Mobility Support in the Internet Using Identifiers

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- **Background**
- Overview & Comparison
- Mobility Handling

Mobility in Future Internet

- Mobility is becoming one of the key demands in the future Internet

- Internet was not created to support mobility

- Difference between Internet and Cellular networks

- There still exist many open questions

Current Solutions

- To support mobility
  - Handle dynamic binding between the mobile and its changing locations
- Routing-based method
  - The mobile is represented by its IP address
  - IP Address-location binding: need dynamic routing
  - Handle mobility in the network layer
- Mapping-based method
  - The mobile is represented by **identifiers**
  - Identifier-IP address binding: need mapping functions
  - Handle mobility in the overlay above the network layer

Identifier-based Solutions

- To support mobility in the global Internet
  - Routing-based solutions may not scale well
  - Mapping-based method should be considered

- Identifier-based solutions
  - A new identifier namespace
  - For not only mobility, but also multi-homing、 multicast, routing scalability, security, …
  - They differ in many aspects in achieving various design goals

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Overview

Solution	Goals	Definition/Structure	Implementation
TCP-Migrate	Mobility	Domain names/Hierarchical	Host change/Transport layer
MobileIP	Mobility	IP address/Hierarchical	Network change
ILNP	Mobility/Multi-homing	IP address suffix/Flat	Host change/Network layer
HIP	Mobility/Multi-homing/Security	Hash of public Key/Flat	Host change/Network layer
LISP	Routing Scalability/Mobility	IP address/Hierarchical	Network change
Serval	Service access/Mobility	Service ID	Host/Network change
I3	Mobility/Multicast	/	Clean-slate
FARA/MobiliryFirst/...	Future Internet Architectures	/	Clean-slate

Definition of Identifiers

- IP addresses
  - Mobile IP, LISP
  - Names of nodes in the network layer
- End-point identifier
  - Names of devices/processes/...
- Others
  - Names of services/user/context/content/...
- Different definitions meet various design requirements
- Multiple identifiers may coexist in future Internet

Structure of Identifiers

- Hierarchical identifiers
  - IP address/Domain Name
    - Proposals: Mobile IP/TCP Migrate/…
  - Rely on existing infrastructure for resolution
    - IP network/DNS
- Flat identifiers
  - Self-authenticating names: hash of the public key
    - Proposals: HIP/NID/…
  - Security enhancements
  - Require additional resolution mechanisms (DHT)

Implementation Issue

- Below/in the transport layer
  - Keep API unchanged, but need to modify TCP/IP stack
  - Re-structure brings new features (multi-path)
- Above the transport layer
  - No modification to TCP/IP stack, but application needs rewriting
  - May need interactions between layers
- In the application layer
  - Easier to implement and deploy
  - Repeat the same functions in various apps
  - Not enough knowledge about the lower layers

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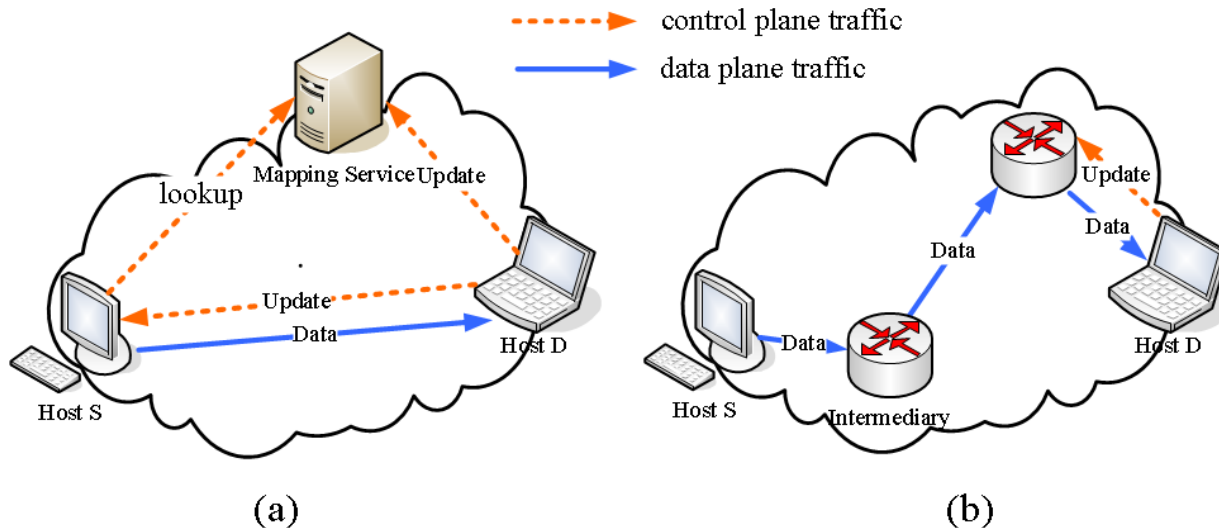- **Mobility Handling**

