# NLRI AppMetaData Path Attribute for 5G Edge Computing Service

**draft-dunbar-idr-5g-edge-compute-app-meta-data-01**

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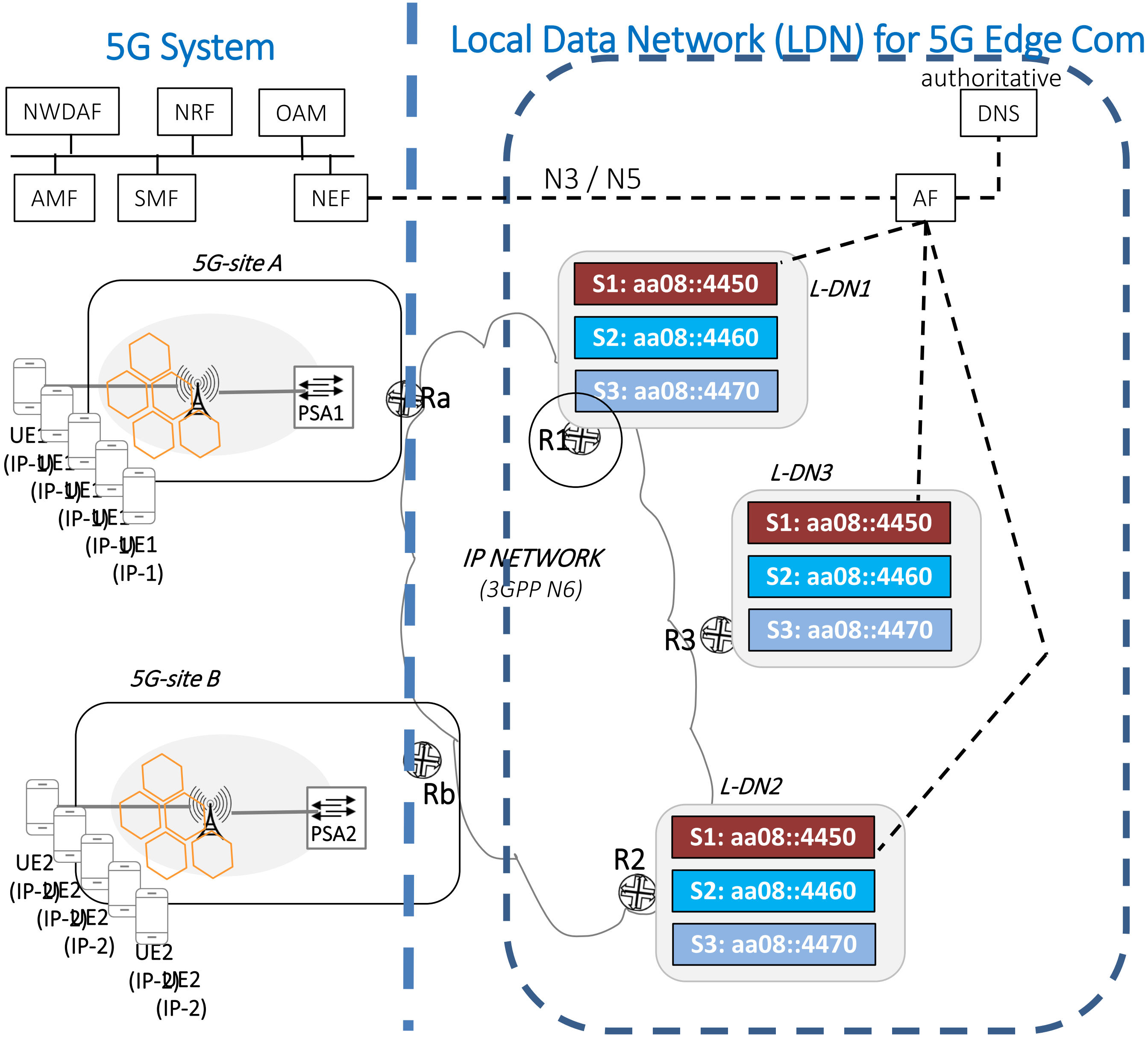
Nov 2020

# Intention of the draft

- Purpose:
  - a new BGP Network Layer Reachability Information (BGP NLRI) Path Attribute: AppMetaData,
    - To distribute the 5G Edge Computing App running status and environment,
    - For other routers in the 5G Local Data Network to make intelligent decision on optimized forwarding of flows from UEs.
    - The goal is to improve latency and performance for 5G Edge Computing services.
  - We would like to hear your feedback.

