LORIF: Location-based Routing and ID-based Forwarding

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Outline

- Background
- LORIF: Location-based Routing and ID-based Forwarding
- Location Compression
- Data Forwarding
- Control Plane
- Collaborating Plan

Background

- With the rapid growth of Internet, scalability and reliability are becoming more and more important
- In current Internet architecture, IP address acts as both identity and topological location of host.
  - Multi-homed hosts significantly increase the routing table size.

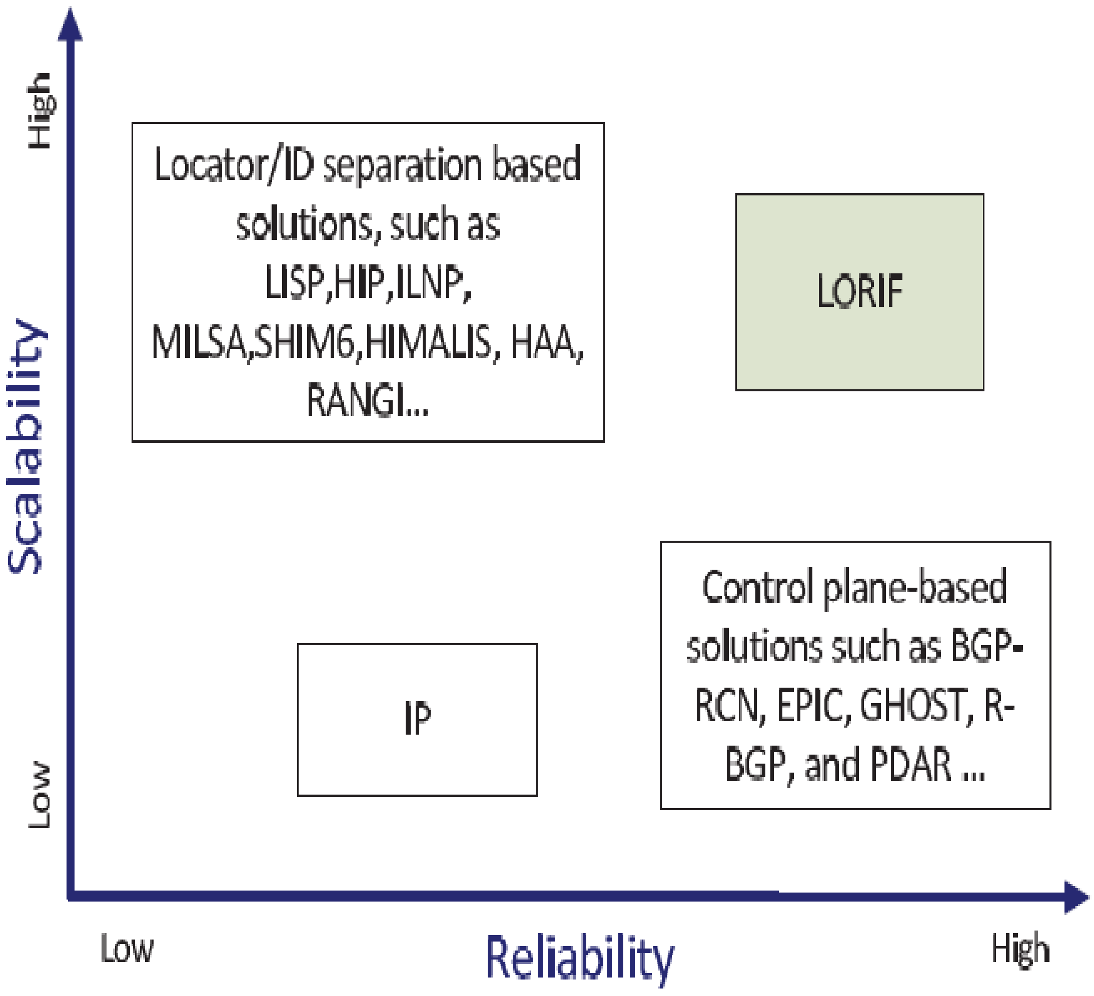
Our Goal

A scalable and reliable architecture for future Internet

- Our approach:
  - Design and implement LORIF:
    - Location-based routing
    - (L)ID-based forwarding
    - Host ID and Location split

