# LISP Multi-AS Backbones

LISP-WG IETF 111 July 2021

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# Agenda

- Uberlay and GB-LISP Recap

- Multi-AS Federation Requirements
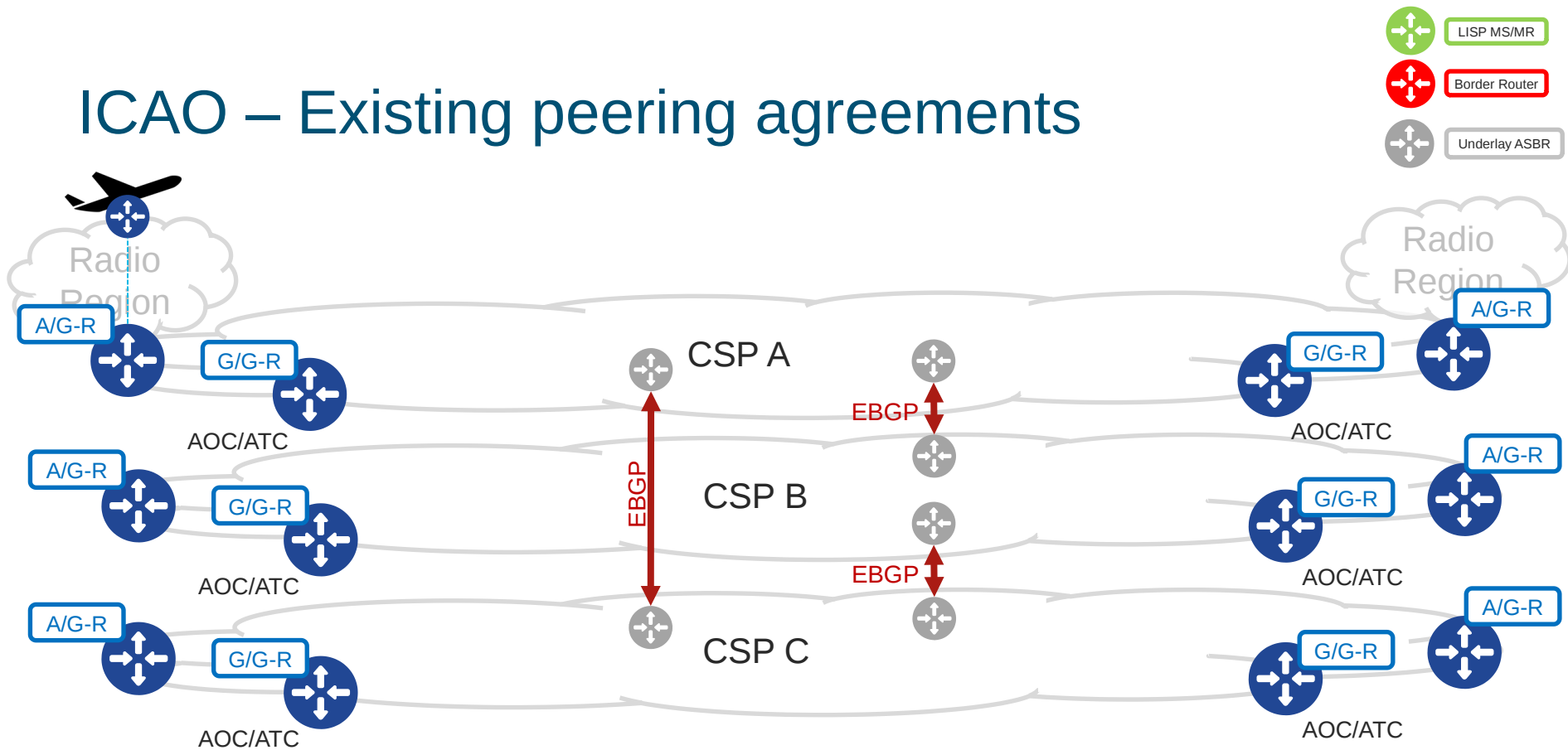
- Next steps

# 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.

- 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.
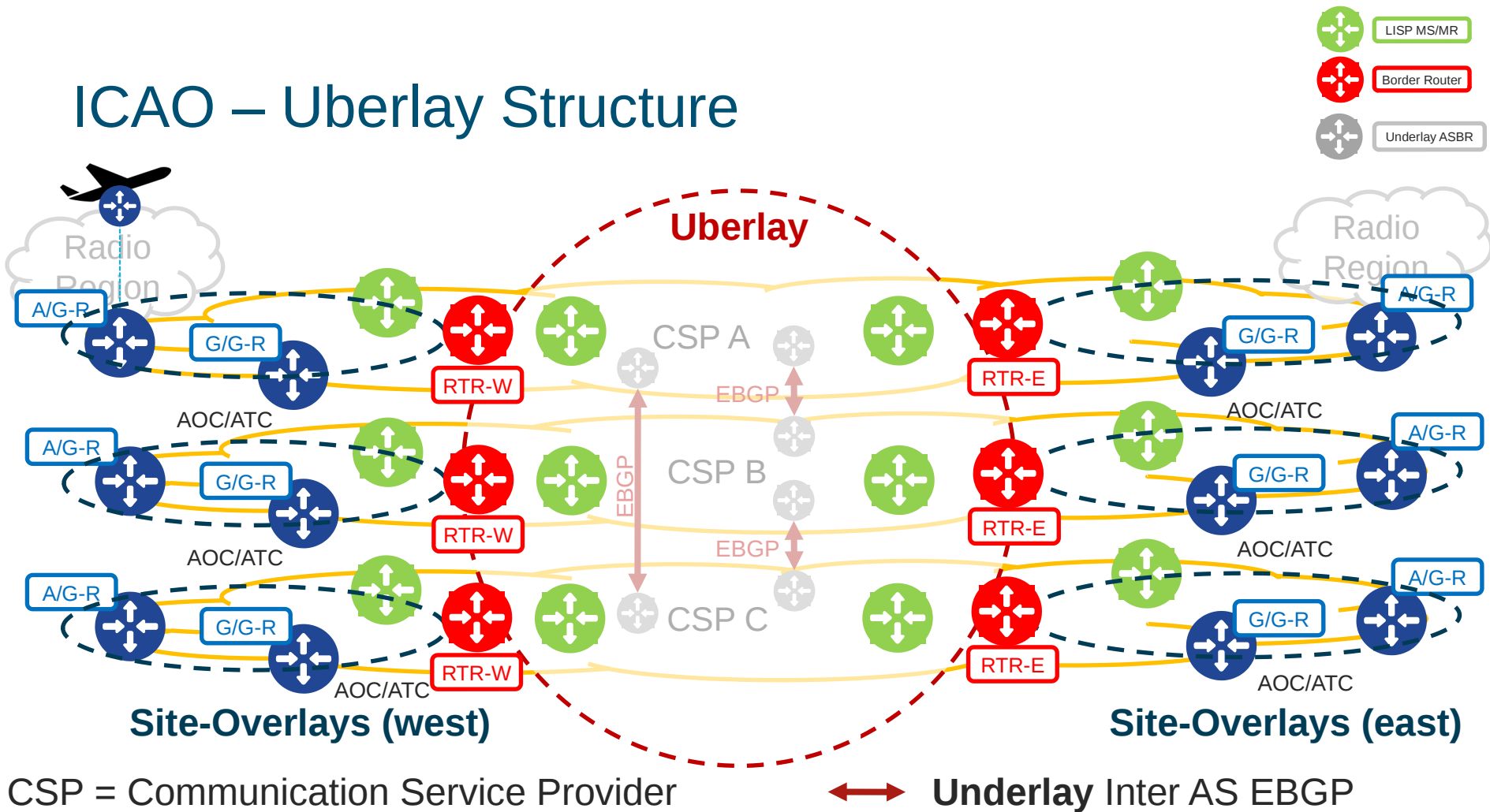  - Peering agreements must be enforced

