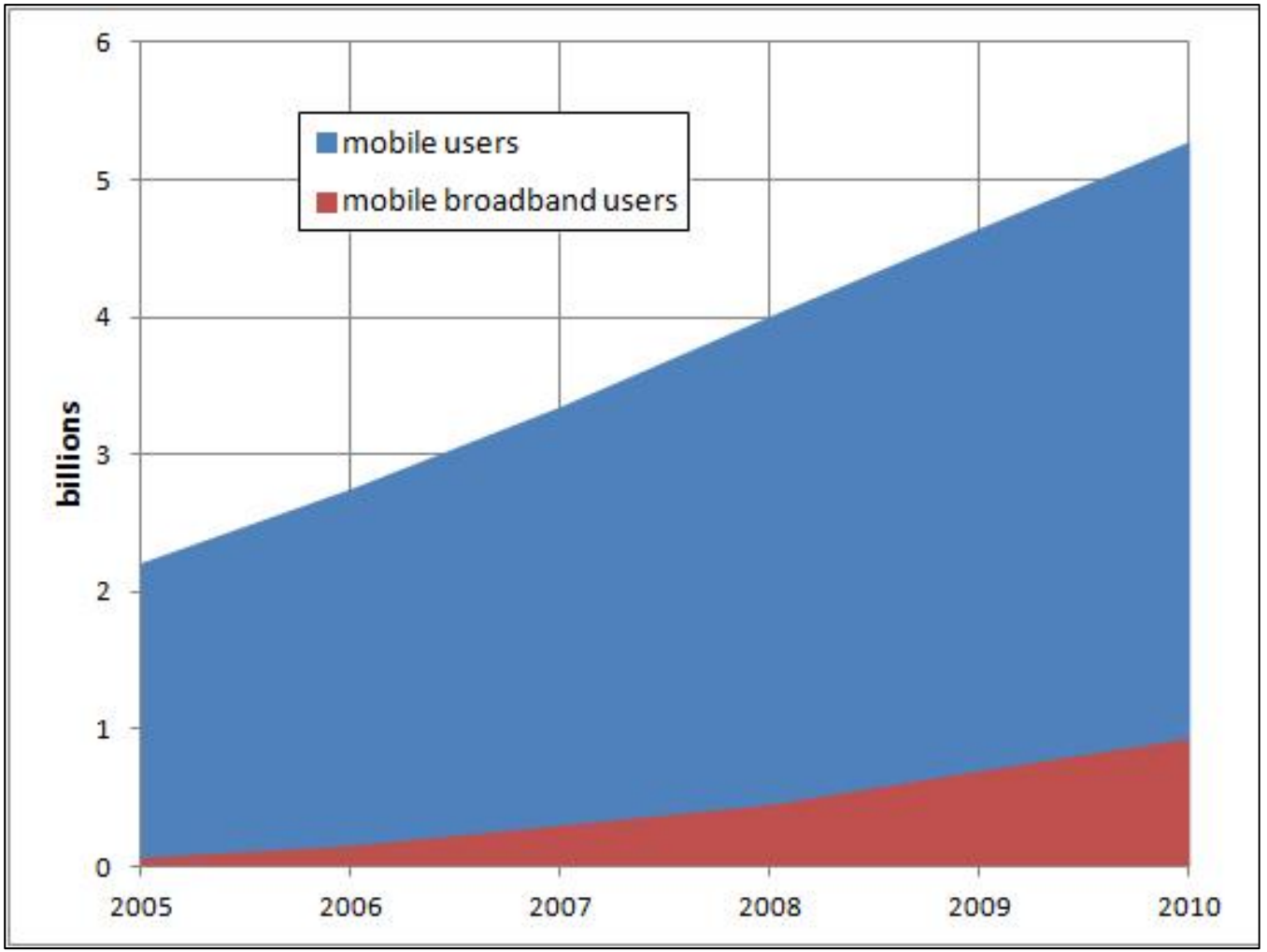
Source: Geoff Huston@APNIC

Routing scalability

- Multi-homing, TE, non-aggregatable prefix assignment
- Endpoint identifiers (EIDs) may have to be separated from routing locators (RLOCs)
- Locator Identifier Separation Protocol (LISP) and so on
- Q1: How to find RLOCs from EIDs?

