A Novel Incrementally-Deployable Multi-granularity Multihoming Framework for the Future Internet

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These slides and Audio recordings of this talk are at:
http://www.cse.wustl.edu/~jain/papers/slice.htm
1. Problem
2. Current Solutions
3. Our Solution
4. Quantification of benefits
Trend: Multihoming + Mobility

- Cloud computing and storage
- Anytime Anywhere computing
- Dynamically changing Locator
- User/Data/Host/Site/AS Multihoming
- User/Data/Host/Site Mobility
- Multihomed stub ASs have doubled in the last 5 years, and their routing prefixes have increased by 50%

Mobile Telephony already distinguishes ID vs. Locator
We need to bring this technology to IP.
Current Solutions

- Host multihoming:
  - Patches to DNS
  - Patches to inter-domain routing (CIDR)
  - New transport protocols (SCTP)
  - ID-Locator split: I3, …

- Often there is no location privacy, no ownership concept

- The ID-Location mapper must belong to the domain of ownership

- AS multihoming is also an issue and is solved by very different methods. E.g., Provider independent address
  Leads to scaling issues in the Internet

- Multi-homing is limited to hosts. Not user or data.
  Data-oriented network (DONA), content-oriented networks, and Mobile People Architecture (MPP)

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Our Solution

1. Define domain of ownership: **Realm**
2. **Tiers** of objects: Users/Data, hosts, sites, AS
3. **Slices**: Grouping of realms

![Diagram showing the relationship between users, hosts, ISPs, and the concepts of user/data multihoming and host/AS multihoming.]

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Design Principles and Goals

- **Principles:**
  - 1. Evolution (Not Revolution) and Coexistence (Backward Compatibility)
  - 2. Incremental Deployment
  - 3. Organizational Control
  - 4. Location Privacy

- **Goals:**
  - 1. Extensibility and Flexibility
  - 2. Support for a Scalable Internet
  - 3. Easiness of Developing a Prototype for Incremental Development
  - 4. Smooth Integration of Security, Mobility, and other Functions
Realms

- Object names and Ids are defined within a realm
- A realm is a **logical** grouping of objects under an administrative domain
- The Administrative domain may be based on Trust Relationships
- A realm represents an organization
  - Realm managers set policies for communications
  - Realm members can share services.
  - Objects are generally members of multiple realms
- Realm Boundaries: Organizational, Governmental, ISP, P2P,…

**Realm = Administrative Group**
Organizational Representation

Realm managers:

- Resolve current location for a given host-ID
- Enforce policies related to authentication, authorization, privacy
- Allow mobility, multi-homing, location privacy
- Different from several other ID-locator splitting proposals. Our Emphasis on organizational control.

Ref: [PAN08]
Organizational Representation: Tiers

Tiers = Realms with similar functions
RHB = Real Hierarchy Blocks = Groups of Realms in a tier
Slices = Groups of RHBs to realize specific multihoming function
Slices

- Tier 1
  - Host Multihoming RHB
  - Site Multihoming RHB
  - Enterprise RHB

- Tier 2
  - Data Multihoming RHB
  - User Multihoming RHB
  - Other Multihoming RHB

RHB: Realm Hierarchy Block

Slice-0
Slice-1
Slice-2
## Terminologies Comparisons

<table>
<thead>
<tr>
<th>Scope</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer</td>
<td>Single host protocol stack</td>
<td>Physical layer, link layer, network layer, transport layer, application layer</td>
</tr>
<tr>
<td>Hierarchy</td>
<td>Any hierarchical structure</td>
<td>Routing hierarchy, social hierarchy</td>
</tr>
<tr>
<td>Realm</td>
<td>Same organization or policy boundary</td>
<td>A user realm, a company realm, a department realm, a routing realm</td>
</tr>
<tr>
<td>Tier</td>
<td>Multiple realms</td>
<td>Infrastructure tier, host tier, data tier</td>
</tr>
<tr>
<td>Slice</td>
<td>Across multiple tiers and RHBs</td>
<td>Slice-0, Slice-1, Slice-2</td>
</tr>
</tbody>
</table>
Host/Site Multihoming Example

- Multihomed Host (MH) monitors links status and updates the bindings between the MH host ID and locators to the RHB-1.
- Network translates the ID to the correct locator of the MH. Thus, location privacy is maintained.
- RHB-1 and RHB-0 have separate and independent ID spaces. Hence, multihoming does not add any complexity in the inter-domain routing system.
Data/User Multihoming Example

- Goal is to create the virtual “multi-attachment”
- We achieve this goal by decoupling the ID and locator semantic and creating “realms” to manage the IDs
Routing Scalability Alleviation

- We estimated two deployment speeds scenarios (10%/year and 20%/year) and found that the total prefixes contributed by the multihomed stub-ASs can decrease significantly. The first one decreases from around 90K to 30K in 5 years, and the second one takes almost 2.5 years to achieve the same results.
Summary

1. Address the current deficiencies in multihoming efforts
2. Extend the multihoming from host/AS to user and data level taking advantage the “multi-attachments” essence
3. Location privacy is important
4. Realm = Organization boundary = Trust domain
5. Id-locator mapping is not disclosed outside the “Realm-Hierarchy” or Slice.