# ICAO – Uberlay Structure

**Uberlay**

Radio Region

Radio Region

A/G-R

G/G-R

AOC/ATC

A/G-R

G/G-R

AOC/ATC

A/G-R

G/G-R

AOC/ATC

RTR-W

RTR-W

RTR-W

CSP A

EBGP

EBGP

CSP B

EBGP

CSP C

RTR-E

RTR-E

RTR-E

A/G-R

G/G-R

AOC/ATC

A/G-R

G/G-R

AOC/ATC

A/G-R

G/G-R

AOC/ATC

**Site-Overlays (west)**

**Site-Overlays (east)**

CSP = Communication Service Provider

**Underlay** Inter AS EBGP

LISP MS/MR

Border Router

Underlay ASBR

# ICAO – Uberlay Mapping System Federation



LISP MS/MR

Border Router

Underlay ASBR

**Uberlay**
Mapping
System
Federation

CSP A

CSP B

CSP C

EBGP

EBGP

Radio Region

A/G-R

G/G-R

AOC/ATC

A/G-R

G/G-R

AOC/ATC

A/G-R

G/G-R

AOC/ATC

RTR-W

RTR-W

RTR-W

RTR-E

RTR-E

RTR-E

Radio Region

A/G-R

G/G-R

AOC/ATC

A/G-R

G/G-R

AOC/ATC

A/G-R

G/G-R

AOC/ATC

**Site-Overlays (west)**

**Site-Overlays (east)**

CSP = Communication Service Provider

**Inter & Intra CSP Federation**
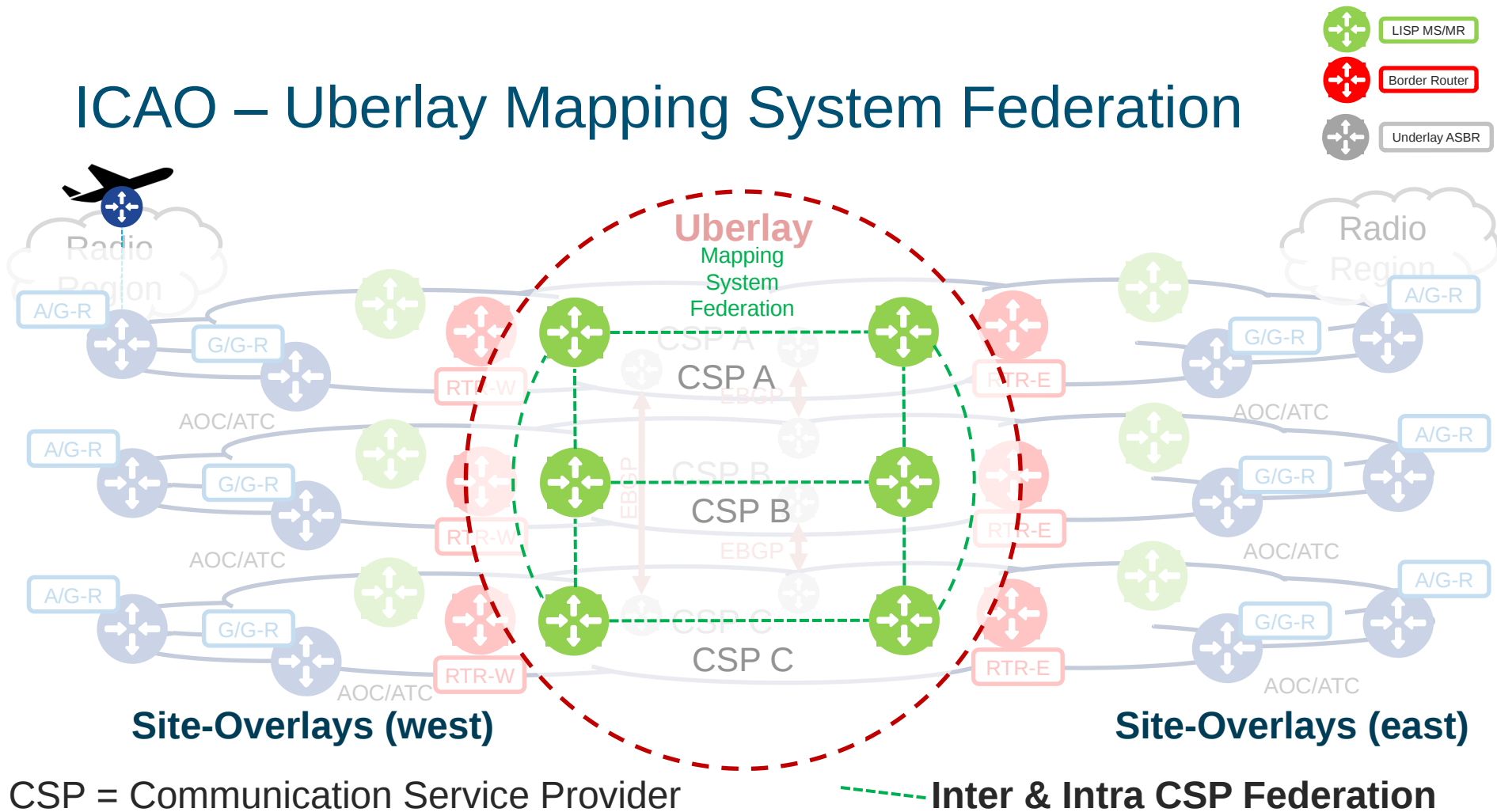
# Multi-AS Uberlay - Federation



LISP MS/MR

Border Router

Underlay ASBR

Mapping System Federation

MS-A

MS-B

XTR-B2

Underlay-AS-A

EBGP

Underlay-AS-B

XTR-A

XTR-B1
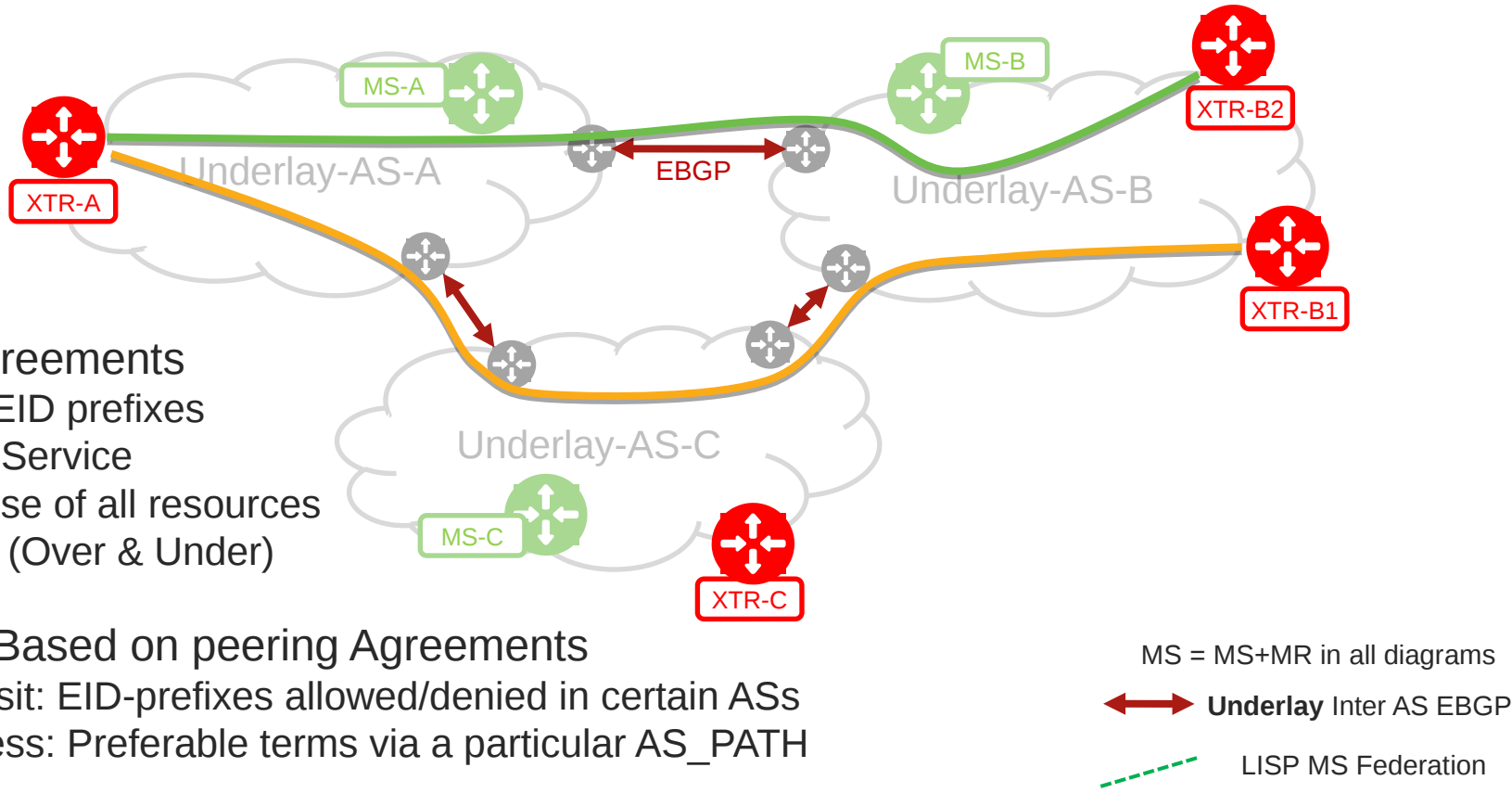
MS-C

Underlay-AS-C

XTR-C

- Each MS/MR services the XTRs in its AS
- As hosts move, their EIDs must be registered to the MS in the AS they are connected to
- EID related Peering agreements across ASs must be enforced

