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CONSTRAINT-BASED ACTIVE-ACTIVE SERVICE REDUNDANCY IN WIRELESS CLUSTER

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ABSTRACT

Techniques are described herein for using different constraints and electing a leader based on those constraints. This may help to fairly distribute services among different leader-capable nodes. The constraints may include resources such as Central Processing Units (CPUs), memory, bandwidth, network forwarding resources, etc. For example, compute-intensive applications may require more CPU resources, whereas some applications (e.g., logging) may require more memory. The constraint may also be a combination of multiple resources, such as a log collector analysis service.

DETAILED DESCRIPTION

In one wireless use case for clustering, the cluster nodes are primarily wireless Local Area Network (LAN) controller devices (e.g., appliance, virtual, hosted on Access Point (AP) or switch, etc.). A cluster service can take the role of a leader or a follower. A leader provides the services actively, and a follower provides a backup for those services. Leader election can be performed on a per-node or per-service basis. When leader election is performed on a per-node basis, all active services are hosted on the leader node. This is because there is only one leader in a given cluster. When electing a leader (either on a per-service or per-node basis), the Highest Random Weight Hashing or Consistent Hashing algorithms may be used to calculate a hash. A service identifier (ID) and a peer Internet Protocol (IP) address may be included in the hash calculation. In case of node-based leader election, the service ID is set to zero.

This approach to hashing utilizes a node ID and/or service ID in leader elections but does not consider compute and storage constraints. As a result, the elected node can be over-utilized. Another problem in the clustering environment is that any leader-capable node in a cluster network can become a leader of a service. This can lead to over- or underutilization of leader-capable nodes in a wireless cluster network. Currently, all configuration for a given AP is always managed by a single controller.

Accordingly, as described herein, a virtual cluster segment may cause compute and storage resources to be considered. A mechanism is also provided for efficient distribution of wireless services (e.g., AP configuration management, Service Set ID (SSID) management, client traffic, rogue detection, various type of telemetry aggregation, etc.). This mechanism accounts for wireless and networking resources (e.g., capacity of the service to handle resources such as APs, radios, clients, Virtual LANs (VLANs), etc.).

A given set of resources may be sub-grouped, effectively allowing for heterogeneous members to handle services that require different types of resources. A constraint may be used for a service whereby a constraint and the services under the constraint may be configured on a set of leader-capable nodes. The leader for a service may be elected among the nodes where a constraint is configured. Leader election may be performed per constraint and/or per service based among leader-capable nodes (i.e., among the nodes where that constraint is configured). A newly elected leader node (e.g., where leader election occurs per constraint and/or per service) may communicate back to APs and other service instances to connect to an elected service leader node. Services that have similar requirements for resources may be configured under one constraint.

Figure 1 below illustrates an example virtual cluster segment. A virtual cluster segment may be defined as a group of services, which may have similar characteristics. As shown, this may include a network where multiple APs are multi-homed with one or more services from one or more APs. A virtual cluster segment may have a one-to-one mapping with a given constraint. Within each constraint, there may be multiple services. A virtual cluster segment may have a corresponding six-octet global identifier for identifying the virtual cluster segment on the controller / leader-capable node. The virtual cluster segment may also be configured for only a single controller.