Mobility

- Mobility becomes the norm



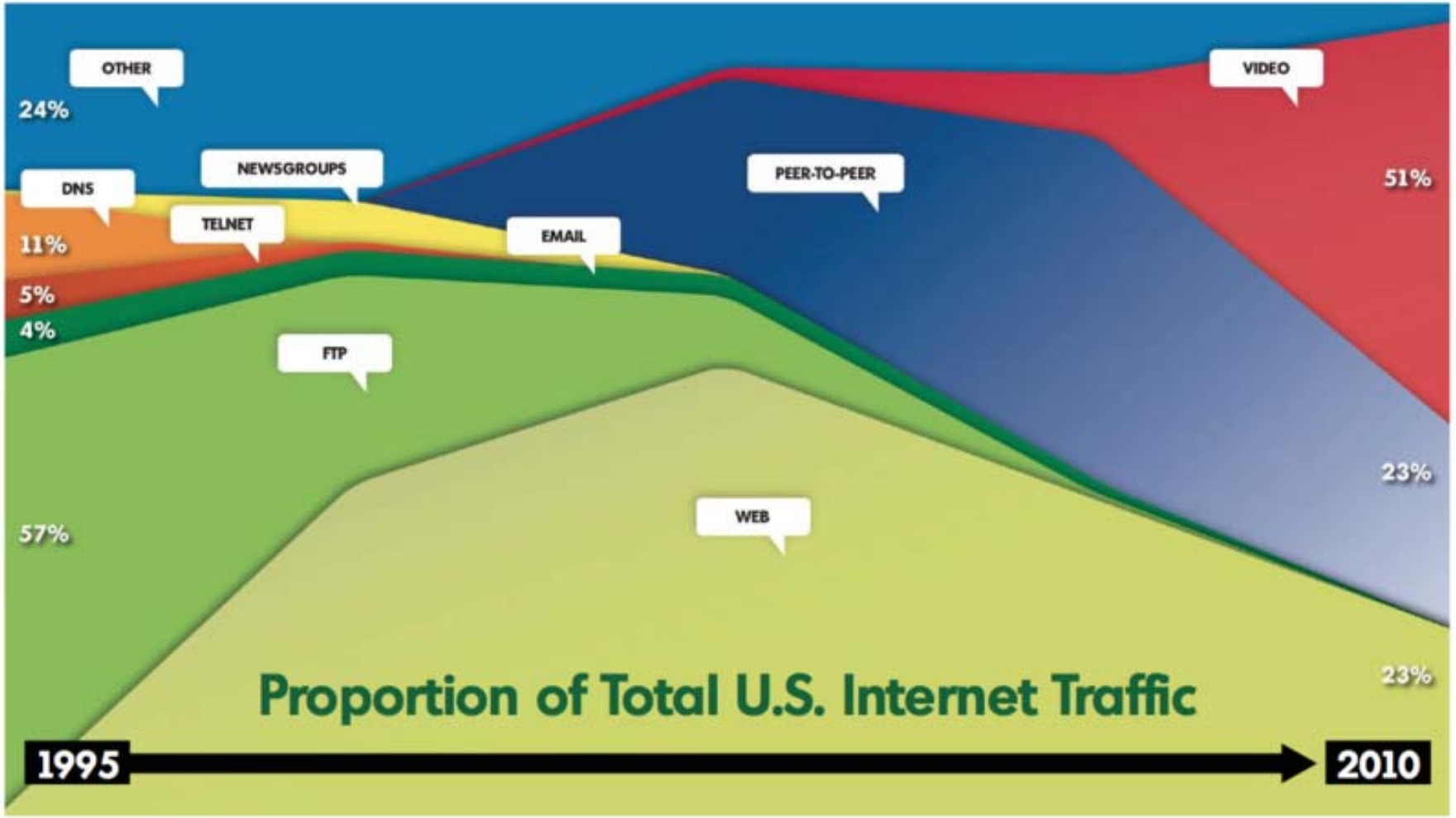
Data: ITU

Mobility

- IP mobility
  - Many unsuccessful proposals
- Different contexts
  - Identifier and locator
  - Home address (HoA) and care-of-address (CoA)
  - Initial address and new address(es)
- Q2: how to find CoA for HoA?

Content networking

- Content-oriented Internet usage



Source: Limelight

Content networking

- Two contrasting approaches
  - Route-by-name
    - DONA, CCN,…
    - Scalability problem
  - Lookup-by-name
    - P2P, CDN,…
    - Application-specific, cost
- The latter could be almost as efficient as the former
- Assume content ID is standardized, like URL
- Q3: how to find the location for content ID?

