Namespace Resolution in Future Internet Architectures
draft-wang-fia-namespace-00

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ICNRG Meeting
IETF93 – Prague July 2015
Outline

- Draft Overview
- Summary of existing namespace resolutions
- Requirements of an open namespace management system
- Proposed Namespace Management System
- Conclusion
Draft Overview

- Presents the architecture and implementation of an open and flexible namespace resolution mechanism to be used with Future Internet Architectures.
- This resolution mechanism allows the resolution of different network entities and can be adapted to the needs of network, application and service providers alike.
Namespace and Resolution Protocols Are Essential

- **Namespace**
  - How are names defined?
  - What is the scope of the namespace?

- **Resolution Policy**
  - Which namespaces are involved?
  - How names are resolved?
  - What actions are associated?

- **Resolution Management**
  - Where is name resolution done?
  - How is the resolution initialized and updated?
Summary of Existing Schemes (1)

- Many namespaces in existing and future networks
  - Defined by different entities
  - With various naming styles
    - URL (human readable, hierarchical)
    - Fixed-sized (IP, IP+Port, MAC address, GUID in MobilityFirst)
    - Flexible (XID in XIA)
    - Attribute (SID:PID in PURSUIT, naming in GreenICN)
    - Compression (RoHC)
  - Valid in different scopes
    - Global
    - Regional (e.g., local network in NAT)
    - Two ends of a link (e.g., in RoHC)
    - Single point (e.g., IP routing at individual router)
Summary of Existing Schemes (2)

- Many name resolution policies
  - Different number of namespaces involved
    - Two Namespaces: DNS, NAT, …
    - Multiple Namespaces: NDN, GreenICN
  - Different resolution directions
    - One-way: DNS, IP Routing, ASP Messaging, MobilityFirst, PURSUIT routing
    - Two-way: NAT, RoHC
    - Sequential: NDN, GreenICN
    - DAG: XIA
Summary of Existing Schemes (3)

- Many name resolution policies
  - Different number of resolution results
    - One-to-one: NAT, RoHC, IP Routing (unicast, single path)
    - One-to-many: DNS, IP Routing (multicast)
  - Different resolution algorithms
    - Exact matching: NAT, RoHC, DNS,
    - Longest matching: IP routing
    - Bloom filter: PURSUIT content routing
  - Different following actions
    - Forwarding: IP routing, NDN routing, PURSUIT content routing, XIA routing
    - Translating/Updating: DNS, NAT, RoHC, MobilityFirst, GreenICN
    - Caching: NDN
Summary of Existing Schemes (4)

Many name resolution management schemes

- Location of the resolution
  - Local: NAT, IP routing, NDN routing, XIA routing, PURTSUIT content routing
  - Remote server: DNS, ASP messaging, MobilityFirst, GreenICN, SDN controller
    - Protocol needed
  - Two end points of a link: RoHC

- Resolution update
  - Single node: NAT gateway (static or manual, dynamic)
  - Hierarchical: DNS servers, SDN (two-level: controller, router)
  - Distributed: Routing protocols (IP, NDN), DHT (MobilityFirst)
  - Two end points of a link: RoHC
Issues of existing namespace resolution systems

- Many namespaces, many resolution policies, and many resolution management schemes
- Inflexible routing in a particular domain
- Reduced performance due to name resolution managed by different entities
- Unclear (or inefficient) interoperation among different FIAs
Requirements

- Design a generic namespace management framework
  - Supporting different types of namespaces
  - Supporting different resolution policies
  - Supporting different resolution management schemes
  - Improving flexibility for routing
  - Enabling co-existence and Interoperability
    - For different architectures/protocols/schemes on same physical infrastructure
  - Enhancing security and privacy protection
 Define namespaces and resolution policies flexibly
  - Open and unified APIs
  - Access control
Definable Routing (Continue)

- Define private/anonymous network on public network infrastructure
- Definability
  - private/anonymous network by namespaces and policies on public network infrastructure
- Flexibility
  - Changing Source/Destination Name by policies for anonymous communication
- Security & Privacy
  - Segment-by-segment Communication.
  - Fully control of routing and resolution
Co-existence of different FIAs

- Flexible name resolution policy for any particular routing scheme.
Compatibility/Interoperability

- Deploy different network schemes/protocols in a unified framework
- Example: Interoperability between NDN and MobilityFirst
Support better mobility

REQUEST FOR SWITCHING
A possible System Architecture

- Control Plane
  - Register namespaces and resolution policies
  - Define access control policies

- Data Plane
  - Policy execution
    - Filters
    - Actions
  - Logic/Algorithms
    - Namespace looking up
    - Longest Matching
    - Compression
    - Translation
    - ...
Define Namespace and Policy

