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Requirement and a Reference Model of L2 ACP based ANI
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Abstract

This document discusses the scenarios, requirements and a reference model of ANI (Autonomic Networking Infrastructure) to be constructed in a layer 2 network using L2 Autonomic Control Plane (ACP) and the related functions. It expands the applicability of ANI to L2 network and maintains the same infrastructure.

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1. Introduction

[RFC8993] defines a generic set of functions of Autonomic Network Infrastructure (ANI). It contains addressing and naming of autonomic nodes, discovery, negotiation and synchronization functions, distribution of information, reporting, feedback loops, and routing inside the Autonomic Control Plane (ACP) [RFC8994]. The Autonomic Service Agent (ASA) is the atomic entity of an autonomic function and is instantiated on autonomic nodes. They use the services and data structures of the underlying ANI via the API exposed. When ASAs communicate with each other, they should use the Generic Autonomic Signaling Protocol (GRASP) [RFC8990]. GRASP runs over a secure substrate that is isolated from regular data plane traffic which is known as Autonomic Control Plane (ACP).

Though the design concept of ANI is generic, the methods for constructing an ACP and routing in ACP [RFC8994], discovery of adjacent system [RFC8990] and interaction of GRASP message are all at the network layer. This document discusses the scenarios and requirements of a layer 2 (L2) ACP as an instance of a Generalized ACP to implement part of ANI functions in L2 network. And it shows a reference model to construct such L2 ACP and the related functions.

2. Scenarios requiring L2 ACP functions in ANI

Current ACP implementation in ANI uses IPv6 link-local address based ACP tunnel, RPL as routing protocol in ACP and GRASP DULL to discover the adjacent node. It is appropriate when the managed network is a large campus, a multi-site network or a carrier network. However there are some cases which require L2 ACP functions in ANI. The L2 ACP is used in such cases that the managed network is a reletively

small layer 2 network where the network nodes have no L3 physical interfaces and the network manager would like to use and verify the L2 topology and reachability first for some management purpose.

```
              +-------+
           +--|core   |--+
           |  +-------+  |                 core switch
           |             |
           |             |
           |             |
           |             |
       +-------+     +-------+
       | agg 1 |---- | agg 2 |              L2 aggregation switch
       +-------+    /+-------+
        |  \       /  |     \
        |   \     /   |      \
        |    \   /    |       \
        |     \ /     |        \
        |      \      |         \
    +-------+ / \ +-------+   +-------+
    | acc 1 |/   \| acc 2 |   | acc 3 |     L2 access switch
    +-------+     +-------+   +-------+
                      |            |
                      |            |
                      |            |
                      |            |
                  +-------+    +-------+
                  | AP 1  |    | AP 2  |    wifi access point
                  +-------+    +-------+
```

Figure 1: L2 Campus Network

In SOHO or SMB case, the network is not large and the network nodes have less resource. They are pure layer 2 nodes or nodes to be enrolled as layer 2 first to form the initial simple topology for cabling verification. In this case, autonomic network management with the layer 2 network nodes is required. Figure 1 shows a typical example of layer 2 network.

For small branch, the number of hosts is usually less than 200, and the number of WiFi AP and access switches are both less than 10. Two layers of core and access switch topology is the most common structure. For a small campus, the number of hosts is usually less than 2000. Three layer structure, core, aggregation and access switch topology with some redundancy, might be used. The number of access switches and WiFi APs are in the order of dozens. The total

number of network nodes, including switches and APs, is usually less than 200.

It is sometimes required to firstly form a local area network disconnected from the Internet. A laptop or mobile phone connected to a specific node, usually the top level gateway as the core switch shown in Figure 1, can be used by the network manager to visualize and verify the topology.

3. Requirements for L2 ACP and related functions in ANI

The generic basic functions of ANI are required for L2 network to be compliant with the high level autonomic network and node structure.

The assumptions and requirements include,

1. IP addresses of the node and its interface may not be available upfront.

2. L2 ACP construction can be based on L2 available information and/or mechanisms, such as MAC address, VLAN or physical port information. It should not rely on the IP addresses of the interface.