MS = MS+MR in all diagrams

**Underlay** Inter AS EBGP

LISP MS Federation
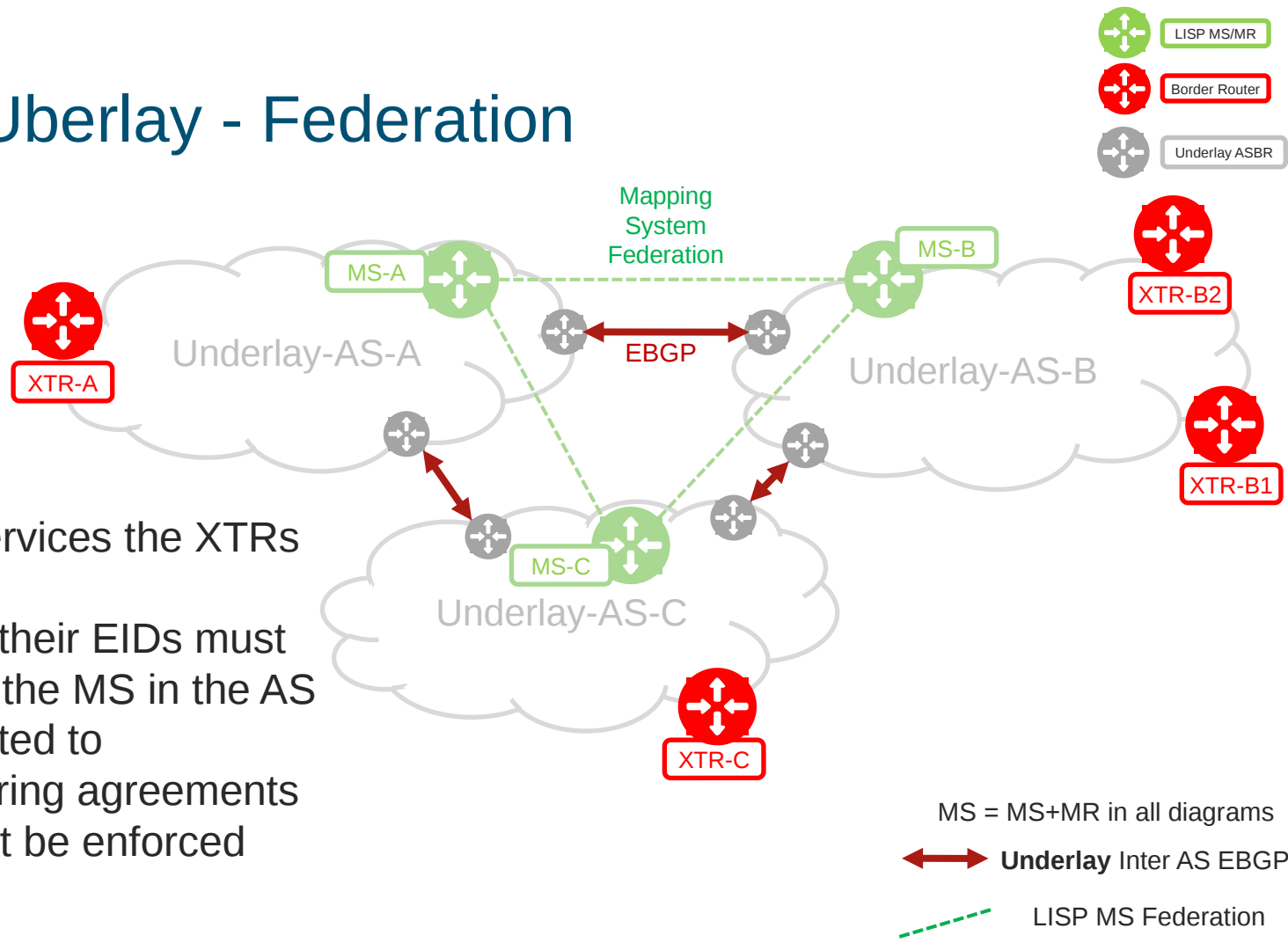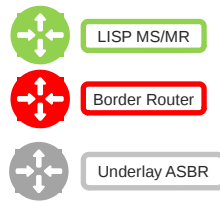
# Peering agreements and policies

Peering Agreements
- Refer to EID prefixes
- Terms of Service
- Govern use of all resources in the AS (Over & Under)
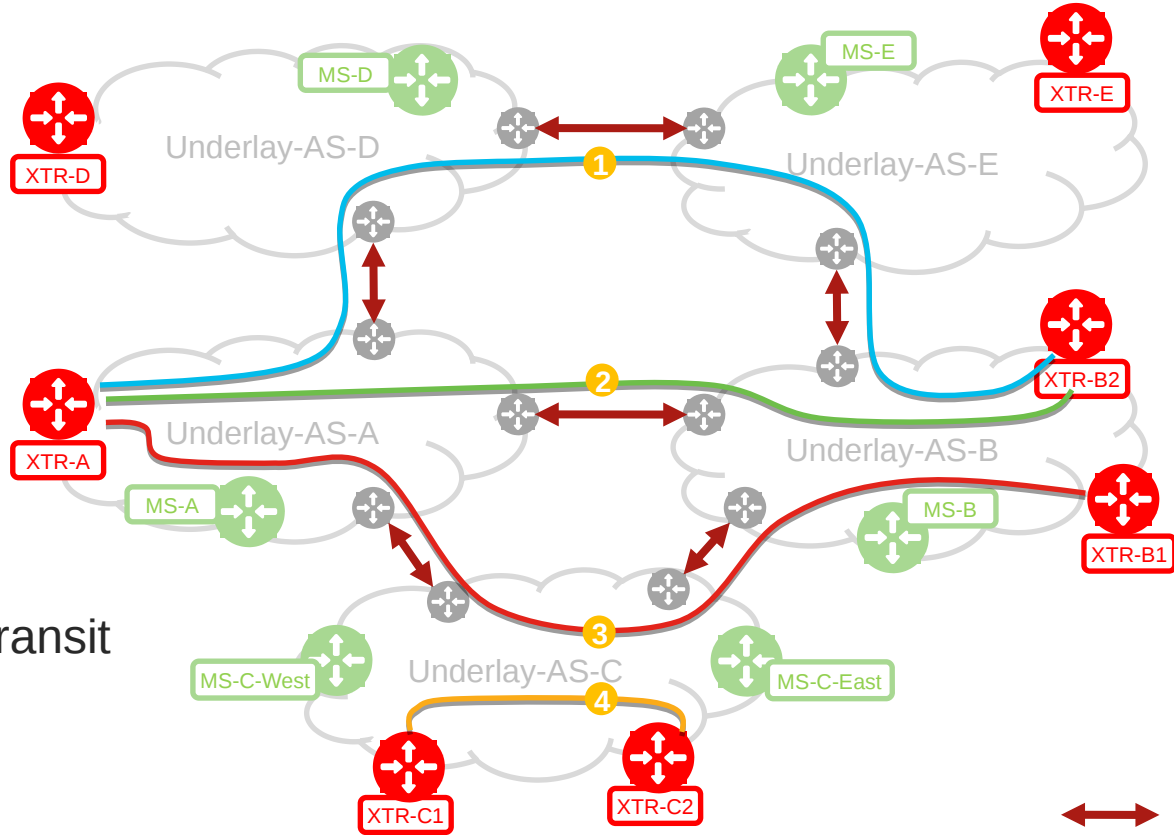
- Policies Based on peering Agreements
  - Transit: EID-prefixes allowed/denied in certain ASs
  - Ingress: Preferable terms via a particular AS_PATH

