NLRI AppMetaData Path Attribute for 5G Edge Computing Service

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

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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)

Local Data Network (LDN) for 5G Edge Computing

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
Load Measurement Sub-TLVs

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* FromPackets + 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)                        |
+-----------------------------------------------+
|               Capacity Index                  |
+-----------------------------------------------+

Type =TBD5: Site preference Index subTLV;

+-----------------------------------------------+
|              Type (TBD5)                        |
+-----------------------------------------------+
|                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.
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”

<table>
<thead>
<tr>
<th>AppServer ID</th>
<th>Interested Routers</th>
<th>Time To Live</th>
<th>Other attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1: aa08::4450</td>
<td>R-PSA1, R-PSA2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2: aa08::4460</td>
<td>R-PSA1,</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 ROUTIES 2: Route Injection from IP to IP Controllers:**

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

Different weight is represented as Site Preference, and advertised by BGP UPDATE
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:

\[
\text{Cost}_i = \min\left( w \left( \frac{\text{Load}_i \times \text{CP}_j}{\text{Load}_j \times \text{CP}_i} \right) + (1-w) \left( \frac{\text{Pref}_j \times \text{Delay}_i}{\text{Pref}_i \times \text{Delay}_j} \right) \right)
\]

- **Load-i**: Load Index at Site-i = \( w_1 \times \text{ToPackets} + w_2 \times \text{FromPackets} + w_3 \times \text{ToBytes} + w_4 \times \text{FromBytes} \)
  
  \( 0 \leq w_i \leq 1 \) and \( w_1 + w_2 + w_3 + w_4 = 1 \).

- **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,
  
  - \( 0 \leq w \leq 1 \): If smaller than 0.5, Network latency and the site Preference have more influence; otherwise, Server load and its capacity have more influence.