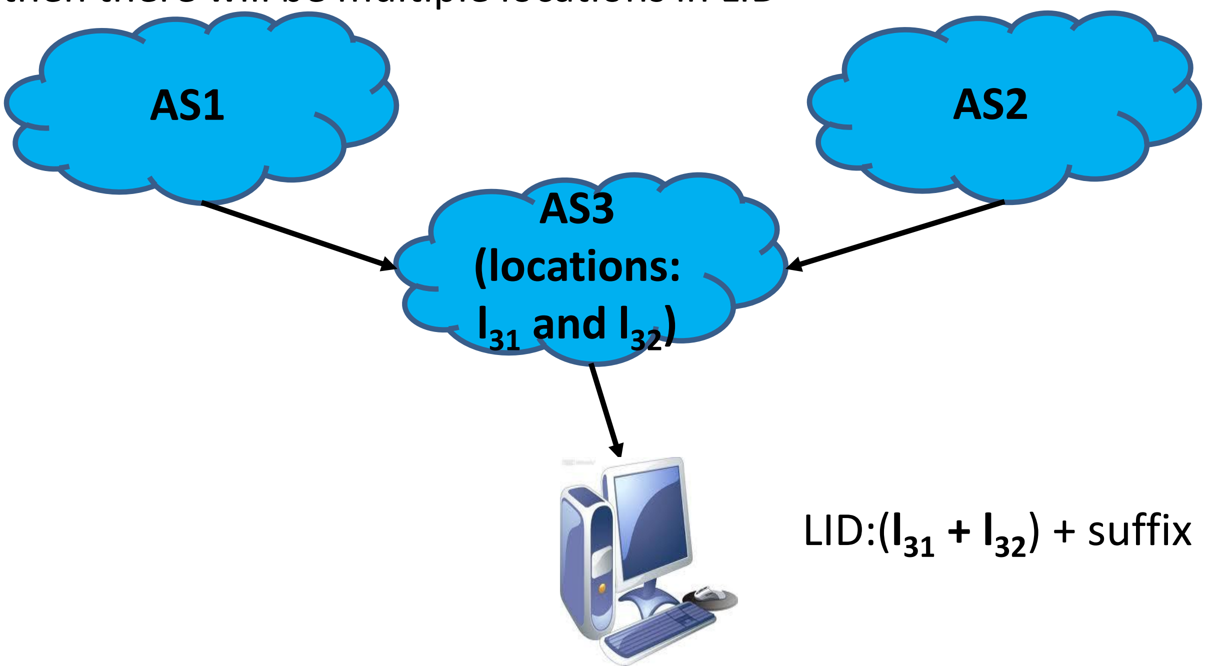
Related Works

- **Locator/ID separation based solutions** can significantly reduce routing table size
- **Control plane-based solutions** improve the reliability of the routing system through additional operations for detecting failures or finding backup paths



Location-based ID

– Location-based ID (LID): Identifier of host in Network Layer which may change according to topological location of AS and is used for forwarding.
– LID consists of two parts: Locations and Suffix
  - Location: Topological location of AS in which host resides in the Internet
  - Suffix: Identifier of host in sub network
– Multi-homed AS has multiple topological locations in the Internet, then there will be multiple locations in LID



Host ID

- Host ID is the identity of the end host. It should be unchanged and unique in the Internet. Host ID can provide an unchanged name for upper layer.
- A mapping from unchangeable Host ID to changeable LID is needed. According to the unchangeable Host ID, LID which represents the topological locations of the end host is retrieved. Then, in Network Layer, LID can be used for forwarding.

Routing and Forwarding

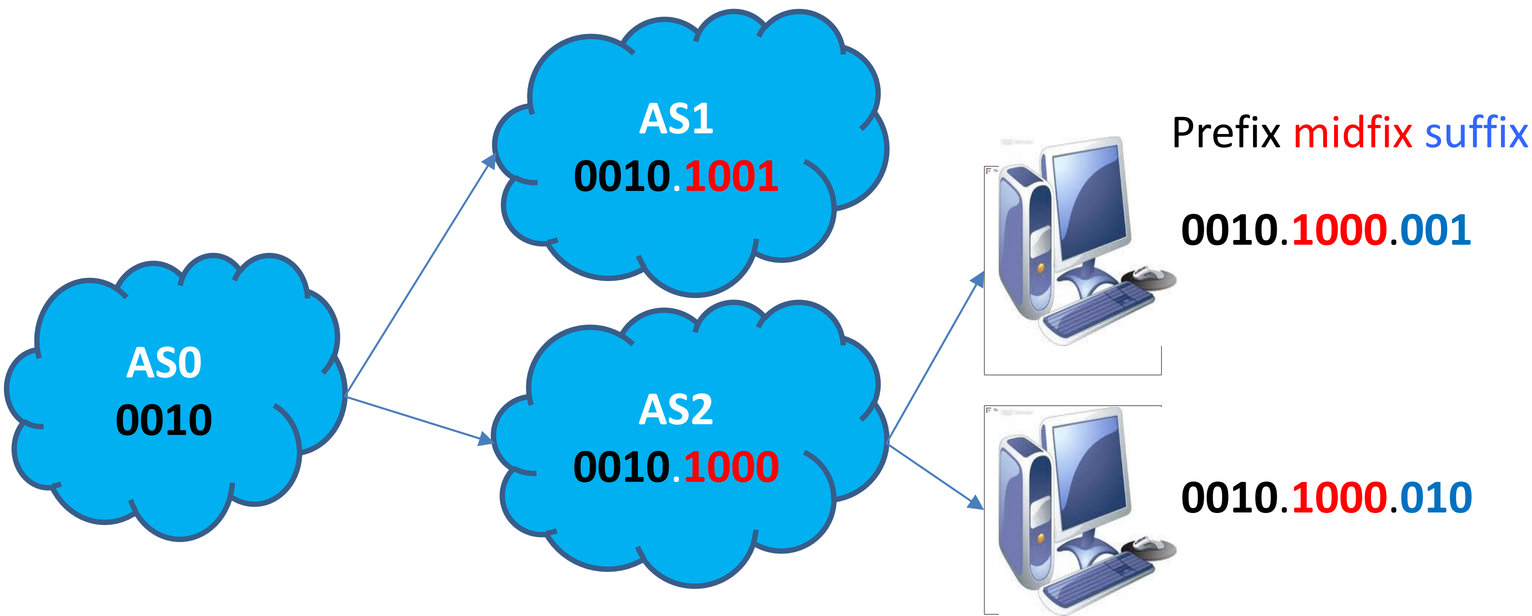
- Location-based Routing
  – Location allocation follows the Internet topology
  – Locations can be aggregated by providers
  – Reduce routing table size
- (L)ID-based Forwarding
  – To improve the reliability of data plane, we provide ID-based forwarding. LID is put into the packet header for forwarding.
  – Multiple locations can be extracted from destination LID in packet header. If one location can not find an available path in forwarding table due to temporary disconnection or node failure, another location in destination LID will be used.