MS = MS+MR in all diagrams

**Underlay** Inter AS EBGP

LISP MS Federation

# Summary of Requirements

- Scope overlay resources (XTRs, MS/MRs) per Underlay-AS
  - Intra-AS scopes are a secondary requirement

- Federation without intermediaries

- Scope EID state per AS or intra-AS region

- Support intra and inter-AS connectivity

- Support EID mobility across ASs

- Support EID multi-homing

- Enforce policies derived from peering agreements (match on EID enforce in the underlay)

- Support different path scenarios: Transit, Direct, Intra-AS

- Should not require RTRs at AS-Borders

# Next steps

- Firm up requirements definition: draft-moreno-lisp-multi-as

- Explore applicability of DDT, document as deployment

- Explore alternative approaches if necessary
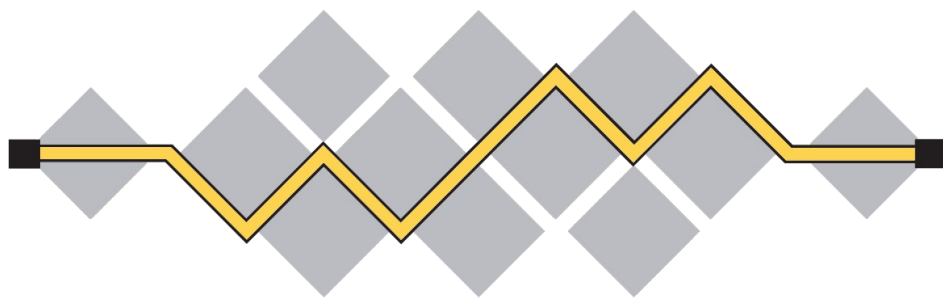
# Background Information

# 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

# 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

- 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)
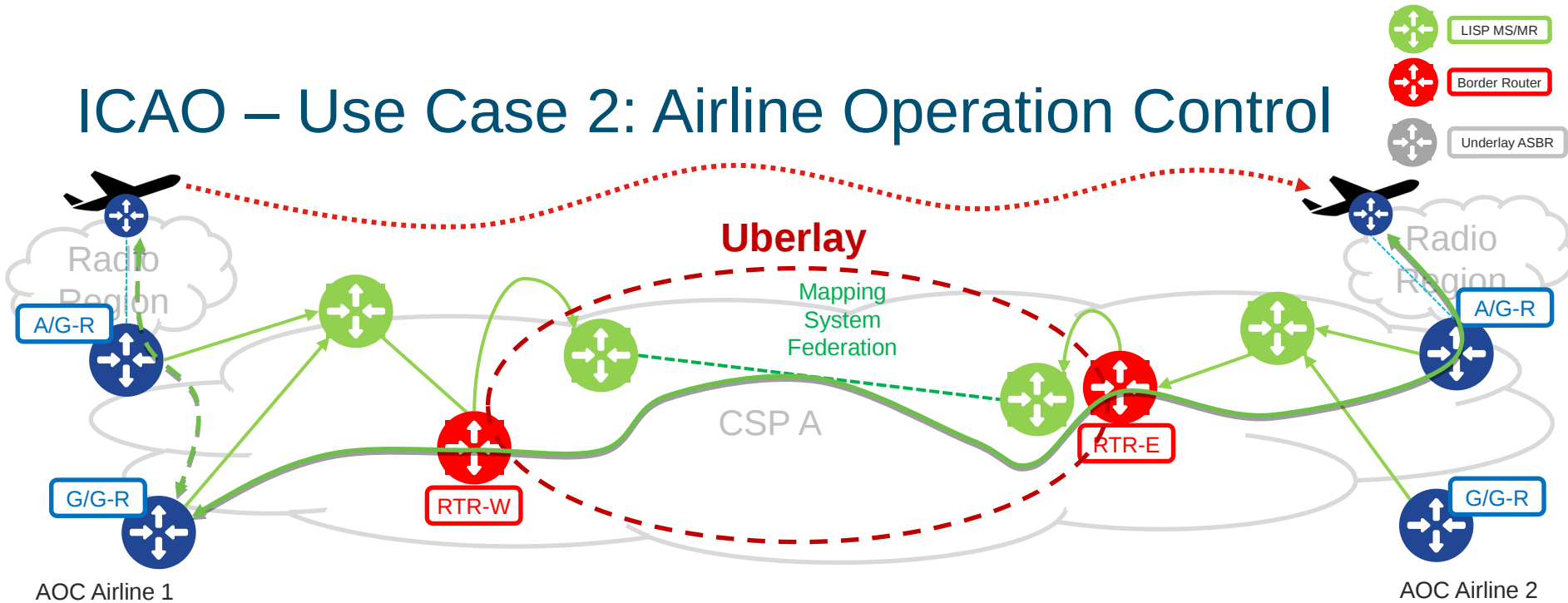
# ICAO – Use Case 1: Air Traffic Control
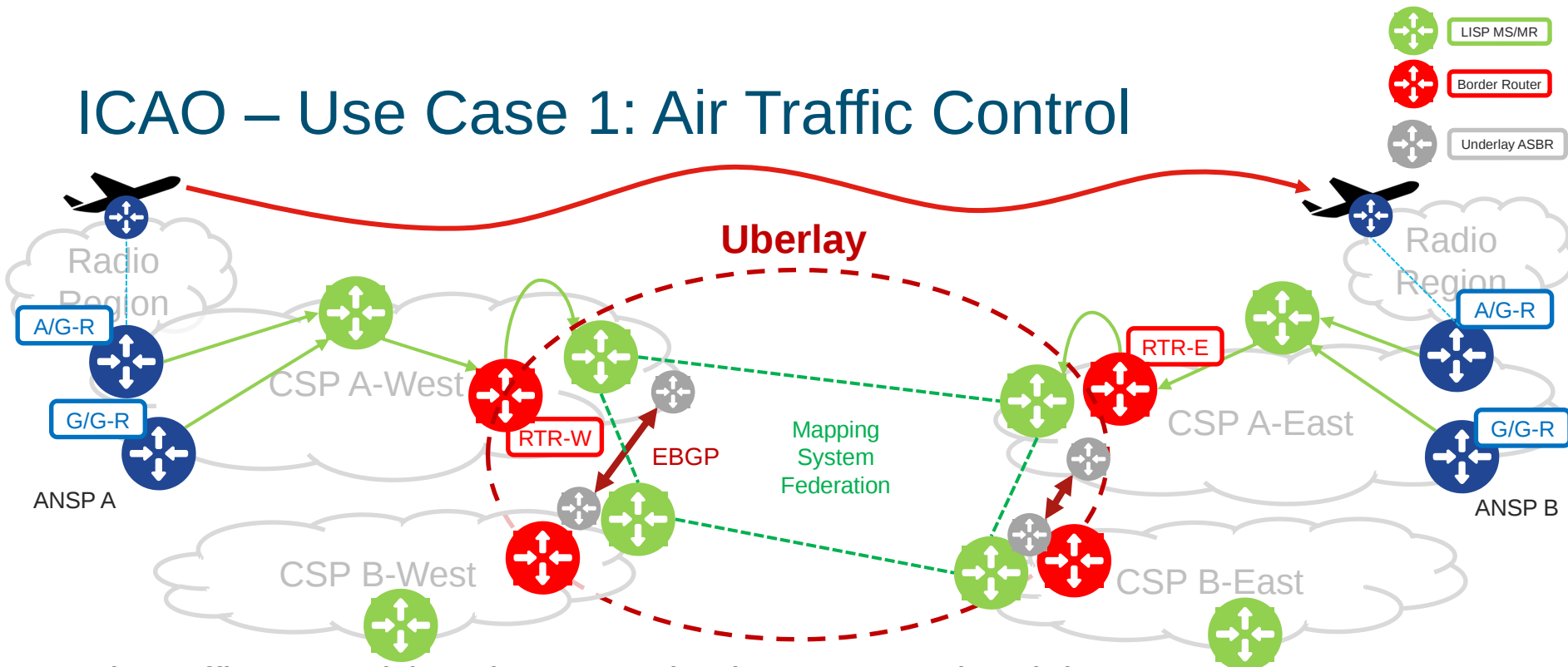