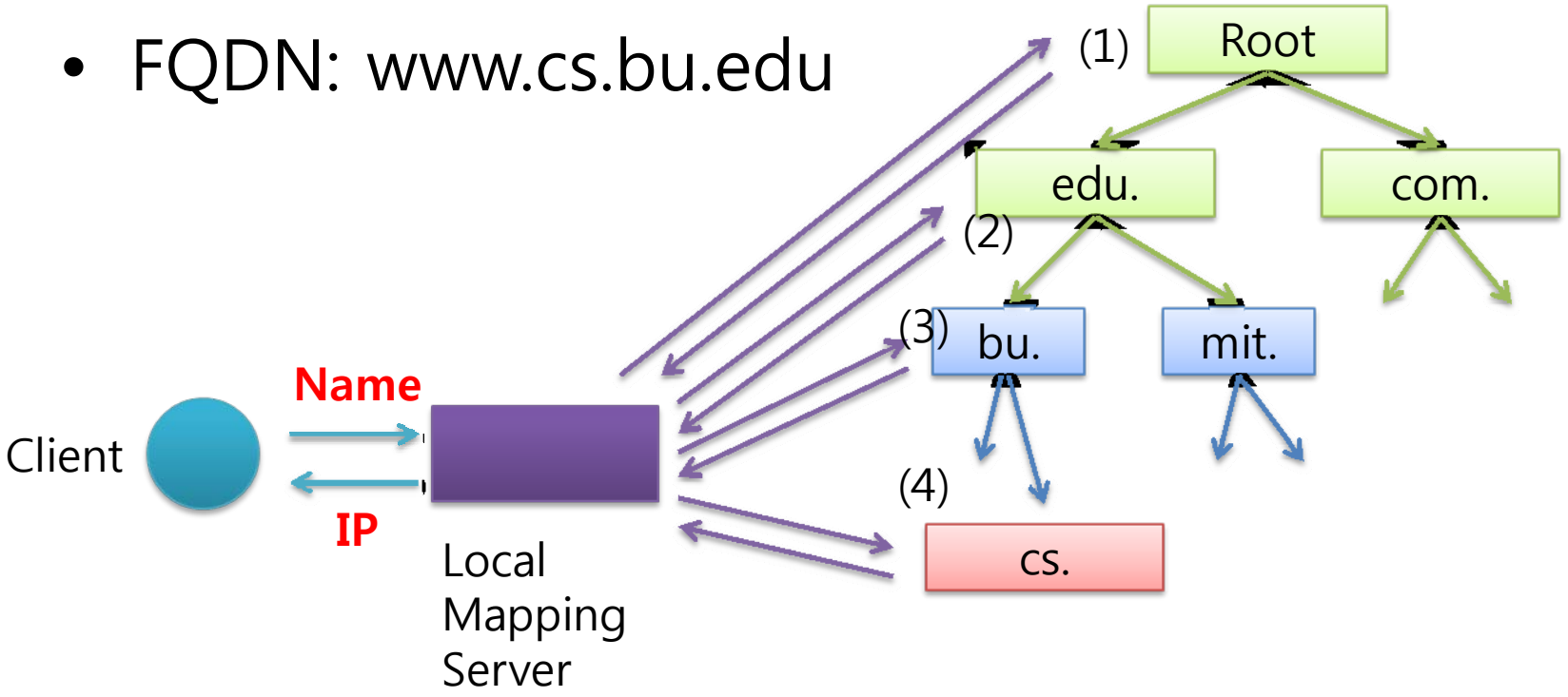
A common mapping infra

- FQDN → IP : DNS
- EID → RLOC : routing scalability
- HoA → CoA : mobility
- Content ID → IP : content networking