# 5G Edge Computing (3GPP TR23.748)

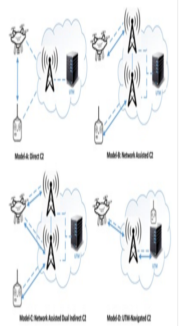



One Application has multiple Application Servers located in Edge Computing DCs

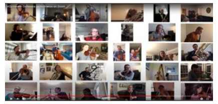
## Use Cases

- Unmanned Aerial Vehicles (Drones) <-> Controller, Traffic Management, and App Servers

  13 detailed use cases described in 3GPP TR22.829



- Virtual concert

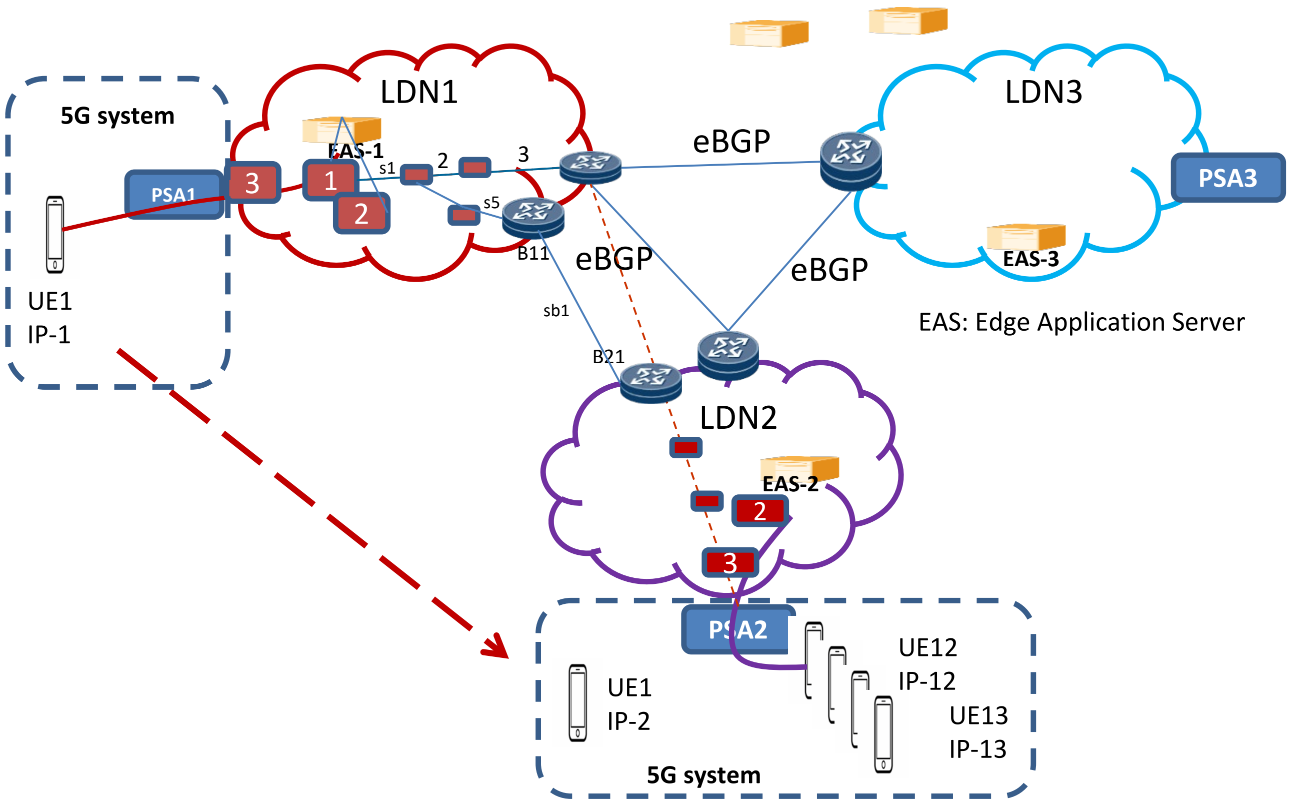


- Virtual Interactive Conference
  - Computing (e.g. the encoding, video stitching, compressing, etc.) can be processed by the server in the edge.