- Air Traffic Control (ATC) communications are Regional, but cross-CSPs
- A dedicated IP address for ATC (ATC-EID) has been proposed.
- Policy: maintain the ATC EIDs local to the region, all CSPs involved must be updated

# ICAO – Use Case 2: Airline Operation Control



Legend:
- LISP MS/MR
- Border Router
- Underlay ASBR

Uberlay

Mapping System Federation

CSP A

RTR-W

RTR-E

Radio Region

A/G-R

G/G-R

AOC Airline 1

Radio Region

A/G-R

G/G-R

AOC Airline 2

- 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 @ connecting CSP's Uberlay Mapping System
  - Registrations, Access Control, Accountability
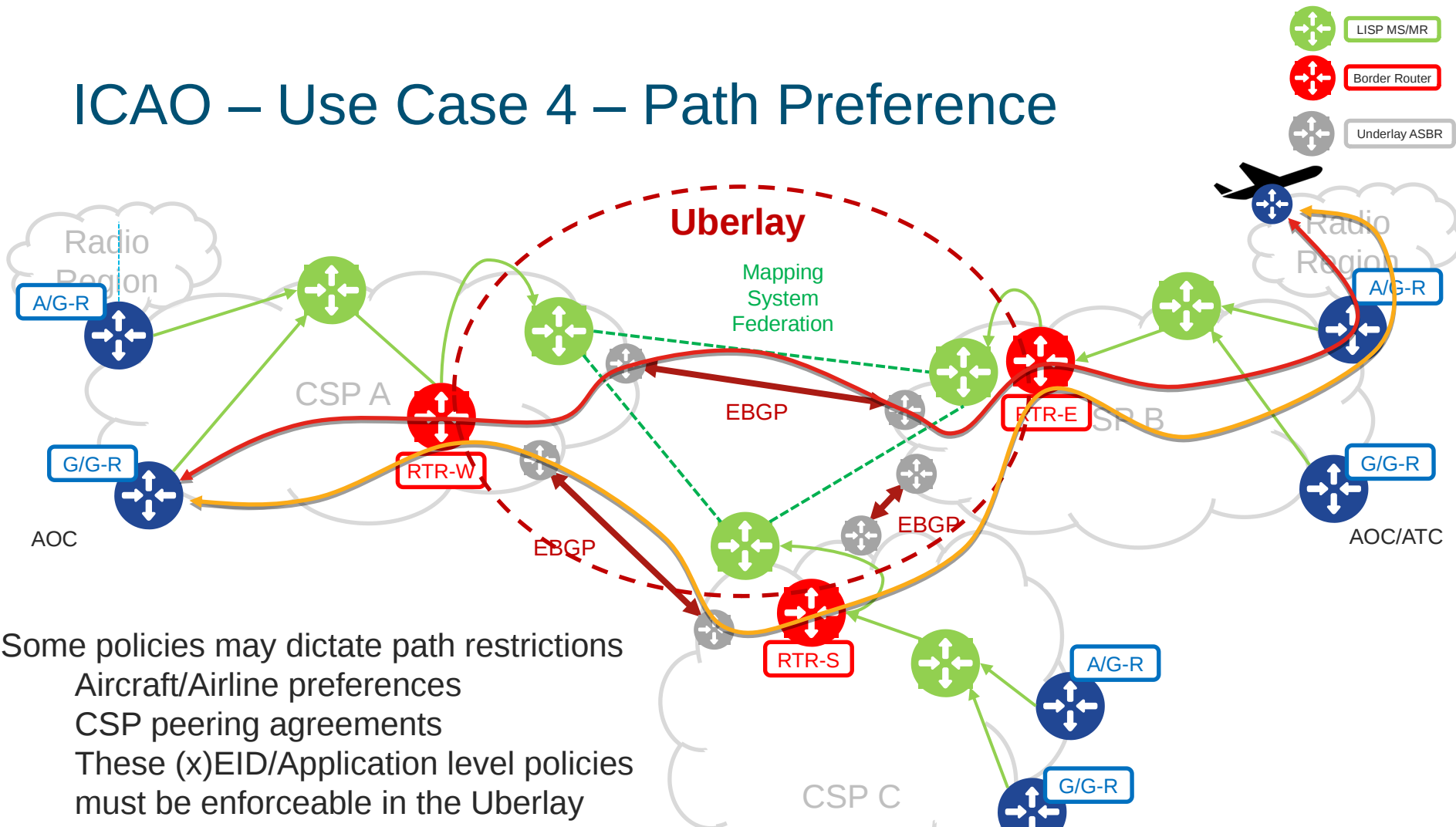  - Path preferences expressed by aircraft, rendered by CSPs

