Naming and Routing in MobilityFirst Future Internet Architecture

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MobilityFirst: Layered Names and Rich Delivery Services

- Current Internet supports only 1 level of name resolution (DNS) - Hostname → IP address
  - Relegates other objects (service, content, context) to indirect naming
  - Moreover, no support for fine-grain mobility

- Thin in network delivery services
  - End hosts do the heavy-lifting for intermittent problems en-route
  - Pre-eminence of overlay services

- MobilityFirst Proposal
  - Layered naming, and direct address for hosts, services, content, context...
  - Inherent support for mobility
  - Rich in-network services: multicast, multipath, multihoming, anycast
Layered Naming

User-level descriptors
E.g., Joe’s car

Network-level identifier
GUID: public key

 Routable Topological Address
(Network assigned)

Resolution Path

GUID Resolution Service
(Network-level multi-entity cooperative)

Name Certification and Resolution Service
E.g., Toyota Motor Corp.

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GUID Naming for Groups and Abstract Entities

- Aggregate objects under single GUID
  - Reference or Indirection GUID: GUID \(\rightarrow\) GUID-set
  - Example: All cabs of Yellow Taxi Cab company
  - Advantages: efficient group delivery, policy aggregation
  - Challenges: Efficient topological aggregation

- GUID for Services or Context
  - Resolver Services ‘manage’ mappings: user level \(\rightarrow\) network-level (GUID)
  - GUID mapped to end points
    - “Connect me to a taxi service in New Brunswick” (Endpoint = a Taxi Dispatcher Service)
    - “Hail a taxi cab within 5 miles of here“ (Endpoint = Taxi)
Dynamic Resolution of GUID to Network Address: Global Name Resolution Service (GNRS)

- Secure and policy-driven access
- Requirements: Low latency (< 100ms) to support mobile CBR apps
- GNRS operations: INSERT, UPDATE, LOOKUP

**Diagram:**
- **GNRS**
  - Distribution Layer: Load Distribution, Replication
  - Locality Layer: Caching
  - Security Layer: Authentication, Access Control, Encryption

- **Insertion** (INSERT)
- **Update** (UPDATE)
- **Lookup** (LOOKUP)

**End hosts**
- Name Certification Service
  - E.g., Toyota Motor Corp.

**Network**
- Distribution
- Load Distribution
- Replication
- Caching
- Authentication
- Access Control
- Encryption
Progressive GUID-to-Address Resolution:
Global/Local Resolution Services

- Addresses resolved incrementally to progress the packet towards destination network
  - Limits granularity of location at GNRS with finer details at local resolvers
  - Direct binding is optional, but is less desirable for mobile scenarios
- Late binding or re-resolution upon failures

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![Diagram showing the process of progressive GUID-to-address resolution with GNRS, Local NRS, and Destination Network.]
Routing: Flat Names, Edge-Aware, Service-Rich

- Network Topology
  - Minimally hierarchical, flat names for networks
  - Aggregate topological constructs to expose finer topology within a network
  - Dynamic attachments of ad hoc and transient networks

Aggregation Nodes:
Represent aggregate information of sub-graph

Dynamic attachment of ad hoc networks to global network. Reachability may be announced through GNRS
Edge-Aware Inter-Domain Routing

- Approach under consideration is to enhance BGP-like protocols with summary node/link info (aggregate node)
  - Summary knowledge of access net properties (Mbps, % avail, etc.), ingress/egress points and alternate paths exchanged between networks/ASs
  - Network topology information for identifying multiple paths, storage points ...
- Inspired by “Vnode” concept in “Pathlet” routing (Godfrey, 2008)
- Support for multicast, anycast, multihoming and multipath

Example of dual-homing route Supported by routing protocol
Storage-Aware, Disruption-Tolerant Local Routing

- Storage aware (CNF, generalized DTN) routing exploits in-network storage to deal with varying link quality and disconnection.
- Routing algorithm adapts seamlessly from switching (good path) to store-and-forward (poor link BW/short disconnection) to DTN (longer disconnections).
Extensible, End-User Requested Delivery Services

- Compute plane services for in-network packet processing
  - ISP infrastructure services: DDoS prevention, content caching
  - Cloud-computing for end-user services

- Architecture allows for new services to be incrementally added
Summary of Naming and Routing in MobilityFirst

- Architecture embraces layered and direct naming for clean separation of identity and location
  - Mobility

- Groups and contexts named similarly as individual objects
  - Support for references and indirection

- Edge-aware routing to support efficient and flexible delivery options for mobile and multi-homed end points

- Extensible, service-oriented network