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Distributed Geo-Spatial LISP Blackboard for Automotive
draft-barkai-lisp-nexagon-00

Abstract

This document specifies the use of LISP Blackboard for distributed Geo-Spatial Publish/Subscribe automotive applications.

Status of This Memo

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1. Introduction

(1) The Locator/ID Separation Protocol (LISP) [RFC6830] splits current IP addresses in two different namespaces, Endpoint Identifiers (EIDs) and Routing Locators (RLOCs).
LISP uses a map-and-encap approach that relies on (1) a Mapping System (basically a distributed database) that stores and disseminates EID-RLOC mappings and on (2) LISP tunnel routers (xTRs) that encapsulate and decapsulate data packets based on the content of those mappings.

(2) H3 is a geospatial indexing system using a hexagonal grid that can be (approximately) subdivided into finer and finer hexagonal grids, combining the benefits of a hexagonal grid with hierarchical subdivisions. H3 supports sixteen resolutions. Each finer resolution has cells with one seventh the area of the coarser resolution. Hexagons cannot be perfectly subdivided into seven hexagons, so the finer cells are only approximately contained within a parent cell. Each cell is identified by a 64bit int.

(3) The Berkeley Deep Drive (BDD) Industry Consortium investigates state-of-the-art technologies in computer vision and machine learning for automotive applications. BDD based taxonomy of published automotive scene classification.

These standards are combined to create an in-network key-value blackboard - reflecting the state of each 1sqm hexagon tile of road. The lisp network maps traffic form vehicle endpoint IP identifiers (EID) to the routing location (RLOC) of h3 hexagon identifier (HID).

Th lisp network blackboard bridges the time-space gap between vision & sensory (publishers) - and - driving apps/smart-infrastructure (subscribers). Drivers (EID) communicate with blackboard tiles (HID), EID<=> RLOC <=> HID, small tiles to publish, large tiles to subscribe to regional information.

One of of the key use-cases is providing drivers with 20-30 seconds preemptive heads-up on potential hazards and obstacles; across traffic, around the block, beyond turns and curvatures, in a nutshell beyond sensory line-of-site.

(1) LISP blackboard keys are 64bit H3 IDs referring to ~1sqm H3 level 13
(2) LISP blackboard values are 64bit compiled-states of each H3 road-tile
(3) LISP blackboard pub-sub regions are at H3 level-9 containing l13 tiles
(4) LISP Blackboard is sharded to scale state-updates and edge propagation
(5) Edge LISP XTRs use the H3 IDs to map publish-subscribe to right shard
(6) Edge XTRs are also used to replicate bulk state updates to clients
(7) Bulk updates Multicast-replication can use native access multicast

```
              /     \          /     \          /    \          H3-level9
             | H3-l9 |        | H3-l9 |        |      |            .
         ---  \ ___ / ---  --- \_____/ ---  --- \____/ ---         .
        v                 v                v                v      .
        v                 v  \     |     / v                v      .
        v    ((((|)))) >>>     EDGE XTR    <<<  ((((|))))          .
                /|\                                /|\             .
                RAN                                RAN             .
        v                 v                v                v   H3-level13
        v                 v                v                v
    ............/\/\/\/\/\/\/\/\/\/    \/    \/\/\/    \/\/\/\..<<Subscriber
- - - - - - - - - - - - - - - - -   H3-l13  - -    H3-l13 - - - - - - -
.............  Publisher>> \/\/\/\____/\____/\/\/\____/.........
```

2. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

3. Deployment Assumptions

The specification described in this document makes the following deployment assumptions:

(1) A unique 64-bit H3 Hex-Tile identifier is associated with each lang-lat
(2) Clients (Publisher/Subscriber) and network (Blackboard) share this index
(3) A 64-bit automotive BDD state value is associated with each hexagon tile
(4) Hexagon state is combined by 16 fields of 4-bit (nibble) up-to 16 enums

```
|-0-|-1-|-2-|-3-|-4-|-5-|-6-|-7-|-8-|-9-|-A-|-B-|-C-|-D-|-E-|-F-|
 0123012301230123012301230123012301230123012301230123012301230123
```