# ICAO – 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

# ICAO – Use Case 4 – Path Preference



Some policies may dictate path restrictions
Aircraft/Airline preferences
CSP peering agreements
These (x)EID/Application level policies
must be enforceable in the Uberlay

# 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

Each AGR has RLOC address

Mapping Server maintains RLOC-EID mapping

LISP MS/MR

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

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

Traffic tunnelled over Internetwork

Interworking Region (LISP + RLOC Space)

Radio Region 1

Radio Region 2

Radio Region 3

AC-R

A-R

AC-R

AC-R

A/G-R1

A/G-R2

A/G-R3

G/G-R

AOC - ATS Region X

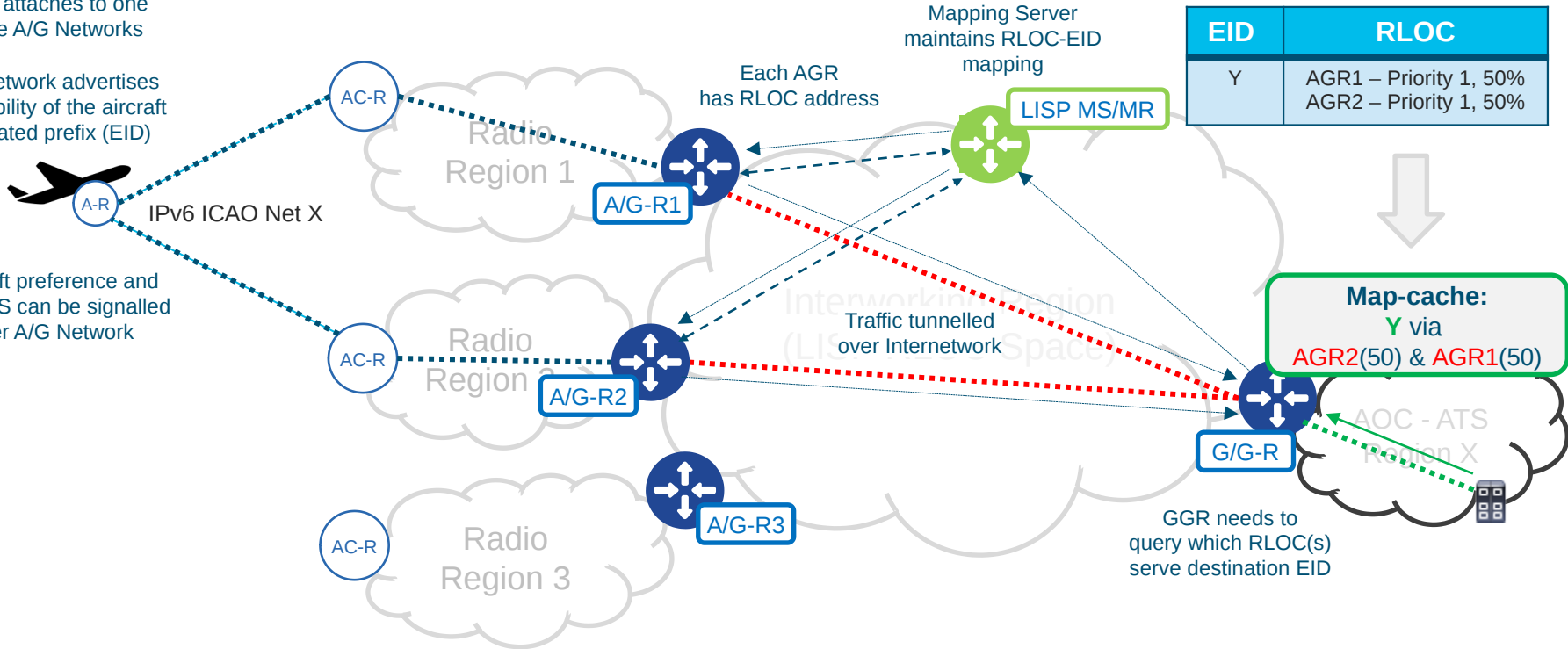GGR needs to query which RLOC(s) serve destination EID