I. An Evolutionary Approach

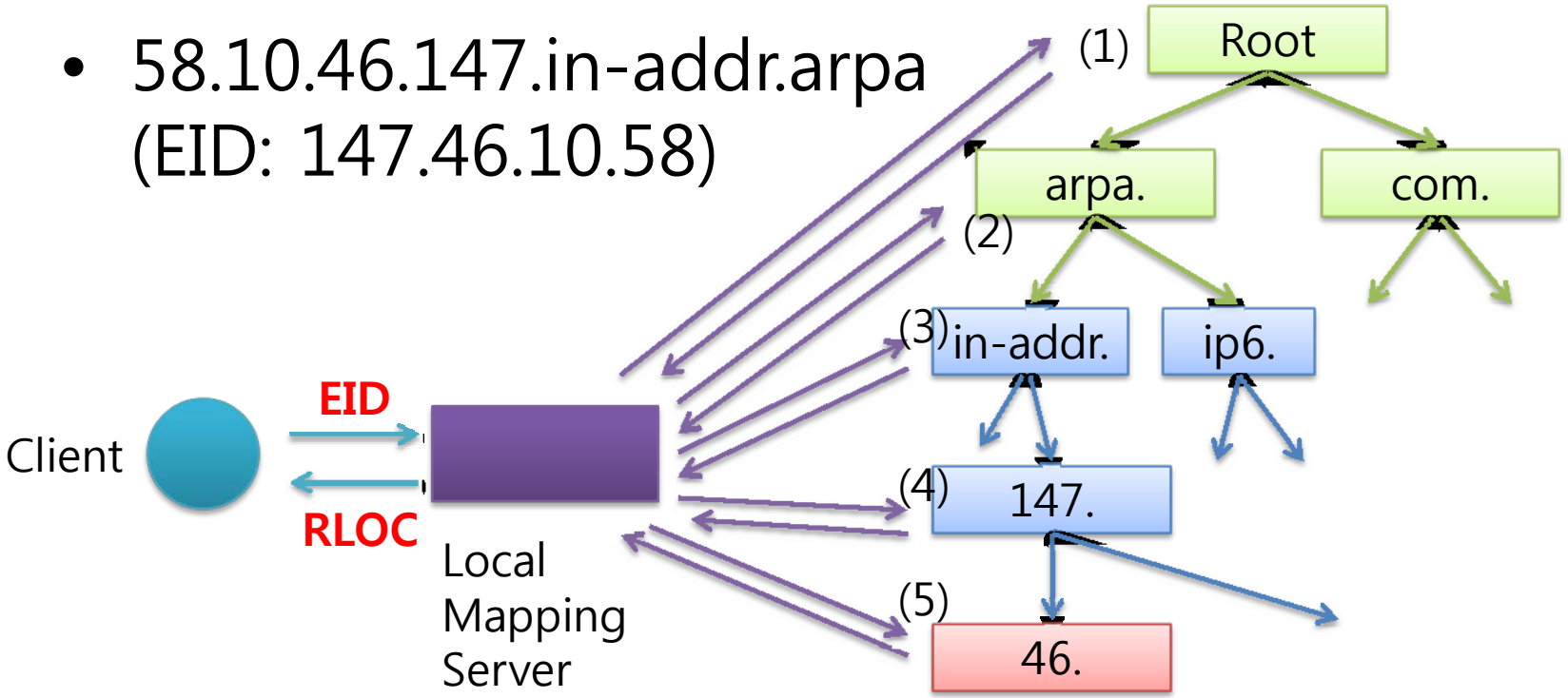
FQDN → IP

- FQDN: www.cs.bu.edu



EID → RLOC

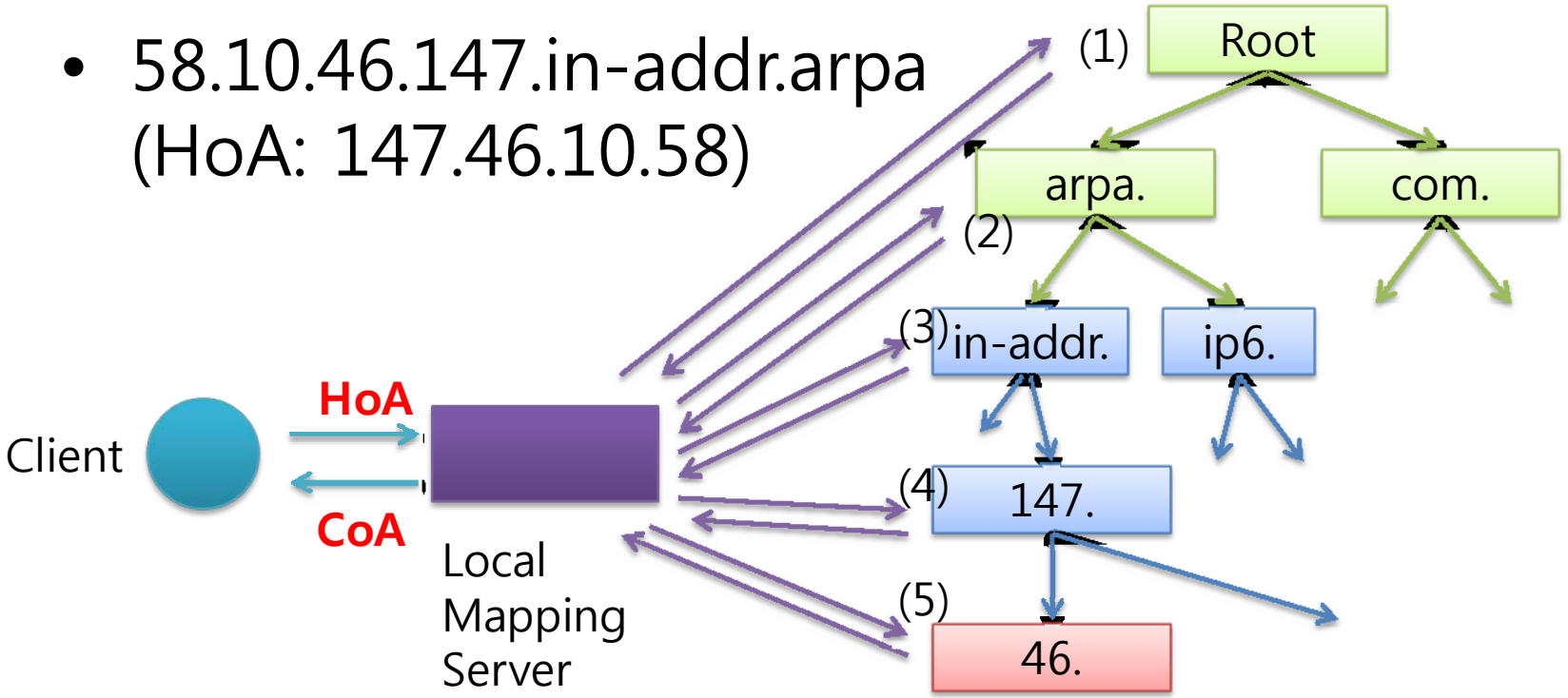
- 58.10.46.147.in-addr.arpa
  (EID: 147.46.10.58)