Research Challenges

- Location allocation
  - Locations should be aggregateable
  - Extensible to more customers
  - Support provider switching
- LIDs/Location compression
- Control plane design
- Data forwarding based on LID
- Implementation Issues
  - Provider switching
  - Host mobility
  - Data forwarding on router
  - Control plane on router

Hierarchical Location Allocation

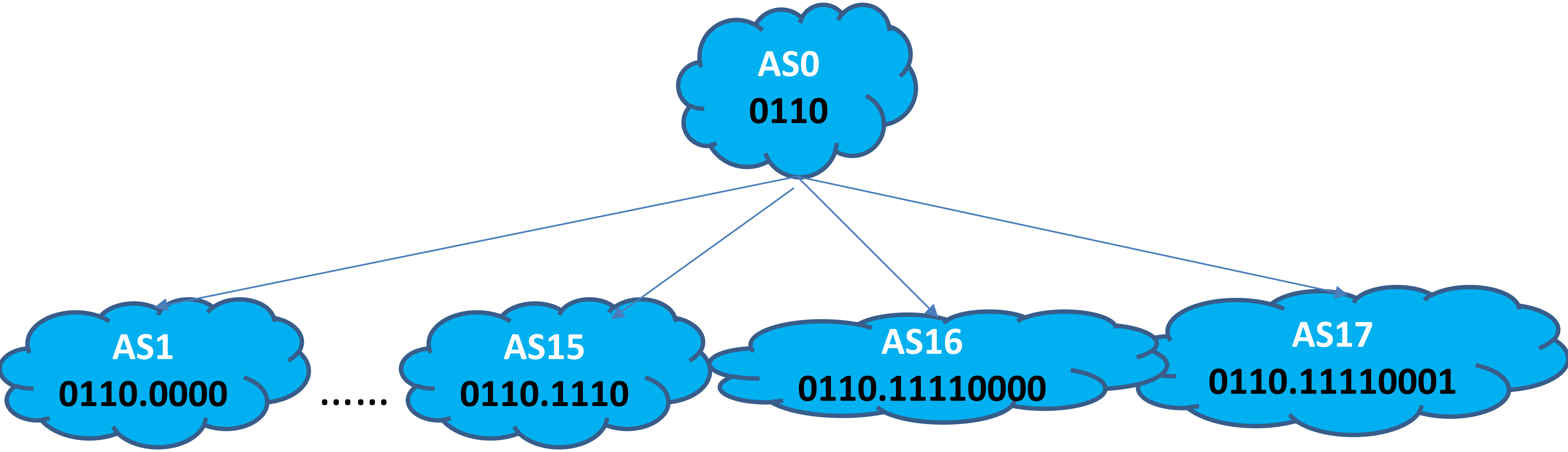
- Hierarchical allocation
  - Keeps locations aggregatable: ASes with same provider have a location with same prefix
- Prefix allocation strategy
  - Every AS inherits its providers' locations as prefixes
  - Tier-1 ASes don't have prefix



Midfix Allocation Strategy

- Every AS gets one **midfix** from each of its providers.
- Tier-1 AS can configure their own unique midfix following the midfix allocation strategy, or be assigned by a centralized authority, such as IANA.
- Default length of midfix is 4 which provides 15 available value initially while the last value is reserved for extension.