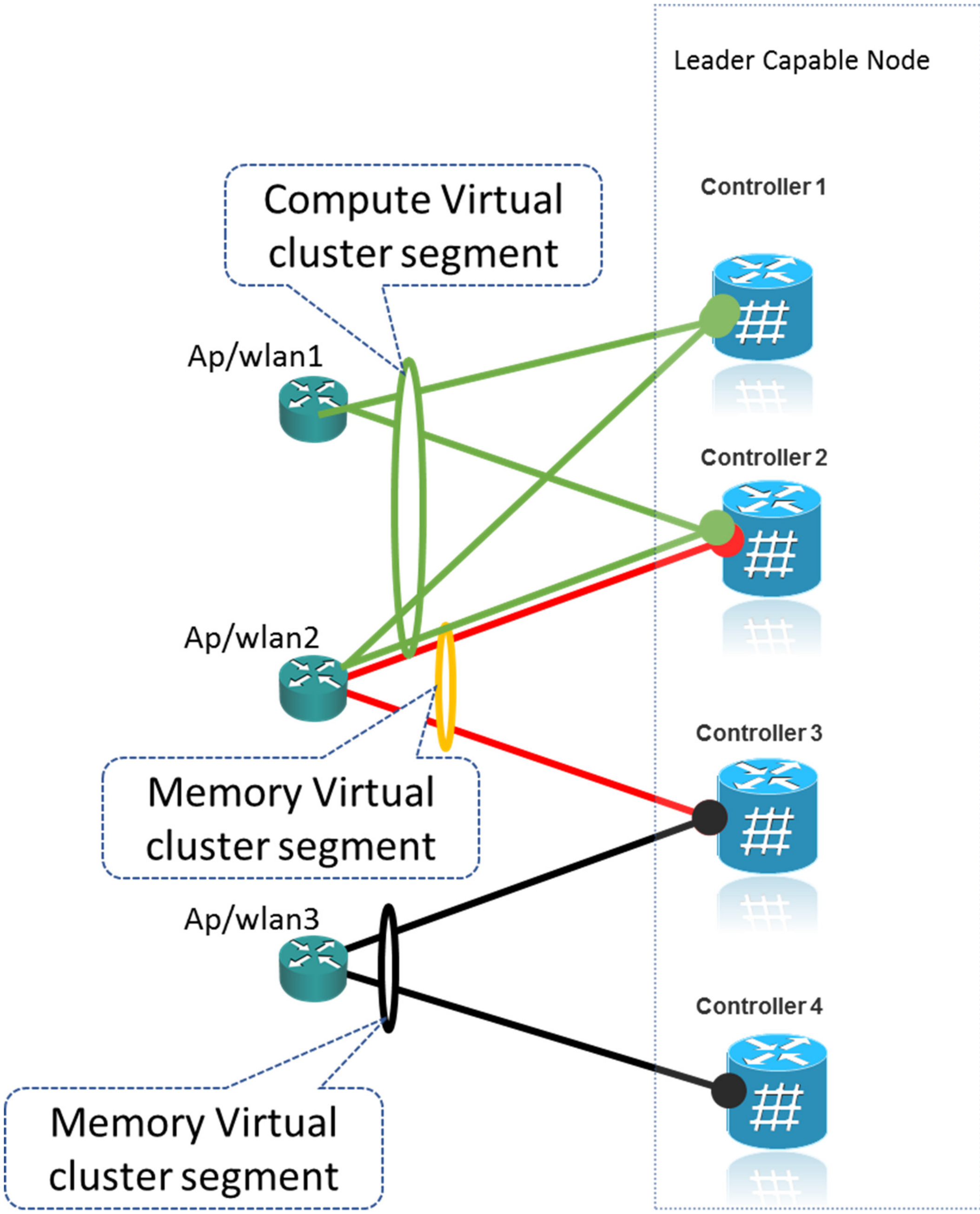

Leader Capable Node
Compute Virtual cluster segment
Controller 1
Ap/wlan1
Controller 2
Ap/wlan2
Memory Virtual cluster segment
Controller 3
Ap/wlan3
Controller 4
Memory Virtual cluster segment

Figure 1

Figure 2 below illustrates exchange of a virtual cluster segment ID, and Figure 3 below illustrates configuration and deletion of virtual cluster segment. With respect to Figure 2, during secure tunnel establishment, the virtual cluster segment ID is exchanged between leader-capable nodes. This exchange occurs between nodes where the same virtual cluster segment is configured. This is done during a secure capability exchange. Services IDs under a virtual cluster segment are also exchanged between nodes. Once the tunnel is established, per-service leader election may be performed per virtual cluster segment, per service (e.g., in the same cluster segment). Each leader-capable node runs leader election on a per - virtual cluster segment basis. The elected leader for a service may send a notification to the remote AP / Wireless LAN (WLAN) controller that the service is active on that node.