* Assume the ISP has class B address block: 147.46.0.0/16

HoA → CoA

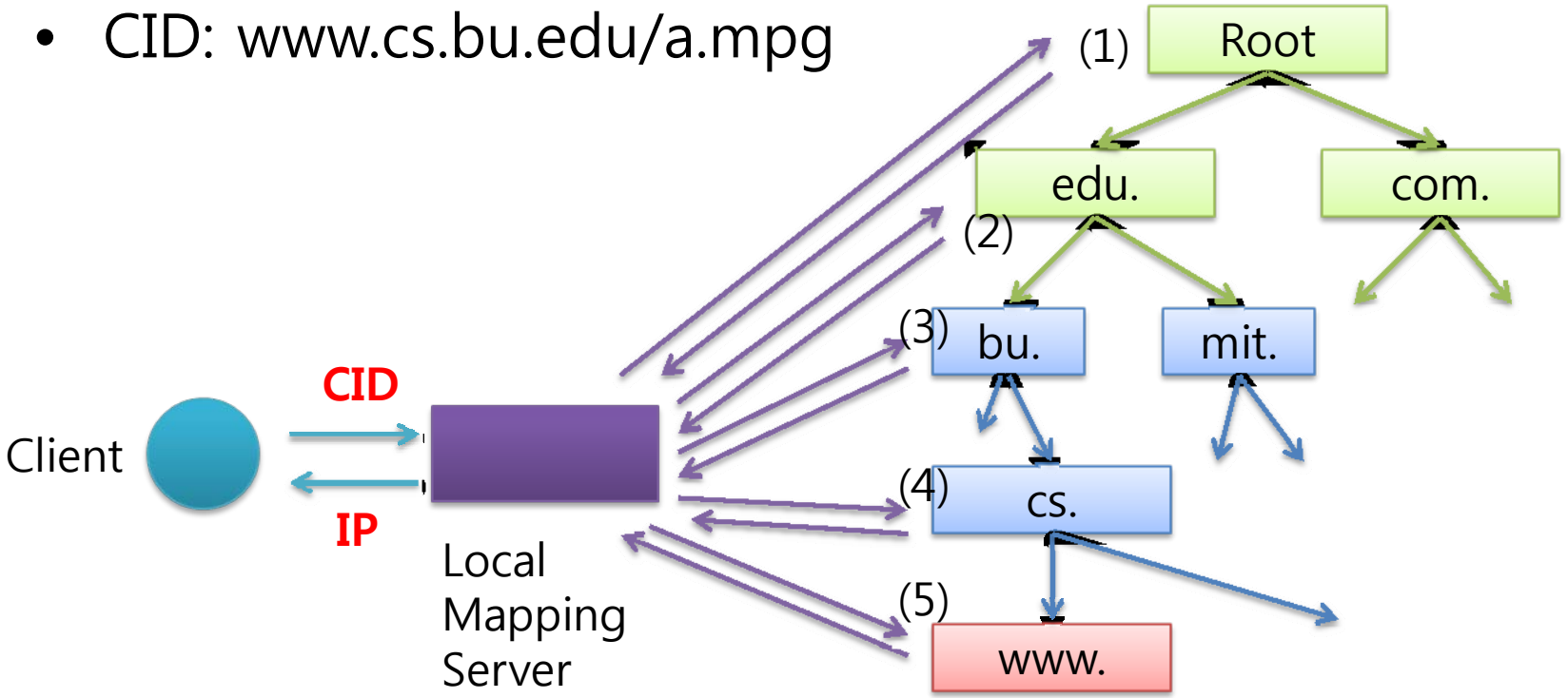
- 58.10.46.147.in-addr.arpa
  (HoA: 147.46.10.58)



