Enhanced MILSA Architecture for Naming, Addressing, Routing and Security Issues in the Next Generation Internet

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These slides and Audio/Video recordings of this talk are at:
http://www.cse.wustl.edu/~jain/papers/emilsa.htm
MILSA = Mobility and Multi-homing Supporting Identifier-Locator Split Architecture

1. Internet 3.0 and our project
2. Problems with the current Internet
3. Our proposed solution: MILSA
4. Enhancements to MILSA
Internet 3.0: Next Generation Internet

- Internet 3.0 is the name of the Washington University project on the Future Internet (inspired by NSF’s FIND and GENI)
- Project supported by Intel and Huawei
- Named along the lines of “Web 2.0”
- Goal 1: Develop a *clean slate architecture* to overcome limitations of the current Internet
- Goal 2: Develop an *incremental approach* to implement the architecture
Internet Generations

- **Internet 1.0** (1969 – 1989) – Research project
  - RFC1 is dated April 1969.
  - ARPA project started a few years earlier
  - IP, TCP, UDP
  - Mostly researchers
  - Industry was busy with proprietary protocols: SNA, DECnet, AppleTalk, XNS

- **Internet 2.0** (1989 – Present) – Commerce ⇒ new requirements
  - Security  RFC1108 in 1989
  - NSFnet became commercial
  - Inter-domain routing: OSPF, BGP,
  - IP Multicasting
  - Address Shortage IPv6
  - Congestion Control, Quality of Service,…
Problems of Current Internet

1. Trusted $\Rightarrow$ Un-trusted
2. Control, management, and data path intermixed
3. Perimeter based.
4. Difficult to represent organizational, administrative hierarchies and relationships.
Problems of Current Internet

- Security
- Mobility
- Multi-homing
- Two type addresses
  - PI: Provider Independent
  - PA: Provider Aggregatable

1. Multi-homing is PI based
2. Easy for end-site, but put high burden to the routing system
Problems of Current Internet

ARPANet → Internet

Commercialization

- Security
- Mobility
- Multi-homing
- Scalability
- Traffic Engg
- Renumbering

See our Milcom 2006 Paper

http://www.cse.wustl.edu/~jain/papers/emilsa.htm

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Key Problem: Overloaded Semantics of IP Addresses

TCP: “I need it to be session identifier”

Routing System: “I need it to be routing locator”
Physical vs Logical Connectivity

- Physically and logically connected: All computers in my lab = Private Network, Firewalled Network
- Physically disconnected but logically connected: My home and office computers
- Physically connected but logically disconnected: Passengers on a plane, Neighbors, Conference attendees sharing a wireless network, A visitor

Physical connectivity ≠ Trust
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**
- Address of an object indicates its *physical attachment point*
- Networks are organized as a set of *zones*
- Zones are *physical* grouping of objects based on connectivity. Does not imply trust.

**Zonal Hierarchy = Network Structure**
Id-Locator Split Architecture (MILSA)

- Realm managers resolve current location for a given host-ID ⇒ Provides privacy and organizational control
- Allows mobility, multi-homing
- Ref: Our Globecom 2008 paper [3]
MILSA: Key Features 1

- Hierarchical URI-like Identifiers (HUI): Example

```
“Education, WUSTL, US, Mail, John, {Hashed key}”
```

<table>
<thead>
<tr>
<th>Type code</th>
<th>Org code</th>
<th>Country code</th>
<th>App. code</th>
<th>End-host code</th>
<th>Hashed code</th>
</tr>
</thead>
</table>

- HUI can have same length as IPv6 address for transition benefit
- Realm Manager:
  Realm-Zone Bridging Server (RZBS)
- Provides the ID to locator translation
- Trust Relationship: Realm managers belong to a realm and have trust relationships with its clients and higher level realm managers. Set up trust relationship with other realm managers as needed.
MILSA: Key Features 2

- Control and data plane separation:
  Realm manager is used only in the control plane
  (Resolving Names/IDs to locators)

- A node can register multiple locators in multiple zones with a realm manager ⇒ Multihoming

- Object Delegation:
  A node can register other node or realm manager as proxy ⇒ Allows location privacy
Problems for the Current Internet

- Routing scalability
- Traffic engineering
- Mobility
- Multi-homing
- Renumbering
- Security
- Incremental deployment

Current Proposals

- Two possible approaches:

  **"ID/Locator Split"**

  **Pros:**
  - Clear
  - Mobility, Multi-homing support
  - Trust, policy enforcements

  **Cons:**
  - Need host modifications

  **"Core-edge separation"**

  **Pros:**
  - No host Modification

  **Cons:**
  - Mobility, Multi-homing
  - Trust, policy enforcements
Current Proposals

- "Core-edge separation" mechanisms are to solve the routing scalability problems
  - *IP-in-IP tunneling*: LISP-ALT, LISP-NERD, APT, IVIP, TRRP, CRIO
  - *PI-PA indirection*: SIX/One
    PI = Provider Independent address
    PA = Provider Aggregatable address

- "Id/Locator Split" trying to solve other different parts of the problem space
  - HIP (mobility, security), Shim6(multihoming), I3(mobility, multicast), Hi3(mobility, security).
Enhanced MILSA Approach

- Hybrid design = Combines *Core-edge separation* and *ID/Locator split*.
  - One solution for all problems identified by the routing research group (RRG)
    - Prevent PI addresses usage for global routing
    - *ID/Locator split* to gain benefits in mobility, multihoming, renumbering, security, etc.
    - New *Secure ID system* for naming: two different name spaces for two different purposes (not like currently overloaded IP addresses)
    - Support for future *integrated service architecture*
    - Support for *smooth transition and incremental deployment*
Hybrid Transition

- Allows coexistence, put the decision to future competence
  ⇒ reduce investment risk
- Allows evolvement in either direction
- Deploy incrementally, and reduce the global routing table size gradually
- Legacy hosts and new hosts coexist and can talk to each other

Ref: Our Globecom paper [3]
Summary

1. Internet 3.0 must be designed for commerce
   ⇒ Must represent multi-organizational structure and policies
2. Realm managers in Mobility and multi-homing supporting ID-locator split architecture (MILSA) enforce trust policies while allowing mobility, multi-homing, scalability, ...
3. Hybrid transition mechanism allowing both core-edge separation and id-locator split strategies to coexist and transit to either direction in the future
4. Incrementally deployable
   ⇒ Allows reducing the routing table size gradually
References


References (Cont)