LISP MS Federation
LISP-WG IETF 108 July 2020

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Agenda

• Ground Based LISP refresher
• Multi-operator Federation Requirements
• Solutions discussed
Ground Based LISP (GBL) - Reference Topology

AC-R: Access Ground Router
A-R: Airborne Router
A-E: Airborne End-system
A/G-R: Air/Ground Router (LISP XTR)
G/G-R: Ground/Ground Router (LISP XTR)
Ground Based LISP (GBL) – Behavior (1)

Aircraft attaches to one or more A/G Networks

A/G Network advertises reachability of the aircraft delegated prefix (EID)

Aircraft preference and link QoS can be signalled over A/G Network

IPv6 ICAO Net X

Mapping Server maintains RLOC-EID mapping

Each AGR has RLOC address

Aircraft preference and link QoS can be signalled over A/G Network

Map-cache:
Y via
AGR2(50) & AGR1(50)

GGR needs to query which RLOC(s) serve destination EID

EID | RLOC
--- | ---
Y | AGR1 – Priority 1, 50%
   | AGR2 – Priority 1, 50%

Traffic tunnelled over Internetwork

AGR1 – Priority 1, 50%
AGR2 – Priority 1, 50%

Y via
AGR2(50) & AGR1(50)
Ground Based LISP (GBL) – Behavior (2)

Aircraft attaches to one or more A/G Networks

A/G Network advertises reachability of the aircraft delegated prefix (EID)

Aircraft preference and link QoS can be signalled over A/G Network

IPv6 ICAO Net X

Route optimised for served ground users

<table>
<thead>
<tr>
<th>EID</th>
<th>RLOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>AGR1 – Priority 1, 50%</td>
</tr>
<tr>
<td></td>
<td>AGR2 – Priority 2, 50%</td>
</tr>
<tr>
<td></td>
<td>AGR3 – Priority 1, 50%</td>
</tr>
</tbody>
</table>

Map-cache: Y via AGR3(50) & AGR1(50)
Per Application Path Preference

Air-to-ground path decided on Aircraft Router
Ground-to-air path governed by Aircraft defined metrics
Exception routing for certain Apps based on DSCP
ICAO Federated Network

• The International Civil Aviation Organization (ICAO) Aeronautical Telecommunications Network (ATN) is run by a consortium of different providers.
  • This network must support mobility and multi-homing across the different providers.

• The Uberlay model has been proposed as a way to architect this mixed environment. Each provider owns and operates their own xTRs, border-RTRs and Map Servers.

• The providers require a mechanism to peer with each other without requiring an intermediary organization to run the Uberlay for them.
  • A federated Uberlay Mapping System amongst the providers is desirable.
ICAO – Existing peering agreements

CSP A

CSP B

CSP C

CSP = Communication Service Provider

Underlay Inter AS EBGP
ICAO – Uberlay Structure

CSP = Communication Service Provider

Underlay Inter AS EBGP
CSP = Communication Service Provider

ICAO – Uberlay Mapping System Federation

Site-Overlays (west)

Site-Overlays (east)

Inter & Intra CSP Federation
• Each MS/MR services a scope of xTRs
• The MS will hold mappings for the xTRs in its scope

MS = MS+MR in all diagrams
Air Traffic Control (ATC) communications are Regional, but cross-CSPs
A dedicated IP address for ATC (ATC-EID) has been proposed.
Policy: maintain the ATC EIDs local to the region, all CSPs involved must be updated
Airline Operation Control (AOC) communications may traverse CSPs, often an Airline will work with a single global CSP.

A dedicated IP address for AOC (AOC-EID) has been proposed.

Policy: Maintain authority at connecting CSP’s Uberlay Mapping System
- Registrations, Access Control, Accountability
- Path preferences expressed by aircraft, rendered by CSPs
Drivers for Re-homing EIDs across CSP Uberlay Map Systems

- Resiliency and survivability. A problem in one CSP should not impact aircraft connected to other CSPs
- Latency. Minimize RTT of signaling
- Authority assignment. CSPs must be able to autonomously render and assure services, service levels and the enforcement of policies
- Accountability and Audit. CSPs are accountable for all communications of connected devices and must be able to show complete Audit logs
- Trust. Limited across CSPs, governments and other stakeholders
ICA0 – Use Case 3: Multi-link

- Aircraft connects to more than one CSP
- Aircraft sends communication preferences to A/G-Rs (A/G Interface) per GB-LISP
  - Mappings are registered with matching Priorities and Weights
  - Aircraft signals whether it is leaving a link or adding new links
- RTRs register the separate Aircraft mappings in the different Uberlay Map Servers
- Federated MS must merge the mappings for the aircraft
  - Map-Notifications
  - LISP-decent updates
  - Others?
  - Discuss whether there is a need for a site or region identifier
Some policies may dictate path restrictions
Aircraft/Airline preferences
CSP peering agreements
These (x)EID/Application level policies must be enforceable in the Uberlay
Requirements for a Federated Mapping System

• EIDs should be in full control of the SP they attach to.

• The Federated Mapping System in the Uberlay should support the peering agreements by different mechanisms (e.g. engineered paths, etc.)

• Each SP should be autonomous in defining and enforcing policy for EIDs connected to their network. The policy includes constraints derived from peering agreements.