* Assume the ISP has class B address block: 147.46.0.0/16

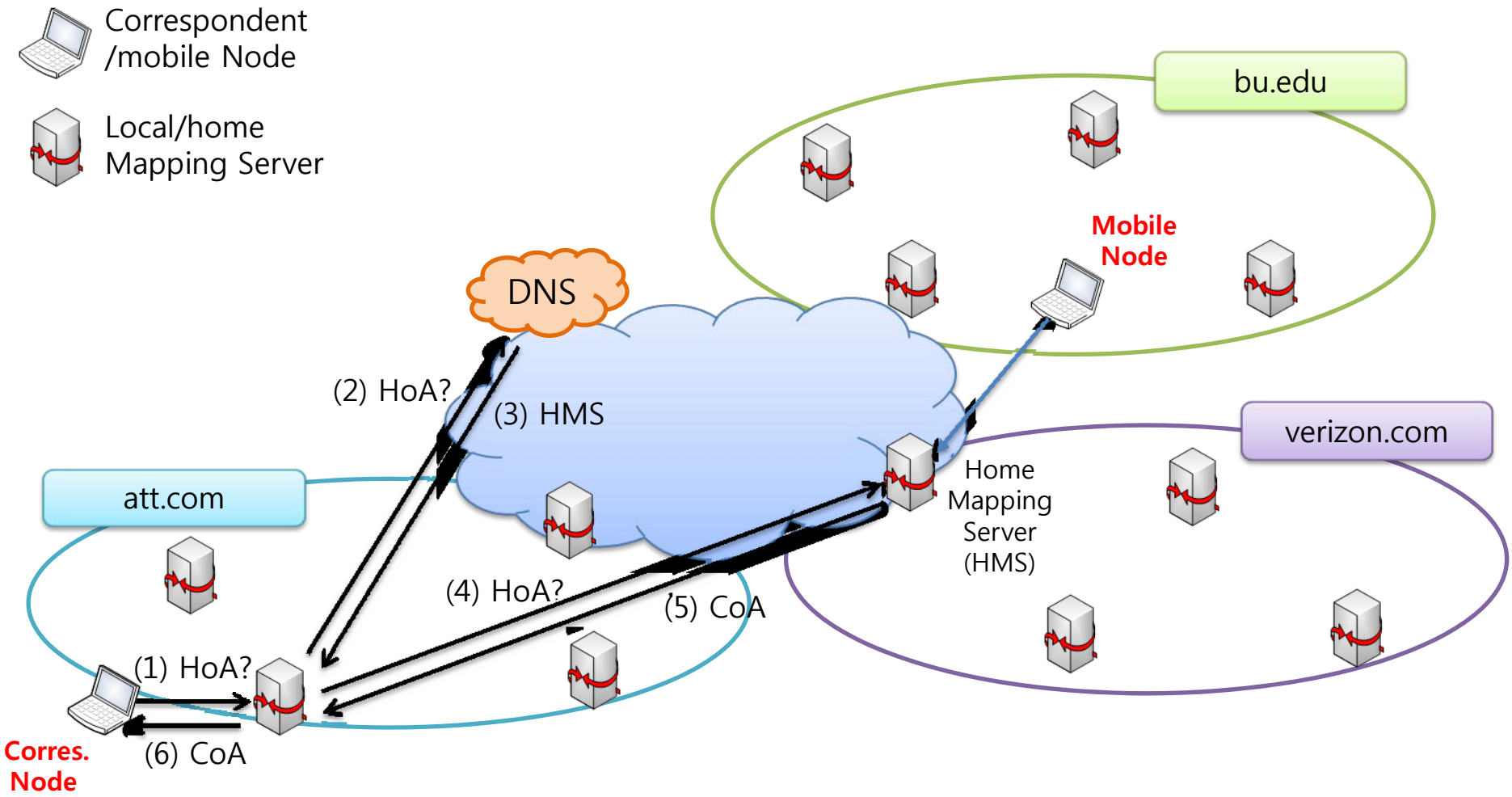
Content ID (CID) → IP

- CID: www.cs.bu.edu/a.mpg



* Assume, for each FQDN, a single server maintains mapping for all the URLs starting with the FQDN