# From IP Network Perspective…

**ANYCAST: IP Layer Application ID -> multiple App servers**
**Benefit of using ANYCAST:**

- ✓ **dynamically load balance across locations based on network conditions.**
- ✓ **leverages the proximity information present in the network (routing) layer and**
- ✓ **eliminates the single point of failure and bottleneck at the DNS resolvers and application layer load balancers.**
- ✓ **removes the dependency on UEs using their cached destination IP addresses for extended period**




Problem 1: Selecting 5G Edge Application Location

- ➢ Many mini data centers can be close in proximity, making it difficult to differentiate in Routing Hops for App servers hosted in them,
- ➢ Some data centers can have higher capacity than others,
- ➢ Some sites may be more preferred when a UE anchored to a new 5G Site

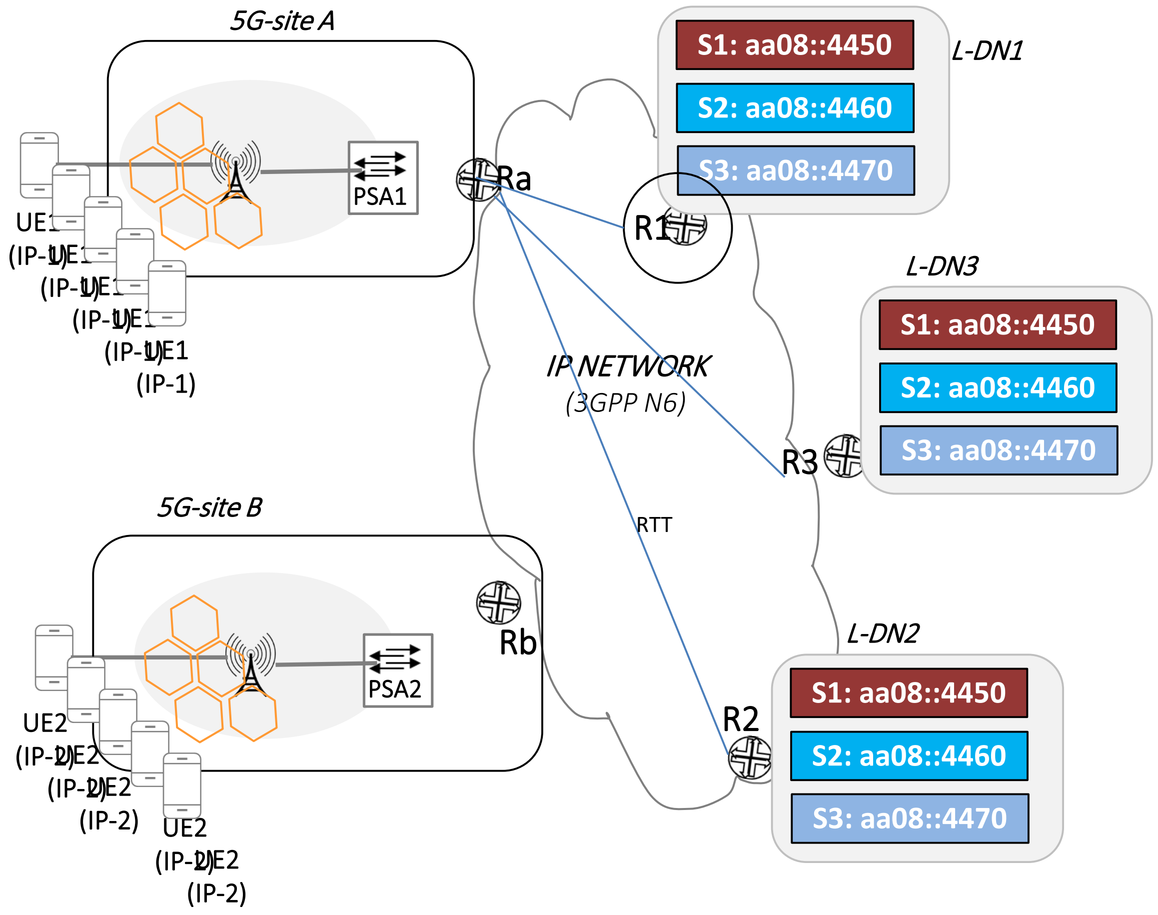
Problem #2: sticking to original App Server