(5) The following fields describe state information for a given tile

```
Field 0x describes the "freshness" of the state eg last published {
 0x: less than 10Sec
 1x: less than 20Sec
 2x: less than 40Sec
 3x: less than 1min
 4x: less than 2min
 5x: less than 5min
 6x: less than 15min
 7x: less than 30min
 9x: less than 1hour
 Ax: less than 2hours
 Bx: less than 8hours
 Cx: less than 24hours
 Dx: less than 1week
 Ex: less than 1month
 Fx: more than 1month
}

field 1x: persistent weather or structural {
 0x - null
 1x - pothole
 2x - speed-bump
 3x - icy
 4x - flooded
 5x - snow-cover
 6x - snow-deep
 7x - construction cone
 8x - curve
}

field 2x: transient or moving obstruction {
 0x - null
 1x - pedestrian
 2x - bike
 3x - stopped car / truck
 4x - moving car / truck
 5x - first responder vehicle
 6x - sudden slowdown
 7x - oversized-vehicle
}

field 3x: traffic-light timer countdown {
 0x - green now
 1x - 1 seconds to green
 2x - 2 seconds to green
 3x - 3 seconds to green
 4x - 4 seconds to green
 5x - 5 seconds to green
 6x - 6 seconds to green
 7x - 7 seconds to green
 8x - 8 seconds to green
```

```
    9x - 9 seconds to green
    Ax - 10 seconds or less
    Bx - 20 seconds or less
    Cx - 30 seconds or less
    Dx - 40 seconds or less
    Ex - 50 seconds or less
    Fx - minute or more left
  }

  field 4x: impacted tile from neighboring {
    0x - not impacted
    1x - light yellow
    2x - yellow
    3x - light orange
    4x - orange
    5x - light red
    6x - red
    7x - light blue
    8x - blue
  }

  field 5x: incidents {
    0x - clear
    1x - light collision (fender bender)
    2x - hard collision
    3x - collision with casualty
    4x - recent collision residues
    5x - hard break
    6x - sharp cornering
  }
  field 6x - compiled tile safety rating {

  }
  field 7x - reserved
  field 8x - reserved
  field 9x - reserved
  field Ax - reserved
  field Bx - reserved
  field Cx - reserved
  field Dx - reserved
  field Ex - reserved
  field Fx - reserved
```

(7) Publish packet contains 1 key-value tuple:

```
|-0-|-1-|-2-|-3-|-4-|-5-|-6-|-7-|-8-|-9-|-A-|-B-|-C-|-D-|-E-|-F-|
|                        H3 Hexagon ID Key                        |
|-0-|-1-|-2-|-3-|-4-|-5-|-6-|-7-|-8-|-9-|-A-|-B-|-C-|-D-|-E-|-F-|
|                      H3 Hexagon State-Value                     |
|-----------------------------------------------------------------|
```

(8) Any number of fields published in a state can be set to a value
(9) If a field is not being addressed by than it should be set to 0x-null
(10) Subscribe packets are the same as publish with the entire state set null

4. Nexagon Publish-Procedure

(1) Publisher observation
(2) Snap to hex accuracy bar
(3) Compiling a Publish Packet
(4) Publish Packet Source IP
(5) Publish Packet Destination IP

5. Nexagon Subscribe Procedure

(1) Subscribe to zone hierarchy
(2) Subscribe Packet
(3) Zone state update packet of upto 100 hexagon tiles

```
1  |-0-|-1-|-2-|-3-|-4-|-5-|-6-|-7-|-8-|-9-|-A-|-B-|-C-|-D-|-E-|-F-|
   |                        H3 Hexagon ID Key                      |
   |-0-|-1-|-2-|-3-|-4-|-5-|-6-|-7-|-8-|-9-|-A-|-B-|-C-|-D-|-E-|-F-|
   |                     H3 Hexagon State-Value                    |
   |---------------------------------------------------------------|
   .                                                               .
   .                                                               .
   .                                                               .
   .                                                               .
100|-0-|-1-|-2-|-3-|-4-|-5-|-6-|-7-|-8-|-9-|-A-|-B-|-C-|-D-|-E-|-F-|
   |                        H3 Hexagon ID Key                      |
   |-0-|-1-|-2-|-3-|-4-|-5-|-6-|-7-|-8-|-9-|-A-|-B-|-C-|-D-|-E-|-F-|
   |                     H3 Hexagon State-Value                    |
   |---------------------------------------------------------------|
```

6. XTR Sharding and Handover to blackboard tunnels

(1) Map-Resolve hexagon ID to shard location
(2) Multicast replication to subscribed EIDs

7. Security Considerations

The way to provide a security association between the ITRs and the Map-Servers must be evaluated according to the size of the deployment. For small deployments, it is possible to have a shared key (or set of keys) between the ITRs and the Map-Servers. For larger and Internet-scale deployments, scalability is a concern and further study is needed.

8. Acknowledgments

This work is partly funded by the ANR LISP-Lab project #ANR-13-INFR-009 (https://lisplab.lip6.fr).

9. IANA Considerations

This document makes no request to IANA.

10. Normative References

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