Midfix Allocation Example



Extendable: unlimited length and unlimited number of customers

Prefix-free: don't need delimiter between segments

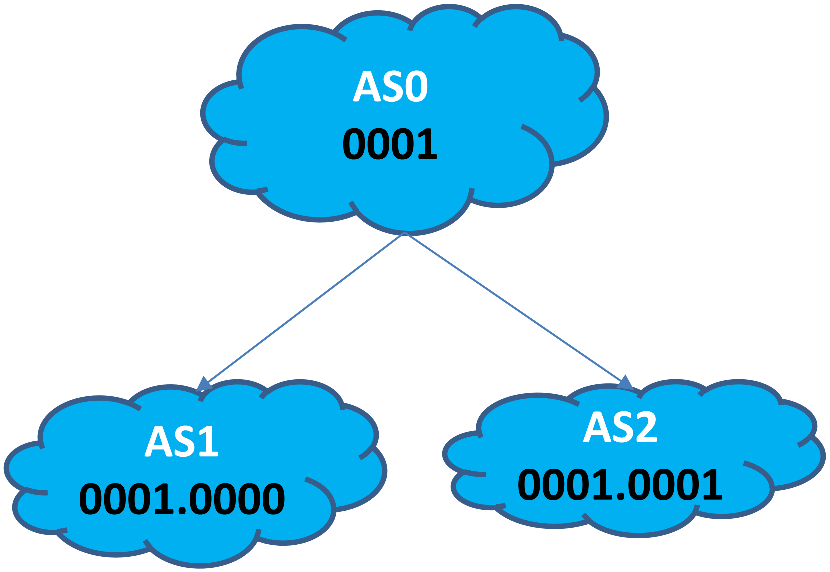
Research Issues

- Multi-homed AS or AS whose provider has more than one AS will have more than one location
- Hosts with multiple locations have a long LID
- Provider switching: connecting provider is not permanent

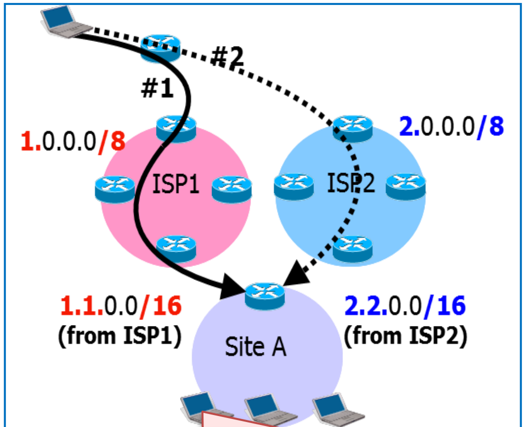
- LID compression
- Capability of assigning multiple locations to an AS

Location Compression

- Location-based compression
  - Location address space is sparse.
  - In the graph, if AS0 only has two customers, midfixes from 0002 to 1111 are not used.
- Midfix-based compression
  - Repeated midfixes (or prefixes)
  - In the graph, 0001 repeats 4 times and this benefits compression.



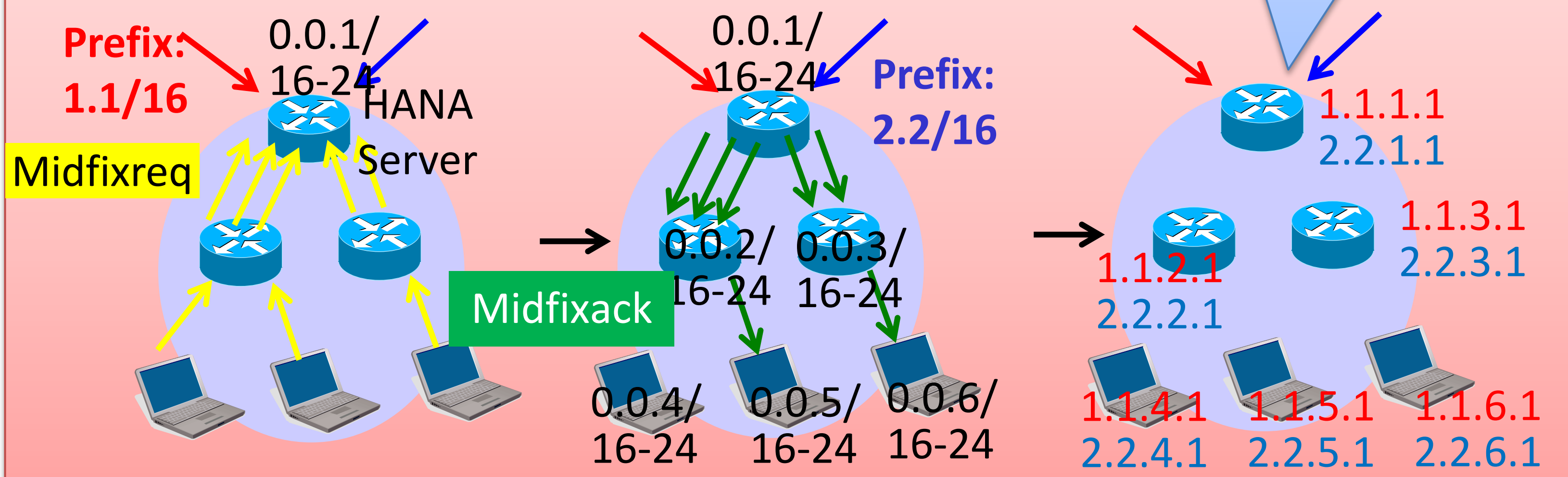
Hierarchical **Automatic** Number Allocation