Problem #3: Application Server Relocation

# Factors in selecting ANYCAST Server in 5G EC

- RTT to "app.net" ANYCAST S1:
  - List of {
    - R1: RTT value
    - R2: RTT value
    - R3: RTT value

    }
- Capacity
- Site Preference



# Solution : a new BGP NLRI Path Attribute: AppMetaData

NLRI BGP UPDATE:

Client route= S1: aa08::4450

AppMetaData TLV

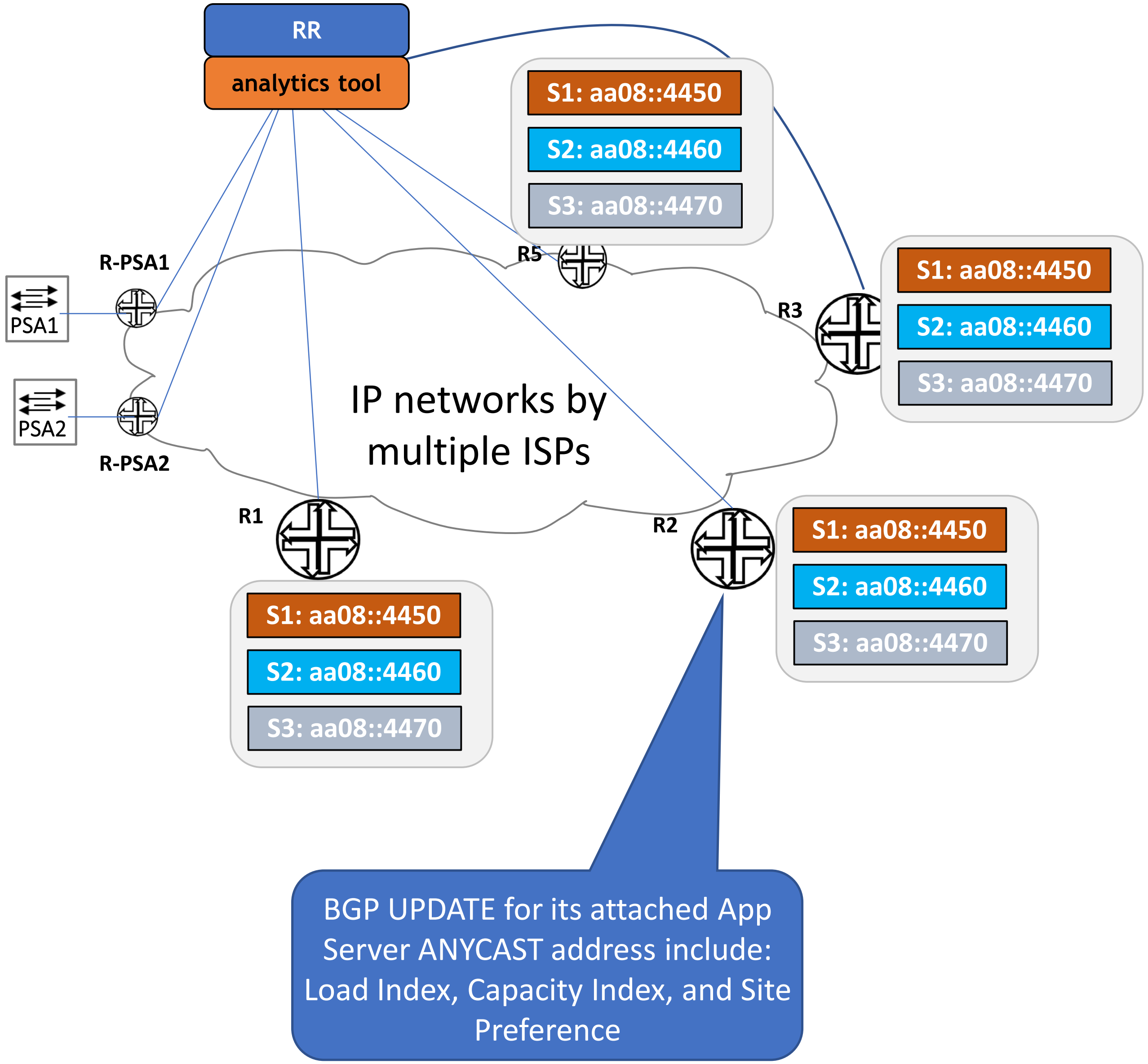
  Load Measurement subTLV

  Capacity Index subTLV

  Site Preference subTLV

Potentially to include Sub-TLVs for

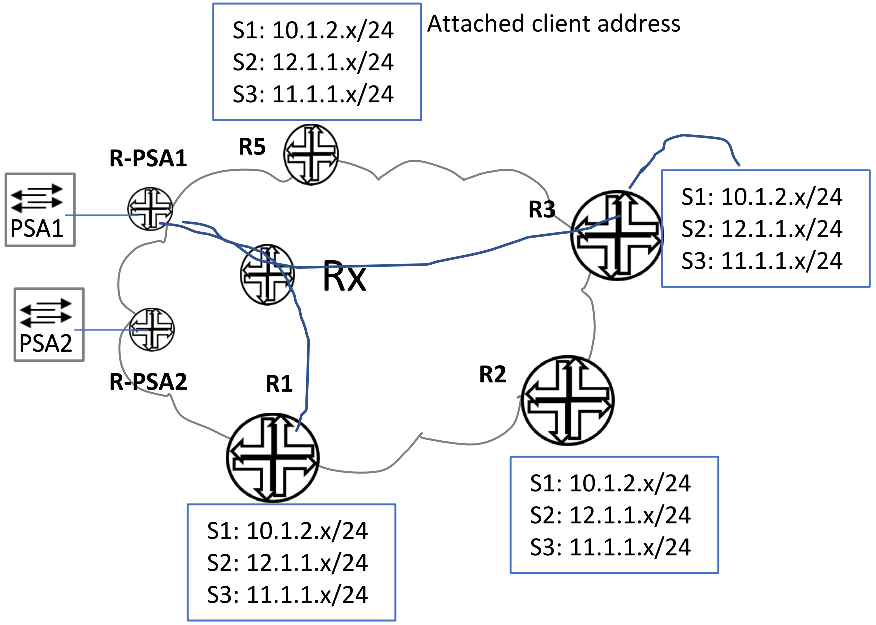
https://datatracker.ietf.org/doc/draft-mcd-rtgwg-extension-tn-aware-mobility/



# Load Measurement Sub-TLVs

```
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|        Type (TBD2)            |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Measurement Period                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           total number of packets to the App Server           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           total number of packets from the App Server         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           total number of bytes to the App Server             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           total number of bytes from the App Server           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

```
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|         Type (TBD3)           |             Length            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                     Measurement Period                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Aggregated Load Index to reach the App Server       |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```




**Load measurement SubTLV:**

**Type= TBD2: measurements of packets/bytes to/from the App Server address;**

**Type =TBD3: Load Measurement Index**

**Measure Period**: BGP Update period or user specified period

**Load Measurement Index:** Weighted combination of bytes/packets sent to/received from the App server:

Load Measurement Index = w1 * ToPackets + w2* FromPackes + w3*ToBytes + w4*FromBytes

w1+ w2+ w3+ w4 = 1 & 0< =wi <=1;

# Capacity Index and Site Preference Index

Capacity Index can also be derived from historic data.