• An EID (aircraft) may multi-home to 2 or more provider networks. So policies would likely need to be enforced at a flow level (Src+Dest RLOCs rather than a Pure Destination EID level)
Options to Consider

• Cache Referral System / DDT
• New Mobility enhancements for a Federated Mapping System
• LISP De-cent
• Others …

• Document as its own draft? Or part of the Uberlay draft?
Concerns

• Avoid replicating the underlay BGP peering topology in the overlay

• The policy applied must be consistent with the underlay peering agreements

• In a federated environment, the policy is flow specific. Destination based policies may not suffice.

• Mobility of EID registrations between Administrative Domains may be a hard requirement. This would mean moving the point of authority in the MS federation (ruling out a few of the existing mechanisms)
Uberlay extensions proposal
1. Map-Request

2. DB Miss, cache Map-Request

3. Send ECM Map Request to All Federation Peers

4. DB Match: Generate Reply
   Optional: Add subs to Paul

4. No DB Match: Calculate Covering Prefix Generate NMR

Paul @ XTR-S MS-W sub to Paul

MS Federation – Map-Request - 1
5. Map Reply with specific EID (Paul)

5. NMR with Covering Prefix (boys)

6. Install/register Mapping for More specific EID (Paul)

6.a. Instantiate subscription to Paul for XTR-W

7. Map-Reply
MS Federation – Registrations/EID Moves - 3

Paul @ XTR-S
XTR-W
XTR-E
MS-S
MS-W
MS-E

8. Map-Register
Paul @ XTR-E

9. Map-Notify (Paul @ XTR-E)
Paul @ XTR-S

10. Receive Map-Notify, update Mappings if present
Paul @ XTR-E

11. Map-Notify (Paul @ XTR-E)

12. Receive Map-Notify, update Map-cache
Paul @ XTR-E

LISP MS Federation
1. Map-Request
2. DB Miss, cache Map-Request
3. Send ECM
   Map Request to All Federation Peers
4. No DB Match:
   Calculate Covering Prefix
   Generate NMR
5. NMR with Covering Prefix (boys-S)

5. NMR with Covering Prefix (boys-E)

6. Received all NMRs: Select/calculate covering prefix for Peter from the different NMRs. Install/register Covering Prefix with empty RLOC set in MS? Do this? or just send an NMR and hold this info in the Map-cache of the requestor?

7. NMR (boys-E)
MS Federation Resiliency – Map-Request – 1b

1. Map-Request
2. DB Miss, cache Map-Request
3. Send ECM Map Request to All Federation Peers
4. DB Match: Generate Reply
   Optional: Add subs to Paul
4. No DB Match: Calculate Covering Prefix Generate NMR
   Paul @ XTR-S MS-W sub to Paul

Map-resolver anycast address
Map-requests are sent to MR anycast
MS Federation Resiliency – Map-Reply – 2b

6. Install/register Mapping for More specific EID (Paul)
6.a. Instantiate subscription to Paul for XTR-W

5. NMR with Covering Prefix (boys)
   - Paul @ XTR-S
   - XTR-W sub to Paul
   - MS-W
   - MS-E

5. Map Reply with specific EID (Paul)
   - Paul @ XTR-S
   - MS-W sub to Paul

4. Instantaneous registration
   - Paul @ XTR-S
   - XTR-W sub to Paul
   - MS-W
   - MS-E

7. Map-Reply
   - Paul @ XTR-S
   - XTR-W sub to Paul
   - MS-W
   - MS-E

Need sync mechanism for 6 and 6a. Send 2 NMR messages per area? Other options/ideas …
MS Federation Resiliency – Registrations/EID Moves – 3b

Send register/notify messages to all MS/MR nodes.

LISP MS Federation
Cache Referral System
1. Map-Register to Ladies MS

Map-Referral Cache is programmed at every Map-Resolver:
Boys: Use MS-S
Ladies: Use MS-W

LISP MS Federation
1. Map-Request to local Map-Resolver

2. Forward Map-Request per Referral Cache

2. DB Match:
   Generate Reply
   Optional: Add subs to Paul

Map-Referral Cache is programmed at every Map-Resolver:
Boys: Use MS-S
Ladies: Use MS-W

LISP MS Federation
3. Map Reply with specific EID (Paul)

Map-Referral Cache is programmed at every Map-Resolver:

Boys: Use MS-S
Ladies: Use MS-W

Mary
Paul

Paul @ XTR-S

MS-S

XTR-W

MS-W

XTR-E

LISP MS Federation
MS Federation: Referral Cache – Registrations/EID

Moves - 3

LISP MS/MR

Border Router

Underlay ASBR

XTR-S

XTR-W

XTR-E

Map-Notify (Paul @ XTR-E)

5. Relay Map-Register per Referral Cache

Paul @ XTR-E

Paul @ XTR-S

XTR-W sub to Paul

7. Map-Notify (Paul @ XTR-E)

6. Receive Map-Register, update Mappings

MS-S

Paul @ XTR-E

MS-E

Paul @ XTR-S

Paul @ XTR-E

Paul @ XTR-S

Map-Referral Cache is programmed at every Map-Resolver:

Boys: Use MS-S
Ladies: Use MS-W

MS-W

Paul @ XTR-E

8. Receive Map-Notify, update Map-cache

MS-W

LISP MS Federation
Pros/Cons

• Pros:
  • Simple model, aligned with DDT logic (single tier).

• Cons:
  • May not satisfy all requirements. SP wants control over EIDs connected to their network so that policies can be enforced.
  • Assumes certain SPs are authoritative for certain EID ranges, regardless of where they connect.