0	n-1 n	m-1 m	N-1
Prefix	Midfix	Suffix	

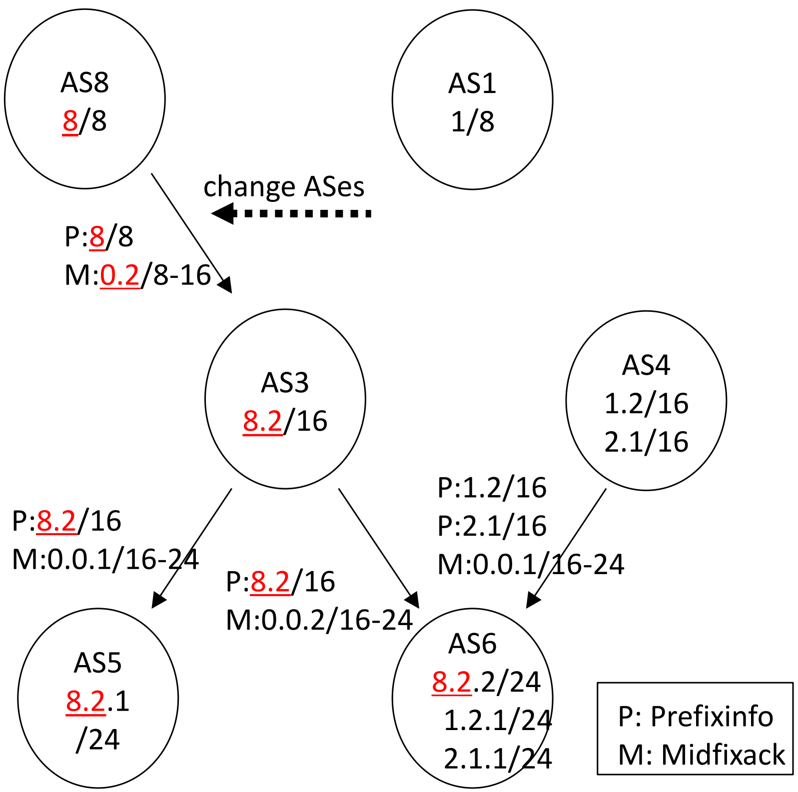
Combine Prefixes (1.1.0.0/16, 2.2.0.0/16) , Midfix (0.0.1/16-24), and Suffix(0.0.0.1/24-32) determined by itself, then yields and assigns locators(1.1.1.1, 2.2.1.1)

Automatic Midfix allocation of hosts/routers in each ISP/site → Reduction of network management costs