Type =TBD4: capacity Index subTLV;

```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Type (TBD4)        |                Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Capacity Index                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Type =TBD5: Site preference Index subTLV;

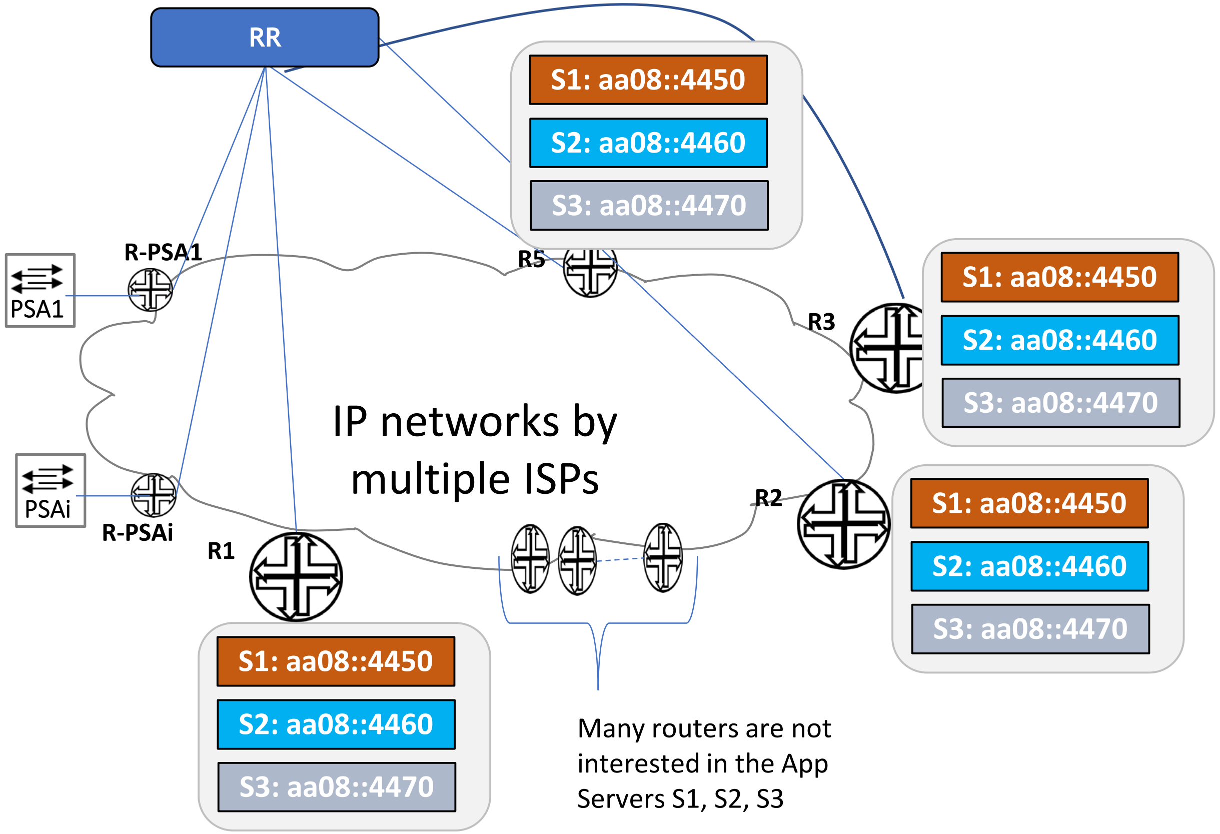
```
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|            Type (TBD5)        |                Length         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Preference Index                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

**Capacity index :** larger value means higher capacity, 1-10. if absent, use default value 5.
**Site preference Index,** which is also the network preference index: larger value means higher preference: 1-10. If absent, use default value 5.

# AppMetaData Propagation Scope

- ➢ BGP RT constrained distribution (RFC4684)
  - there are much more App Servers than the number of routers
- ➢ Create a AppServer-Bound-Group
  - Static configuration
  - each ingress router to ask a network controller upon receiving the first packet to a specific ANYCAST address to be included in the “Application Bound Group Routers”

| AppServer ID | Interested Routers | Time To Live | Other attributes |
|---|---|---|---|
| S1: aa08::4450 | R-PSA1, R-PSA2 | | |
| S2: aa08::4460 | R-PSA1, | | |