Resolution on End-nodes

- Both ends are aware of each other's identifiers and exact location

- Most solutions rely on DNS

- Proposals: ILNP/HIP/TCP Migrate/Serval/…

(a)   (b)
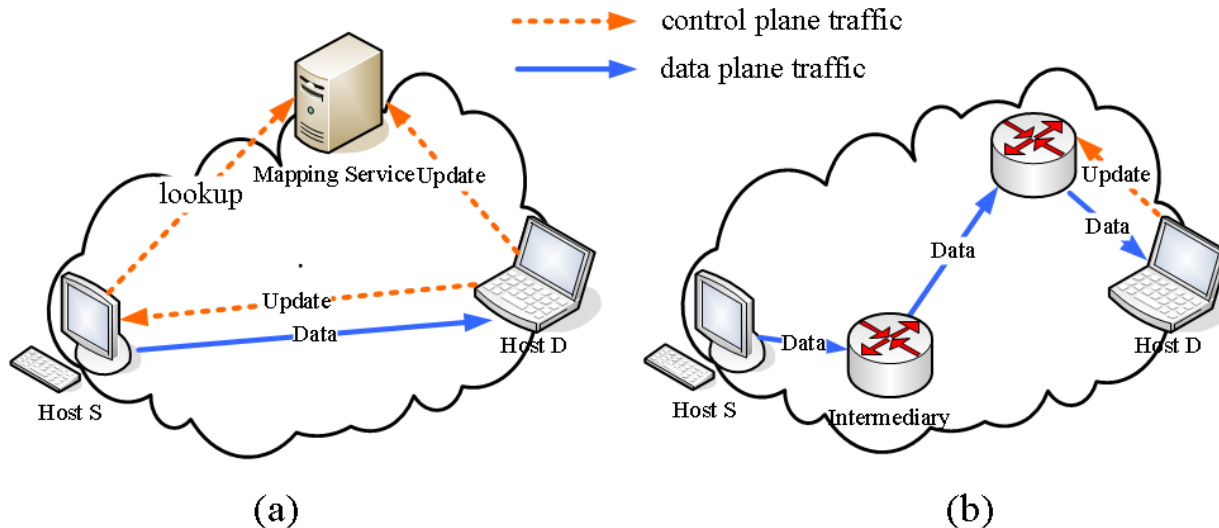
Resolution with Intermediaries

- One or both ends are not aware of the exact locations of its correspondent

- Employ rendezvous to resolve identifiers

- Proposals: Mobile IP/I3/LISP/NID/…

Hybrid Solutions

- Enable both types of resolution methods
- Clean-slate designs that highlight mobility support using identifiers
- Proposals: FARA/MobilityFirst/…