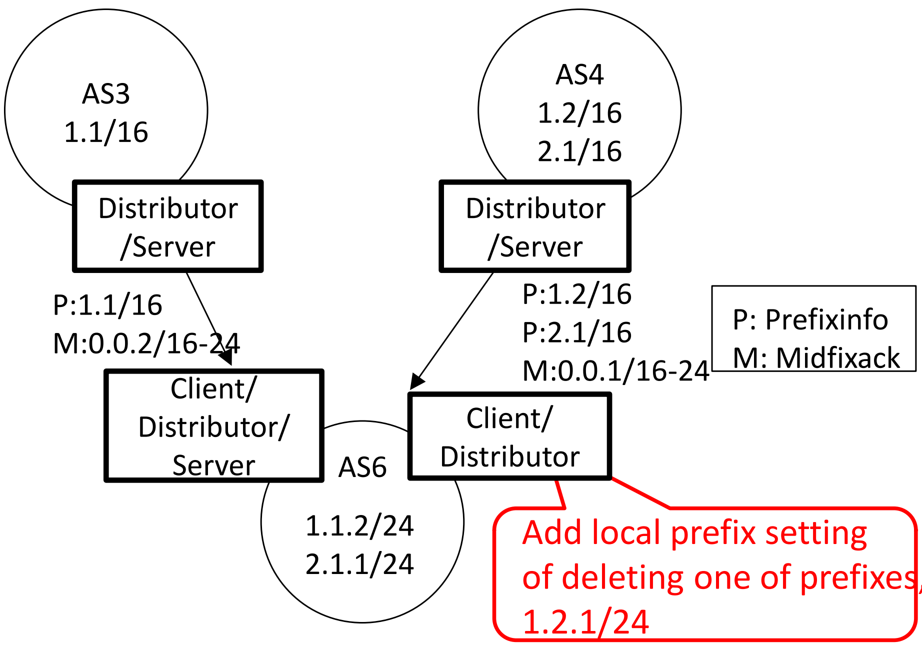


Hierarchical **Automatic** Number Allocation

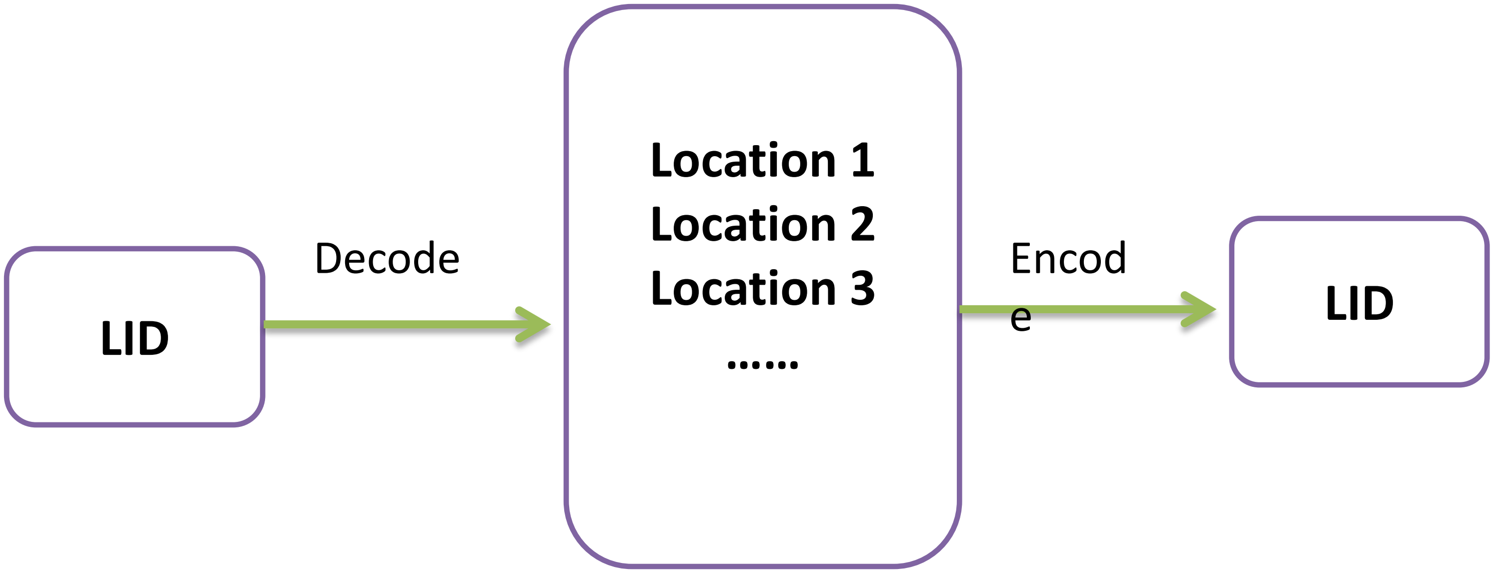
- Capable of dynamic change of allocating locators/locator spaces (developed previously)