# Soft Anchoring of an ANYCAST flow

# Using a group of ANYCAST addresses to achieve the Soft Anchoring a flow to one ANYCAST Location

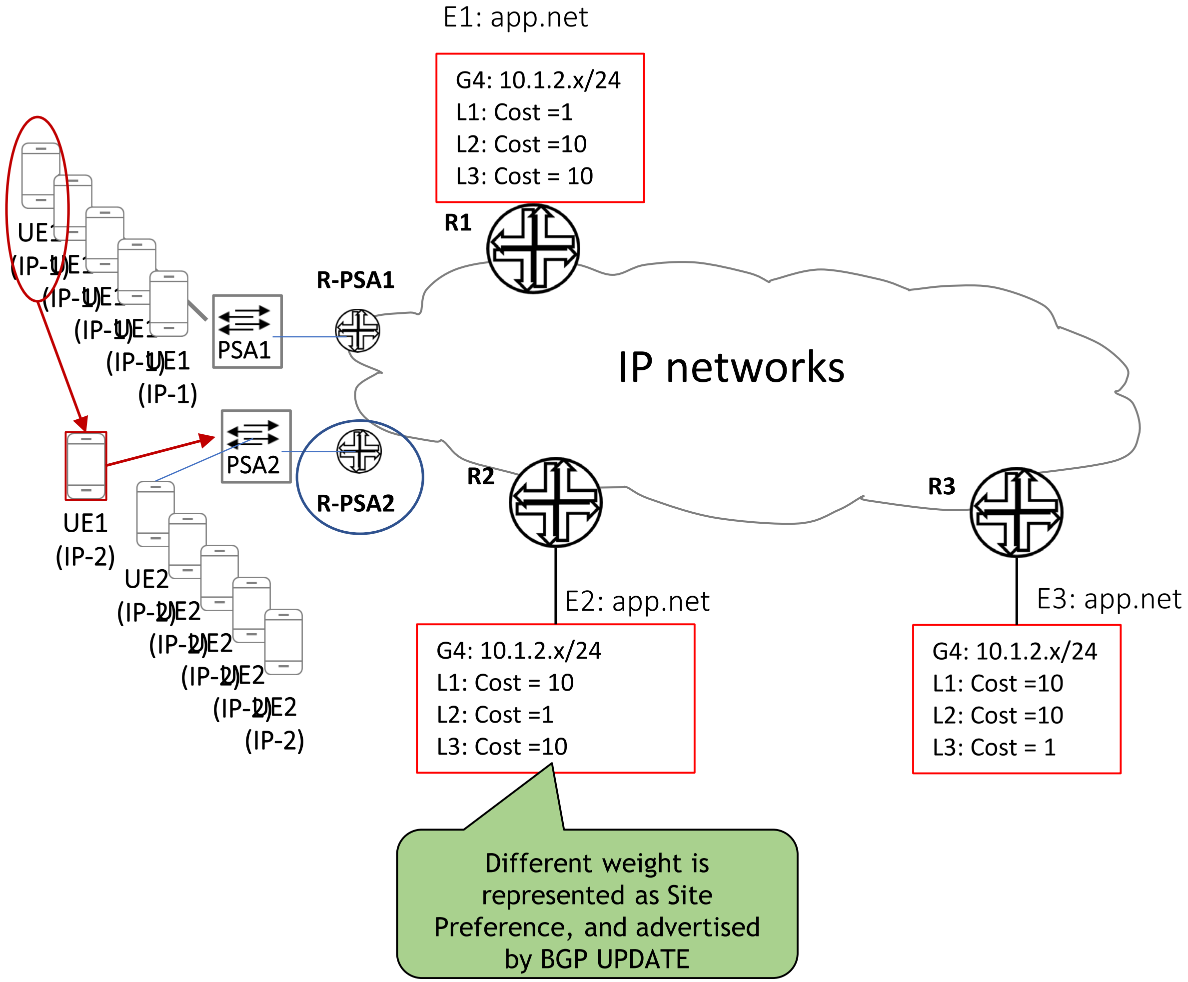
**TABLE 1: DNS configuration:**

```
// global FQDN: app.net
app.net      172800   IN   A          G-4
app.net      172800   IN   AAAA       G-6

// FQDN: op1.app.net
ldn1.op1.app.net        172800   IN   A          L1
ldn2.op1.app.net        172800   IN   A          L2
ldn3.op1.app.net        172800   IN   A          L3
```

**IP ROUTES 2: Route Injection from AF -> IP Controller:**

```
G-4 -> {E1, E2, E3}
L1 -> E1 | {E2, E3} if E1 has failed
L2 -> E2 | {E1, E3} if E2 has failed
L3 -> E3 | {E1, E2} if E3 has failed
```



# Background Information

# Algorithm in Selecting the Optimal Target Location

To compare the cost to reach the Application Server between the Site-i or Site-j:

$$\text{Cost-i} = \min\left(w \ast \left(\frac{\text{Load-i} \ast \text{CP-j}}{\text{Load-j} \ast \text{CP-i}}\right) + (1-w) \ast \left(\frac{\text{Pref-j} \ast \text{Delay-i}}{\text{Pref-i} \ast \text{Delay-j}}\right)\right)$$

- Load-i: Load Index at Site-I = w1*ToPackets+w2*FromPackes+w3*ToBytes+w4*FromBytes

  0<= wi <=1 and w1+ w2+ w3+ w4 = 1.
- CP-i (Capacity-i) (higher value means higher capacity): capacity index at the site i.
- Delay-i: Network latency measurement (RTT) to the A-ER that has the Application Server attached at the site-i.
- Pref-i (Preference Index: higher value means higher preference): Network Preference index for the site-I.
- w: Weight for load and site information,
  - 0<= w <=1: If smaller than 0.5, Network latency and the site Preference have more influence; otherwise, Server load and its capacity have more influence.