# 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
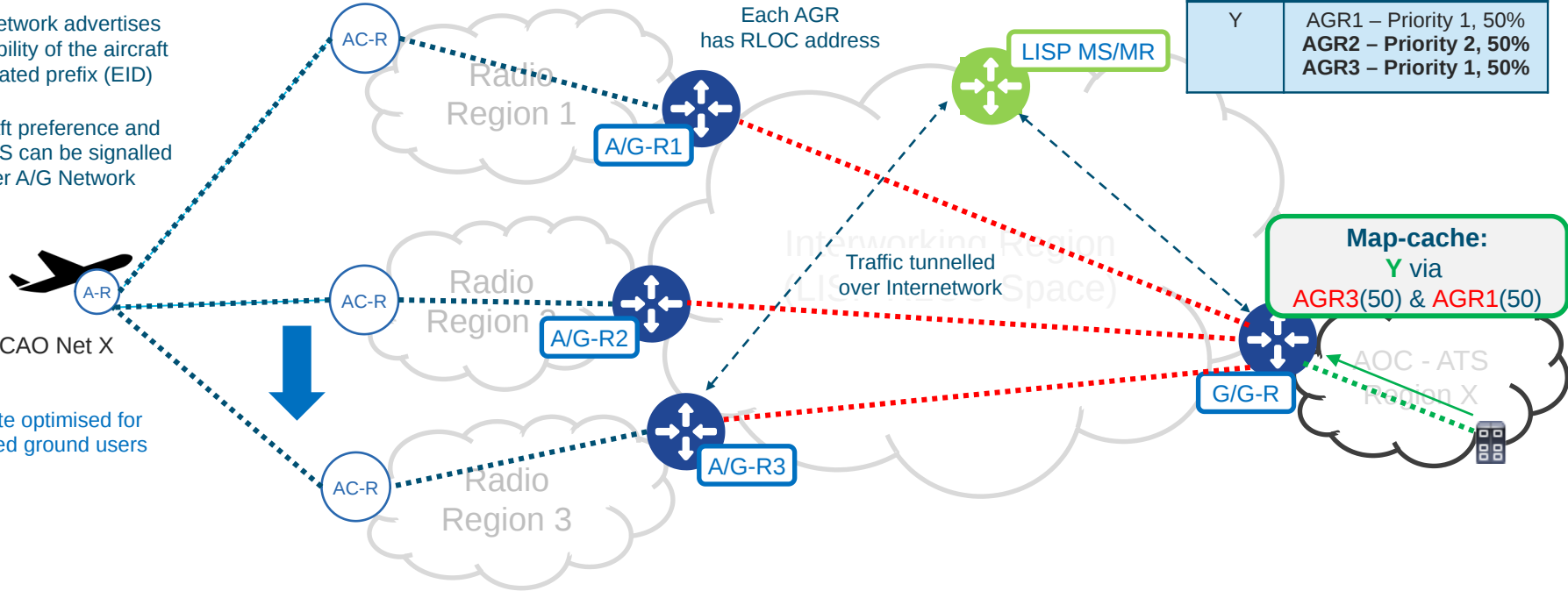
IPv6 ICAO Net X

Route optimised for served ground users

AC-R

Radio Region 1

A/G-R1

Each AGR has RLOC address

LISP MS/MR

AC-R

Radio Region 2

A/G-R2

Interworking Region (LISP RLOC's Space)

Traffic tunnelled over Internetwork

AC-R

Radio Region 3

A/G-R3

G/G-R

AOC - ATS Region X

| EID | RLOC |
|-----|------|
| Y | AGR1 – Priority 1, 50% <br> **AGR2 – Priority 2, 50%** <br> **AGR3 – Priority 1, 50%** |

**Map-cache:**
**Y** via
AGR3(50) & AGR1(50)

A-R

# Per Application Path Preference



| EID (IP, DSCP) | RLOC |
|---|---|
| Y, Green | AGR1 – P2<br>AGR2 – P1 |
| Y, Red | AGR1 – P1<br>AGR2 – P2 |

IPv6 ICAO Net X

Metric registered as priority/weight for ICAO Net-Y

LISP MS/MR

Radio Region 1

A/G-R1

Metric is Propagated

Interworking Region (LISP RLOC Space)

IPv6 ICAO Net Y

A-R Advertises Preference and Quality Metric (e.g. Route Solicitation)

Radio Region 2

A/G-R2

G/G-R

AOC - ATS Region X

Choose A/G-R based on priority/weight
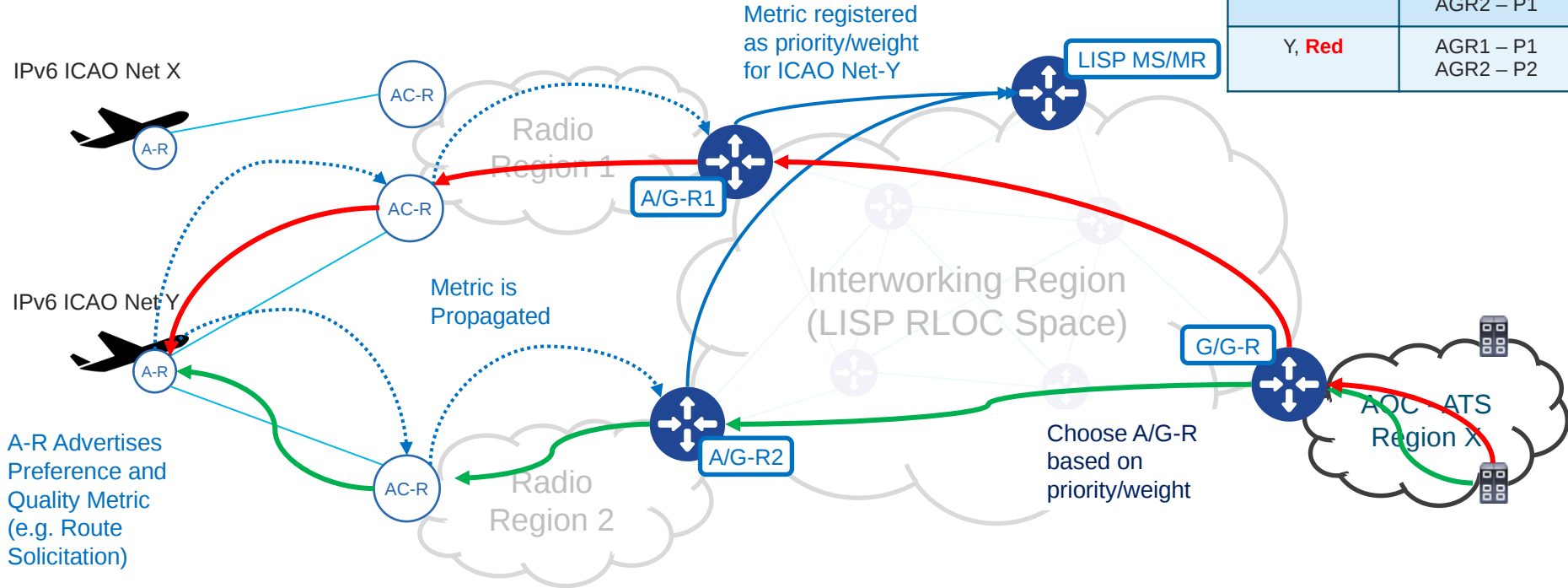
Air-to-ground path decided on Aircraft Router
Ground-to-air path governed by Aircraft defined metrics
Exception routing for certain Apps based on DSCP