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Namespace Resolution in
Future Internet Architectures
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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
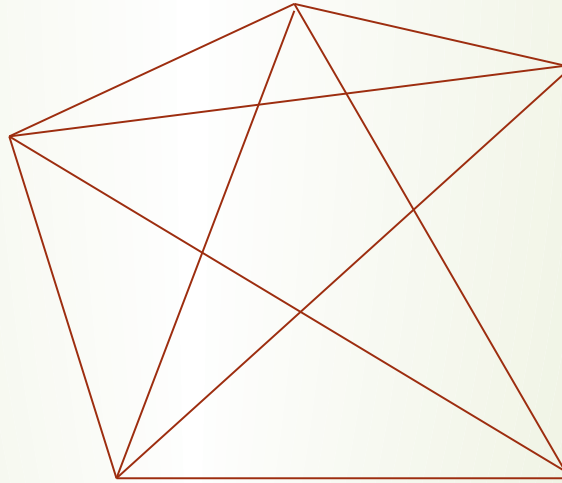
- Namespace
  - How are names defined?
  - What is the scope of the namespace?
- Resolution Policy
  - Which namespaces are involved ?
  - How names are resolved?
  - What actions are associated?
- Resolution Management
  - Where is name resolution done?
  - How is the resolution initialized and updated?

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 frame work

- Example: Interoperability between NDN and MobilityFirst

Support better mobility

Status Updating

NS: User's Device

NS: Alice's Device

TV | 192.168.0.15 | OFFLINE
Phone | 192.168.0.16 | ONLINE
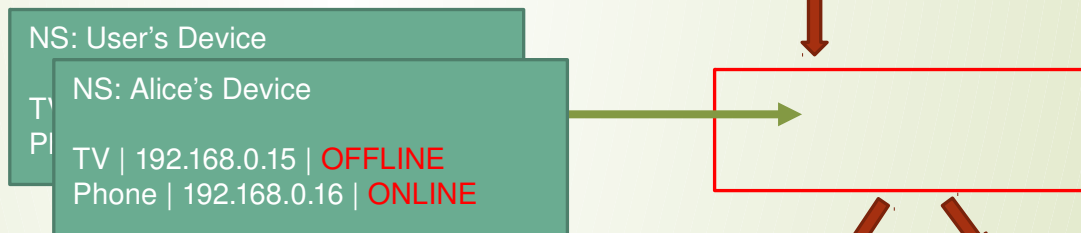
REQUEST FOR SWITCHING

A possible System Architecture

- Control Plane
  - Register namespaces and resolution policies
  - Define access control polices
- Data Plane
  - Policy execution
    - Filters
    - Actions
  - Logic/Algorithms
    - Namespace looking up
    - Longest Matching
    - Compression
    - Translation
    - …

Define Namespace and Policy

- Packet

SourceName	DestinationName	Data

- 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 namepace 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

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Future Internet Architectures (FIAs)

MobilityFirst

XIA

PURSUIT

NDN

GreenICN

......

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)

XIA (Routing)

- 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