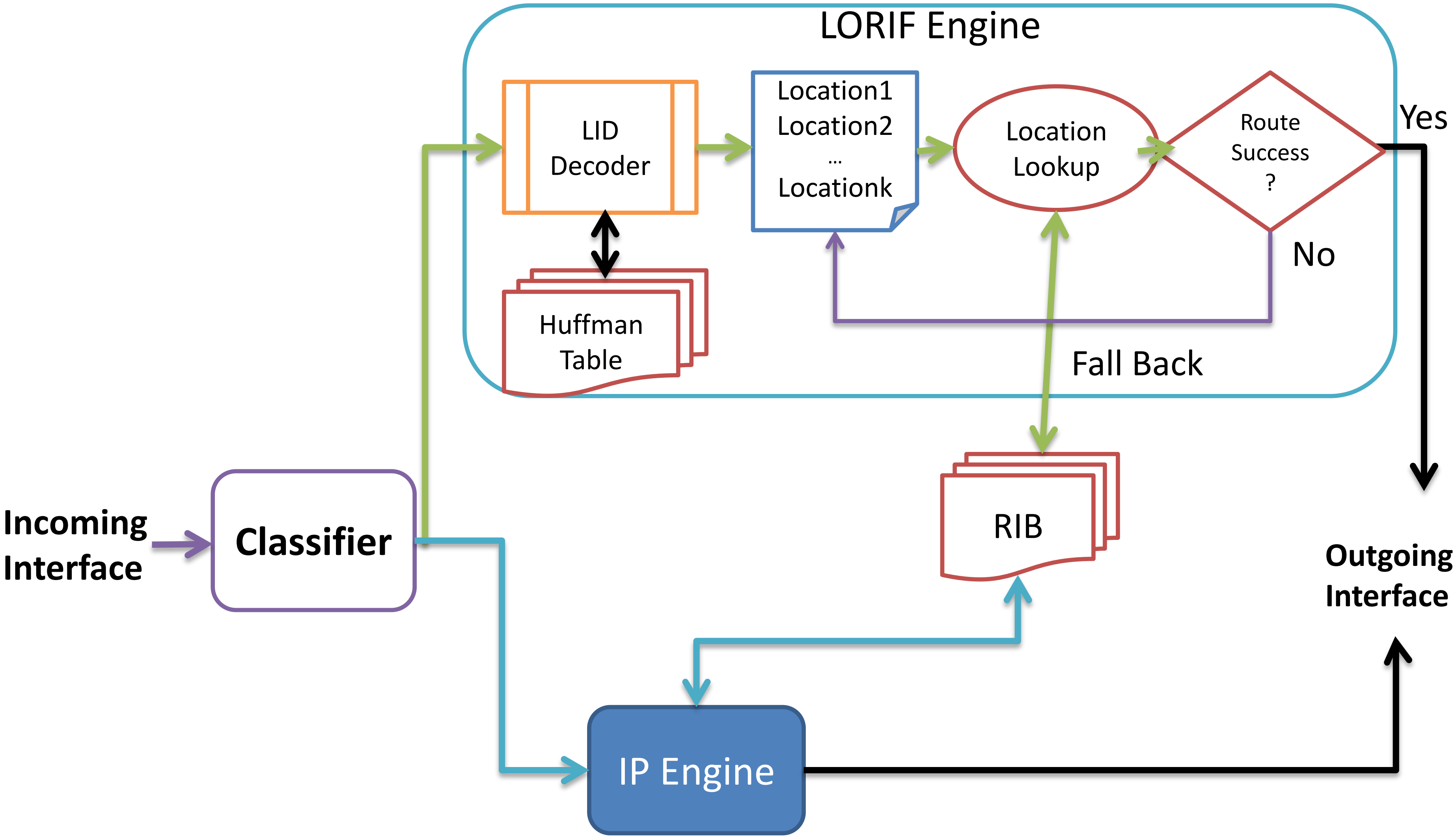
- Selecting prefixes



Decoding LID & Encoding Locations

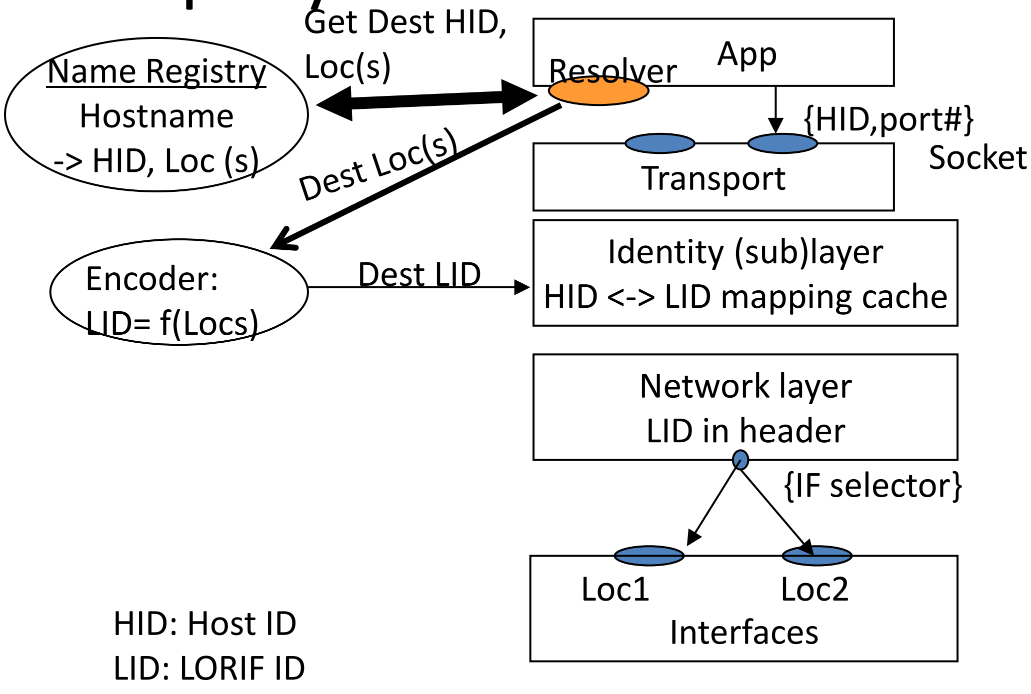


Forwarding Processing

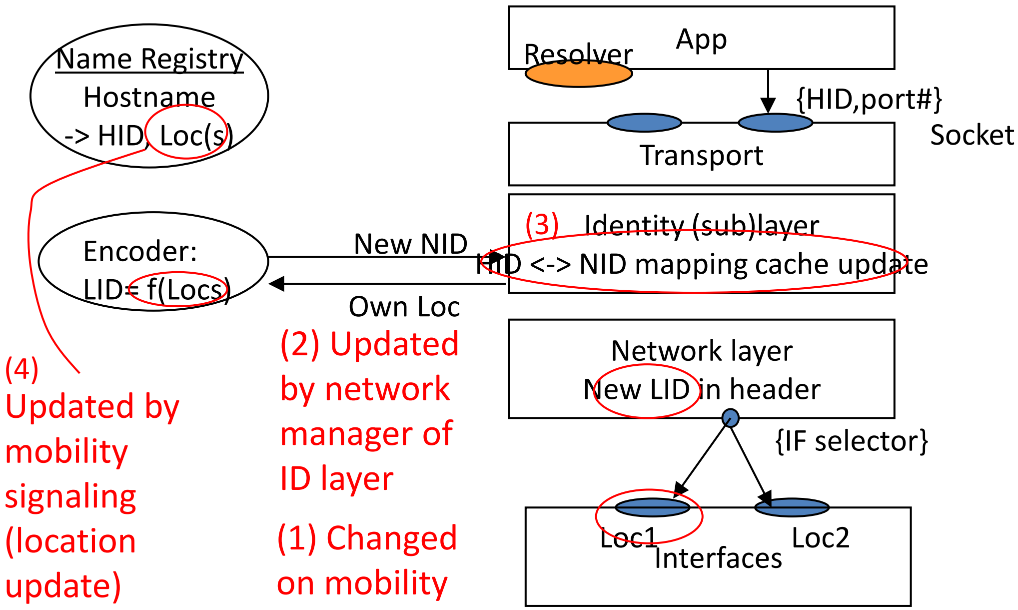


Host Mobility

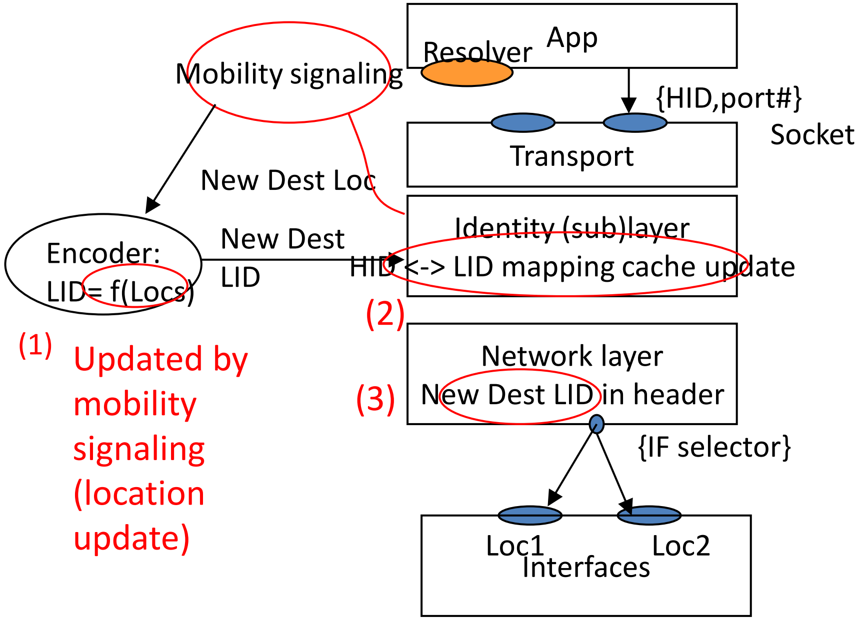
- Maintaining relation <hostname, host id, locations> in the network
  - Relation with LID may be maintained
- Information of location change is synchronized rapidly



Host Mobility



LORIF host (mobile)



LORIF host (correspondent)

Kickoff Project Meeting

- April 2014
- Teams from NICT, Umass, Liberty University met at Umass for two days
- Set out initial goal of the project
- A followup Skype meeting in May 2015
  - Report progress on each side
  - Set out a goal for next month

Collaboration Plan

- Monthly teleconference/face-to-face meeting
- Regular email exchanges
- Jointly publish papers each year
- Initial prototype in the first year

Collaboration Milestone

Host-to-host connectivity
US: Router (primitive) Prototype (Click on Linux), LID Encoding at host
JP: Host Prototype (multihome, signaling) (Linux), HID2Loc Mapping, Design HANA working with ID pairing

Integration of the functions , Lab Test Development (3 Site + VLANs/VPN)
US: Router prototype, Host function enhancement
JP: Host mobility, multipath on multihomed hosts, signaling, HANA for optimum location selection to each AS

Network Deployment (GENI, JGN-X)