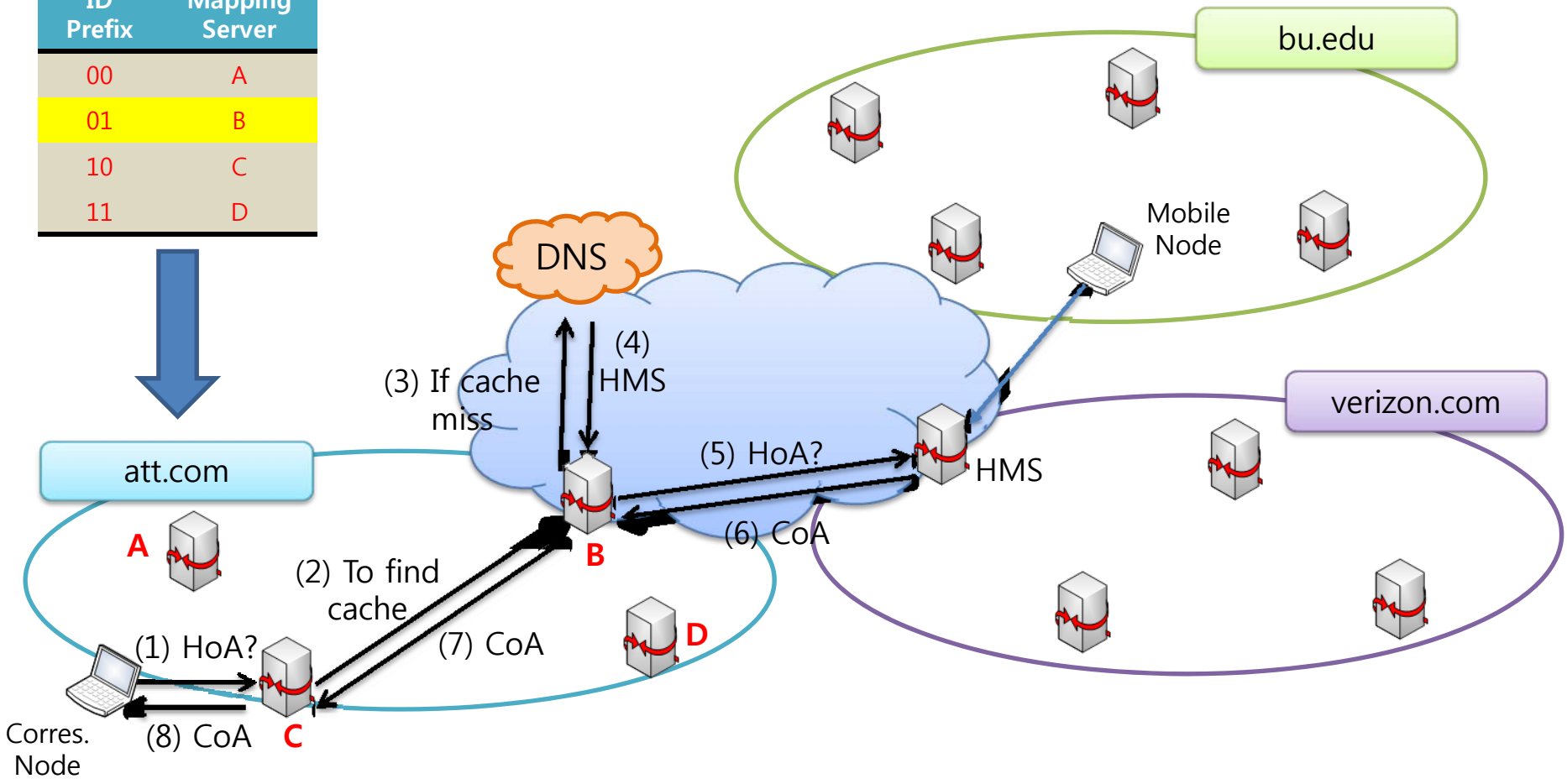
Mobility in-depth



* Mobile node is a Verizon user, moves to BU
* the HMS is the leaf in the DNS hierarchy

Mobility w/ caching

Hashed ID Prefix	Local Mapping Server
00	A
01	B
10	C
11	D



* CN is a user of AT&T, which caches mapping
* Hashed value of MN's HoA starts with 0b01

II. A Clean Slate Approach

1. So far, we talked about an evolutionary approach

2. There will be other mapping schemes, which should be supported in the Future Internet, e.g. RFID

3. DNS may be outdated

Verisign undertakes Project Apollo, which will grow capacity 1,000 times today's level of 4 trillion queries to manage 4 quadrillion queries per day by 2020.

Building a mapping infra: a clean-slate approach

- Hierarchical vs. flat
- Centralized vs. distributed

- Can we leverage the routing structure to realize the mapping infra?