3. Adjacent node discovery should be carried as L2 frame. When GRASP DULL is used, it should function without network layer multicast.

4. It is desired to reuse GRASP messages as much as possible. GRASP messages should be able to be carried by L2 transport substrate.

5. L2 ACP module should provide API to the upper layer to allow ASA to invoke L2 based functions.

6. Physical connectivity and topology information should be able to be collected via L2 ACP for verification.

7. Routing in L2 ACP should support L2 loop-free logical topology creation.

8. Minimal manual configuration is required. However, L2 ACP can assume some management VLAN ID is pre-configured and with a password or encryption key if necessary for security concern.

9. Re-use of the existing well-known multicast MAC addresses is desired.

4. Reference Model of L2 ACP based Autonomic Node

Figure 2 shows a reference model when L2 ACP and the related function is present in ANI.

```
        +-------+                            +-------+
        | ASA 1 |                            | ASA 2 |
        +-------+                            +-------+
            ^                                    ^
            |                                    |
          -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
                        API Invoke (L2/L3)
          -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
            |                                    |
            |                                    |
   ---------------------------------------------------------------
            | Autonomic Networking Infrastructure|
            v                                    v
    +-----------------------------------------------------------+
    | Basic ANI functions                                       |
    |   - Data strcutures                                       |
    |   - Discovery, negotiation and synchronization functions |
    |   - Information and Intent Distribution                   |
    |   - ...                                                   |
    +-----------------------------------------------------------+
    +---------+ +-----------------------------------------------+
    |         | |L2 ACP                                         |
    |         | |- Neighbour Discovery with L2 GRASP DULL       |
    | L3 ACP  | |- Addressing and reachability                  |
    |         | |- Topology collection and loop-free creation   |
    |         | |- GRASP with L2 extension in L2 ACP            |
    +---------+ +-----------------------------------------------+
   ---------------------------------------------------------------
                           OS Functions
   ---------------------------------------------------------------
```

Figure 2: Model of an Autonomic Node with L2ACP

The conceptual API should allow the ASAs to communicate with other ASAs by invoking a set of L2 transport based functions in the underlying ANI. The semantics of data models expressed by the invoked L2 APIs are expected to be consistent as much as possible with the L3 API with the similar functions.

Generally L2 ACP provides the similar functions as L3 ACP without requiring the L3 address and reachability as the transport substrate.

The DULL instance of GRASP is used to discover neighbours. It uses the IPv6 link-local multicast address. In layer 2 network, L2 GRASP DULL is expected to be sent without the requiring L3 addresses. One of the possible way is to extend L2 control plane protocol to carry GRASP information. Link Layer Discovery Protocol (LLDP) defined by IEEE 802.1 can be a candidate of such a protocol as it is able to discover L2 neighbour nodes and the related L2 information such as the physical port information and VLAN IDs.

RPL is suggested as a routing protocol used in L3 ACP [RFC8994]. Routing is mostly used for L3 network. RPL is not directly applicable to run in L2 ACP. Therefore similar functions of topology collection and loop-free topology creation is required for L2 ACP. L2 ACP should have its own addressing and L2 reachability scheme to securely reach L2 autonomic node.

5. Security Considerations

[Editor's notes: It is not completed. Further discussions are needed.]

The network leverages the L2 ACP and the related functions are usually small to medium size network in a single or very closed physical locations. Therefore physical security to prevent access by unauthorized persons can be used to protect against interlopers and eavesdroppers.

6. IANA Considerations

No IANA action is required for this document so far. More consideration will be required for future normative specification of extensions of GRASP, LLDP and/or other protocols.

7. References

7.1. Normative References

[RFC8990] Bormann, C., Carpenter, B., Ed., and B. Liu, Ed., "GeneRic Autonomic Signaling Protocol (GRASP)", RFC 8990, DOI 10.17487/RFC8990, May 2021, <https://www.rfc-editor.org/info/rfc8990>.

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7.2. Informative References

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TBD

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