1 Table of Contents

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1.1 Revision History

DATE	VERSION	EDITOR	CHANGES
03 Jun 2023	0.1	Ariya Parsamanesh	Initial creation
06 Jul 2023	0.2	Ariya Parsamanesh	Added the failover timing test section
07 Mar 2024	0.3	Ariya Parsamanesh	Changed the LAN switches to CX switches. Updated the failover timing test section after upgrade to 10.5.1.0 Added LAN switch spanning tree states.

2 Branch Gateway Redundancy

The aim for this technote is to provide branch gateways (BGW) redundancy and to be able to share the uplinks on each of the branch gateways.

The gateways in a High Availability (HA) group establishes a virtual link (GRE Tunnel) between redundant Aruba Gateways to share the WAN interfaces. This happens only if WAN ports are configured with different uplink VLANs. You should note that the uplinks on both BGWs can be active.

The second part of this is by configuring VRRP between all the VLANs on the LAN side. It is recommended to configure the same SD-WAN Gateway as the Conductor for all the VLANs.

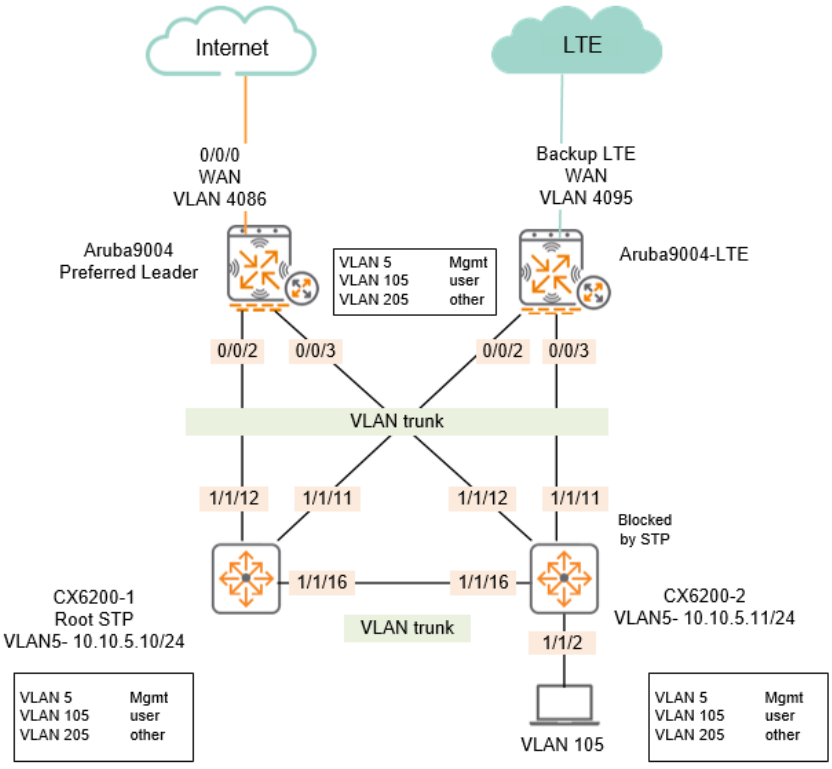
2.1 Assumptions

- The two BGWs are already added to the Aruba Central account
- The BGWs are running AOS 10.5.1.0 firmware
- BGWs are licenses with Foundation gateway foundation
- One of the BGWs is 9004 and the other is 9004-LTE

2.2 Topology

In this topology we are not using any VPNCs, we have 2x BGWs in a HA sharing their uplinks between them. One of them has wired Internet link while the other has LTE link.

The topology diagram shows a typical deployment for it where we have 2 LAN switches that are dual connected to BGWs. In this topology the LAN switches are not stackable switches, this is to highlight the importance of Spanning tree root.