LEVER: Realizing mapping by leveraging routing

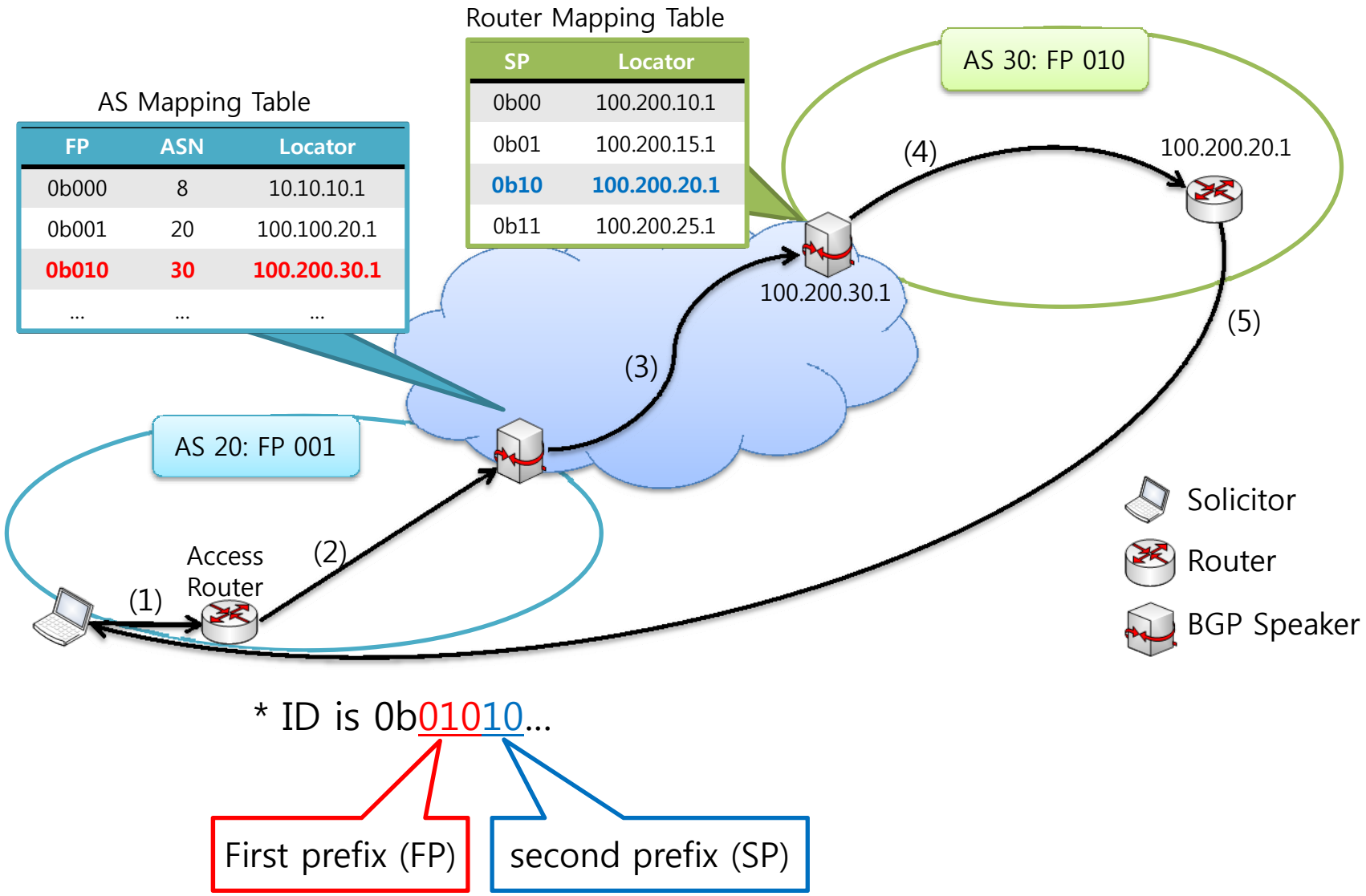
- Mapping server co-locates with router
  - E.g. local mapping server = router

- For a given ID, how can we find a mapping server who is in charge?

LEVER: how to advertise IDs?

- the ID space is divided among ASs
  - Each AS is in charge of mapping for the IDs in its partition, which is advertised by BGP
  - BGP router knows which ASs are in charge of which ID partition: AS mapping table
  - We can extend/leverage BGP
- A partition of an AS is divided among its routers
  - Each router is in charge of mapping for the IDs in its sub-partition, which is advertized
  - A router knows the IDs maintained by other routers in the same AS: router mapping table
  - We can leverage intra-domain routing

LEVER: how to find mapping of an ID



LEVER

- Relies on IP routing
- Overlay
- Incentives
  - ICANN may enforce the mapping service
    - E.g. ID partition $\propto$ assigned address block
  - ISP can offer registry operator biz

Thank you!

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