(a)   (b)
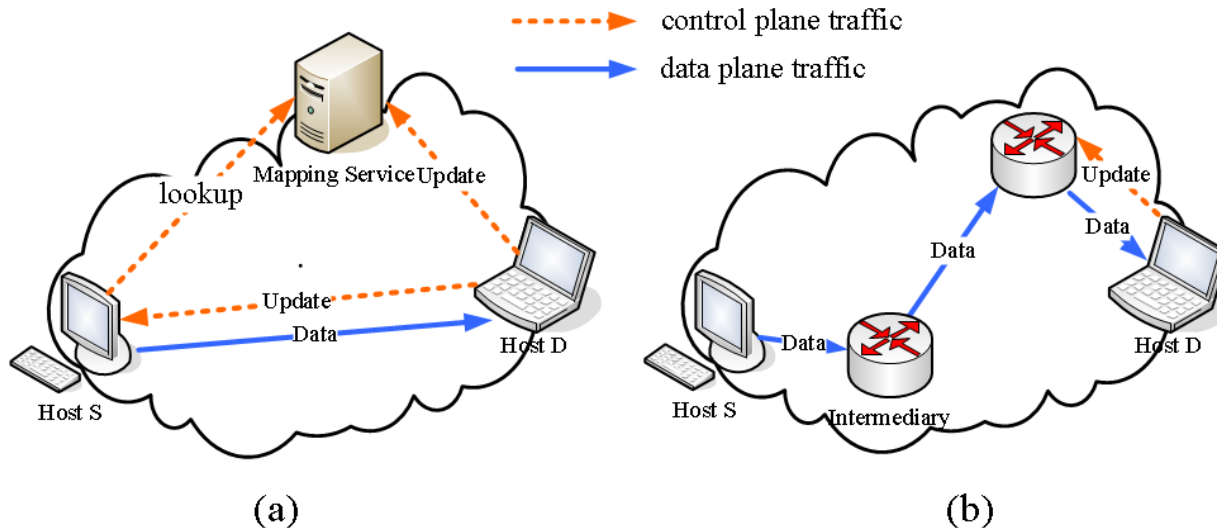
Mobility Management

- Location management
  - In cellular network: Track the location of MT
    - Location update/call delivery
  - In the Internet: maintain/disseminate mobile's identifier-locator bindings
    - Mapping update/lookup/…
- Handoff management
  - In cellular network: keep a MT's connection active when roaming
  - In the Internet: Ensure packets are forwarded to the mobile's latest location in time

Another Viewpoint

- Identifier-based solutions: handle mobility in the overlay network
  - ID-IP resolution is a level of indirection
  - Overlay routing: based on identifiers
- Location management
  - Disseminate routing information
  - Set up logical links towards destinations
- Handoff management
  - Maintain the logical links
  - An individual protocol for handover

Identifier Overlay Network

IP Network

S

X

Z

Y

D
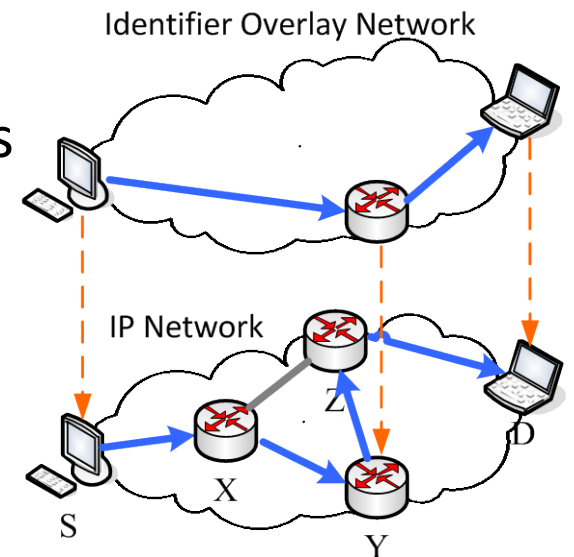
Location Management

- Rely on a global infrastructure
  - DNS/DHT/…
  - Run a centralized/distributed protocol
  - Mapping storage/lookup/update

- Not a particular research point in mobility-related solutions
  - Widely studied in many areas

Handoff Management

- Keep the mobile's mapping up-to-date
  - Propagate new mappings in the overlay network

- Mobility may bring frequent mapping updates
  - A heavy overhead to the overlay network
  - Cause more packet loss due to stale mappings
  - A key issue in mobility-related solutions

Handoff Management: Tradeoff

- Localize the mapping updates
  - Deploy rendezvous
    - Introduce intermediary nodes in the overlay
  - Benefits in both lowering control overhead and keeping mappings up-to-date
  - But may result in a path stretch in the data plane
    - As packets need to pass the rendezvous
- Tradeoff between propagation scope of mapping updates and routing path stretch
  - loss of mapping information on the overlay nodes

Handoff Management: Solutions

- End-to-end ways
  - Propagate mapping updates to all the correspondent
  - No path stretch, but have drawbacks in some scenarios
    - For frequent roaming nodes, packet-loss sensitive apps, …

- Employ rendezvous
  - Propagate mapping updates to fewer nodes
  - May bring path stretch
    - For nodes away from rendezvous, delay-sensitive apps, …

- Hybrid solutions?
  - Choose optimal resolution methods in different mobility scenarios

Conclusion

- Various solutions take diverse ways to support mobility in the Internet
- Mobility protocols may be heterogeneous in the future Internet
  - Different protocols to meet various service demands

Questions?

Thank you!