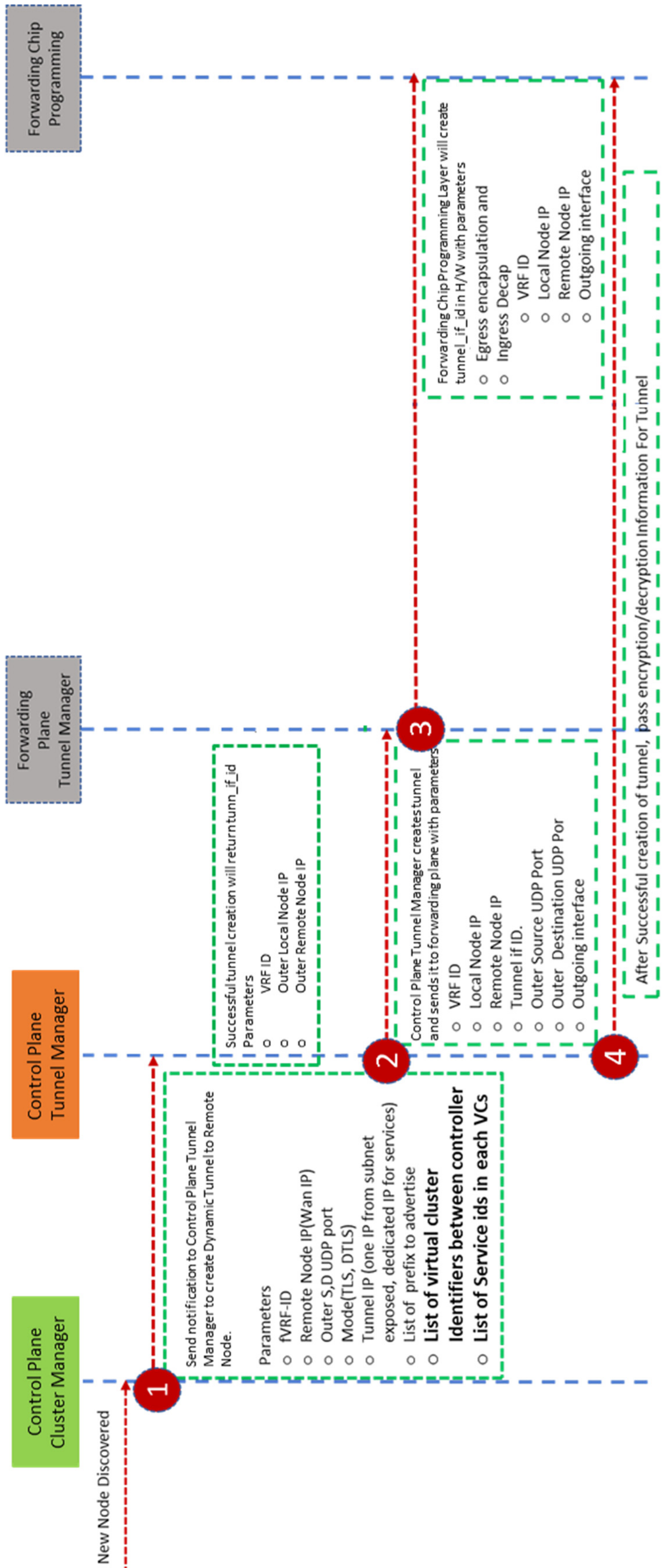
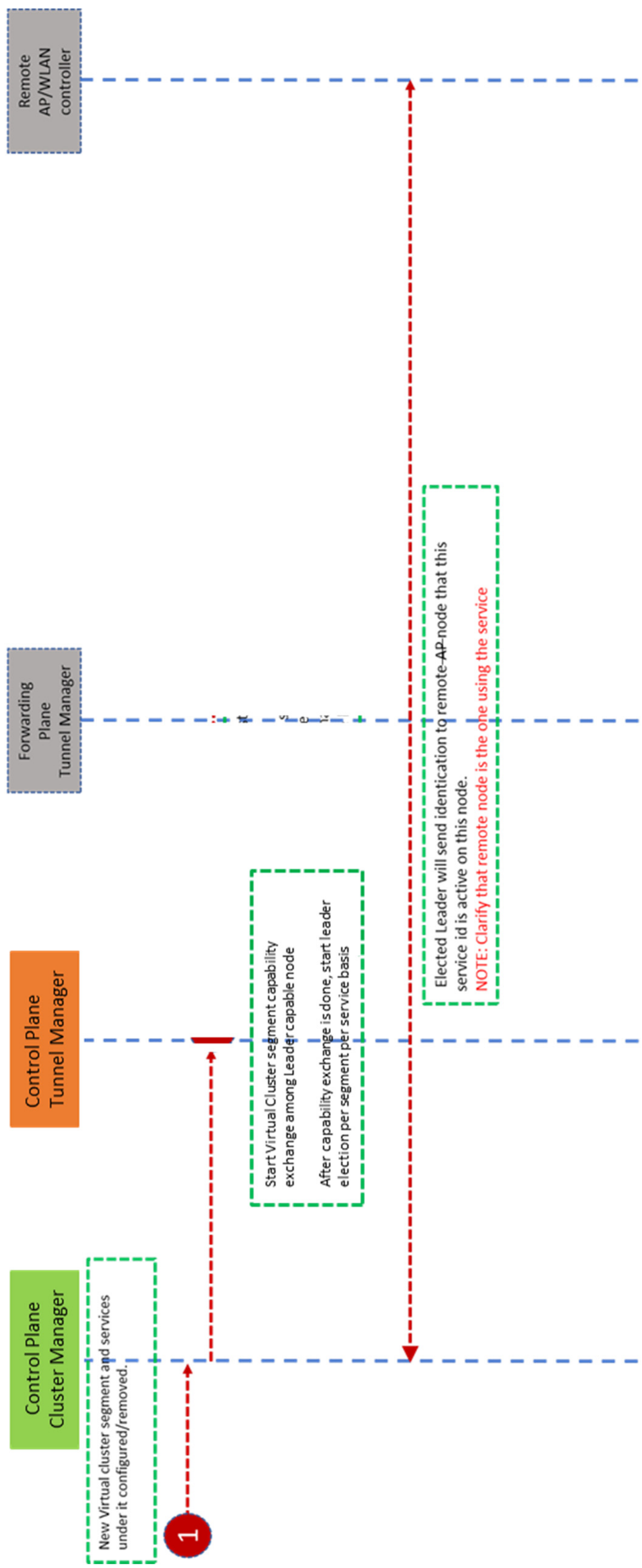