Packet

Policy

- Filter
  - The condition of accessing a namespace
    - For a namespace, e.g.: IF (SourceName==“Alice”) { Input(); }
    Only the packets from Alice can be processed by this namespace.
    - The condition of hitting an entity of a namespace
      - For a Entity, e.g.: IF (DestinationName.IndexOf(“Bob”)!=-1) { Action(); }
      When a packet with a destination name contains “Bob”, there is lookup matching.
  - Action
    - What should be done when a lookup matching has been found (hit a entity)
      - E.g.: ForwardToInterface(“Interface_0”);
      The packet hit this entity will be forwarded to interface “Interface_0”
    - What should be done when no lookup matching has been found in the whole namespace
      - E.g.: ForwardToNamespace(“PIT”);
      If there is no entity hit in the current namespace, forward this packet to namespace “PIT”
Define Namespace and Policy

- **Namespace**
  - Metadata
    - Name
    - Tag
    - Filter
    - Default action (i.e., action to be done when no lookup matching can be found)
  - Entities
    - Name
    - value
    - Action
    - Filter
    - Other extend fields e.g.: status, timestamp …
Conclusion and Next Steps

- We have introduced a new namespace management system that is compatible with any FIA
  - We believe this is needed to interoperate between the different architectures

- Next steps:
  - Interest from the group? Comments on the group page
  - V1 of the draft after comments
  - Approval by the WG as WG-draft
Extra Slides
Future Internet Architectures (FIAs)

Which one will be the winner?
Or we can let them work together!
Domain Name System (DNS)

- **Namespaces**
  - URL (global)
  - IP Address (global)

- **Resolution policy**
  - One-way: URL to IP Address
  - One-to-many mapping
    - One URL to one or multiple IP addresses

- **Resolution management**
  - Resolution at a DNS server
  - A hierarchical architecture for DNS servers
Network Address Translation (NAT)

- **Namespaces**
  - Private IP Address and Port
  - Global IP Address and Port

- **Resolution policy**
  - Bi-directional
  - One-to-one
    - With different restrictions

- **Resolution management**
  - At a gateway
  - Static
  - Dynamic
IP Routing

- Namespaces
  - IP Address (global)
  - Interface ID (in router)

- Resolution policy
  - One-way: IP address to Interface ID
  - Longest match
  - Following action
    - Forwarding

- Resolution management
  - At router
    - SDN: router + controller
  - Update
    - Distributed: Routing protocols: BGP, OSPF …
    - Centralized (two-level hierarchy): SDN
  - Creation / Update algorithms: Shortest path, QoS, …
Resolution in Mobile Communication
Example: Robust Header Compression (RoHC)

- Namespaces
  - Original Header (local)
  - Compressed Header (local)

- Policy
  - Bi-directional
  - One-to-one

- Management
  - Resolution at individual compressor/decompressor
    - E.g., at two ends of a wireless link
  - Header compression
Naming by Application Service Provider (ASP)
Example: Messaging

- **Namespaces**
  - User ID (global)
  - Device Network Address (NA) (global)

- **Resolution policy**
  - One-way
  - One-to-one or One-to-many (Skype)
  - Different restrictions:
    - Accessibility verification
    - Management
      - Defined by ASP
MobilityFirst (Destination Resolution)

- Namespaces
  - GUID
  - Network Address (NA)

- Policy
  - One-way: GUID to NA

- Management
  - Resolution at distributed server
  - Resolution servers are chosen by distributed hash table (DHT)
  - Update
    - Dynamic / Late binding
NDN (Routing for Content Request and Content)

- **Namespaces**
  - URL-like name (global)
  - Interface ID (local)
  - Cached content ID (local)

- **Policy**
  - When receives an interest packet
    - Sequential: CS->PIT->FIB
  - When receives a data packet
    - Once: PIT (one-to-many)

- **Management**
  - Resolution at individual router
  - Update architecture
    - Local: CS, PIT
    - Distributed: FIB
Internames-Green ICN (Destination Resolution)

- **Namespaces**
  - A: Object Name (e.g., URL)
  - B: <realm, dst, SD>
  - C: <gateway, SD>

- **Policy**
  - One-to-one
  - One-way
  - NRS: A->B
  - RRS: B->C (if necessary)

- **Management**
  - Name Resolution Service (NRS)
  - Routing Resolution Service (RRS)
Namespaces
- XID (global)
  - Multiple names are included by using a DAG
- Interface ID (local)

Policy (forwarding)
- One-way: XID to Interface ID
- A sequence of resolution according to the DAG

Management
- Resolution at router
PURSUIT (Content Routing)

- **Namespaces**
  - FID (Regional, associated with a routing tree)
    - Specifying a set of links by Bloom Filter
  - Interface ID (local)

- **Policy (forwarding)**
  - One-way: FID to Interface ID
  - One-to-many

- **Management**
  - FID is calculated by TM