Control Plane Cluster Manager
Control Plane Tunnel Manager
Forwarding Plane Tunnel Manager
Forwarding Chip Programming
New Node Discovered
1
Send notification to Control Plane Tunnel Manager to create Dynamic Tunnel to Remote Node.
Parameters
fVRF-ID
Remote Node IP(Wan IP)
Outer S,D UDP port
Mode(TLS, DTLS)
Tunnel IP (one IP from subnet exposed, dedicated IP for services)
List of prefix to advertise
List of virtual cluster Identifiers between controller
List of Service ids in each VCs
2
Successful tunnel creation will return tunn_if_id Parameters
VRF ID
Outer Local Node IP
Outer Remote Node IP
Control Plane Tunnel Manager creates tunnel and sends it to forwarding plane with parameters
VRF ID
Local Node IP
Remote Node IP
Tunnel if ID.
Outer Source UDP Port
Outer Destination UDP Por
Outgoing interface
3
Forwarding Chip Programming Layer will create tunnel_if_id in H/W with parameters
Egress encapsulation and
Ingress Decap
VRF ID
Local Node IP
Remote Node IP
Outgoing interface
4
After Successful creation of tunnel, pass encryption/decryption Information For Tunnel

Figure 2



Remote AP/WLAN controller
Forwarding Plane Tunnel Manager
Control Plane Tunnel Manager
Control Plane Cluster Manager
New Virtual cluster segment and services under it configured/removed.
1
Start Virtual Cluster segment capability exchange among Leader capable node
After capability exchange is done, start leader election per segment per service basis
Elected Leader will send identication to remote AP node that this service id is active on this node.
NOTE: Clarify that remote node is the one using the service

Figure 3

Leader election may be performed for services within a virtual cluster segment. Per-node leader election provides a mechanism for electing a single node for active services. As described herein, services are included in the constraints. Thus, leader election occurs on a per-service basis under a given virtual cluster segment (e.g., constraint). This provides fair distribution of services/load among multiple leader-capable nodes. The Weighted Highest Random Weight or Consistent Hashing algorithms may be used for electing a leader per virtual cluster segment, per service. Any suitable algorithm for leader election may be employed.

Information regarding a virtual cluster group may be exchanged among cluster members prior to leader election. Detection may be possible based on observing cluster behavior and inspecting traffic over the cluster control channel. Furthermore, services may be load balanced to selected controllers/leader nodes deterministically. Load balance/distribute AP configuration management may pertain to all wireless configuration including those elements which are pushed to APs.

In a controller cluster the wireless configuration management itself may be considered an independent service. This does not necessarily require a change to the interface between the AP and the controller, though that may be possible. The configuration management service may primarily provide northbound interfaces, and distribute the configuration across the cluster. Further distribution of the configuration to APs may occur as per existing mechanisms over Control and Provisioning of Wireless APs (CAPWAP), or may evolve as needed.

In summary, techniques are described herein for using different constraints and electing a leader based on those constraints. This may help to fairly distribute services among different leader-capable nodes. The constraints may include resources such as Central Processing Units (CPUs), memory, bandwidth, network forwarding resources, etc. For example, compute-intensive applications may require more CPU resources, whereas some applications (e.g., logging) may require more memory. The constraint may also be a combination of multiple resources, such as a log collector analysis service.