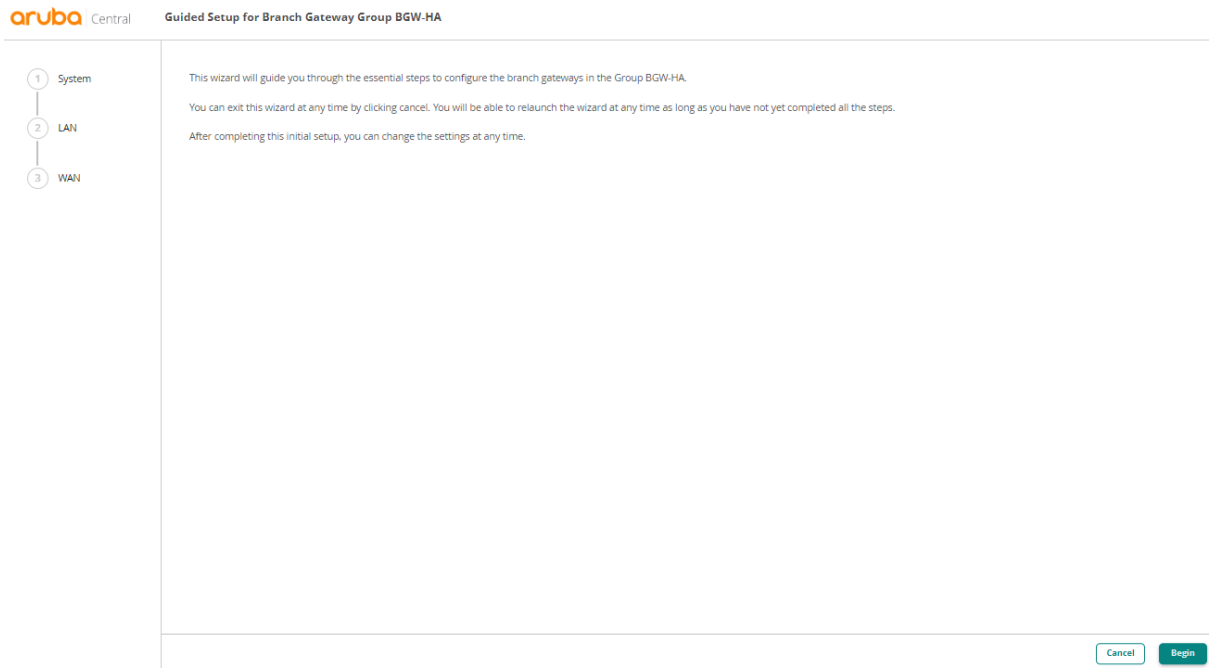


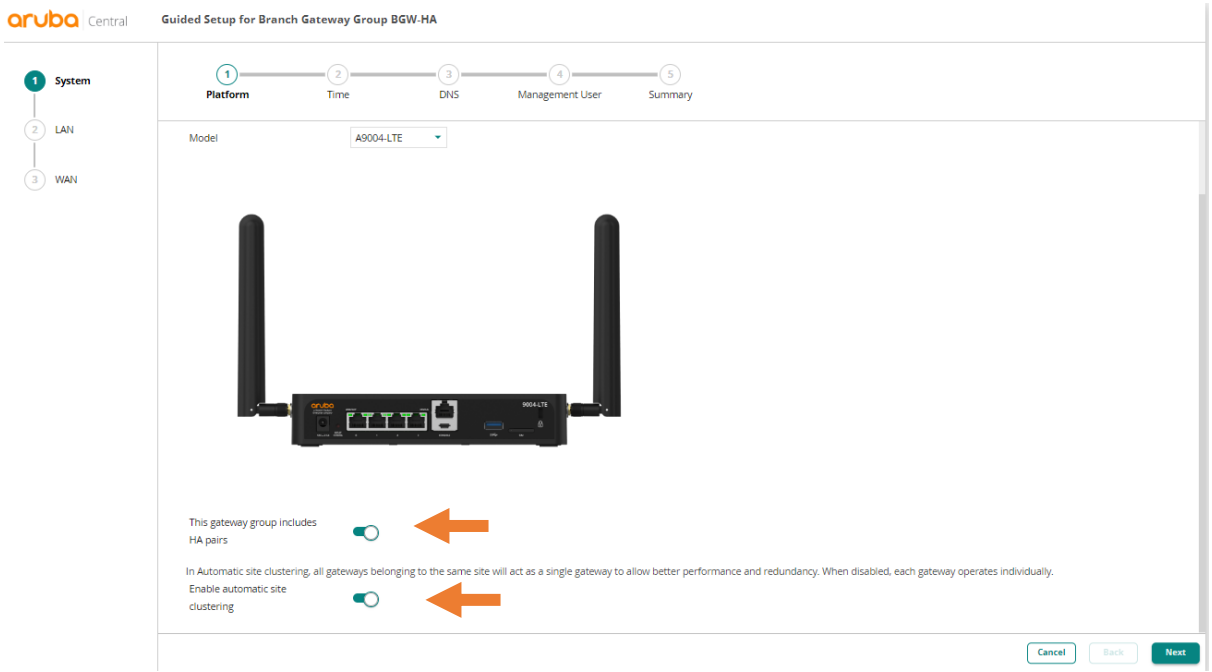
Once you configure the Clustering and its associated VRRP along with WAN uplink sharing, you'll have the following tunnels.

- Clustering - Establishes 1x IPSec Tunnel with peer system-IP address
- Uplink Sharing - Establishes 1x GRE Tunnel with peer, for each uplink VLAN not present on the gateway itself
- Overlay - Establishes 1x IPSec over each configured uplink (Virtual/Shared or Physical) to all configured VPNCs

2.3 HA Group Configuration

The easiest way to configure HA is at the group creation. So start with basic guided workflow.



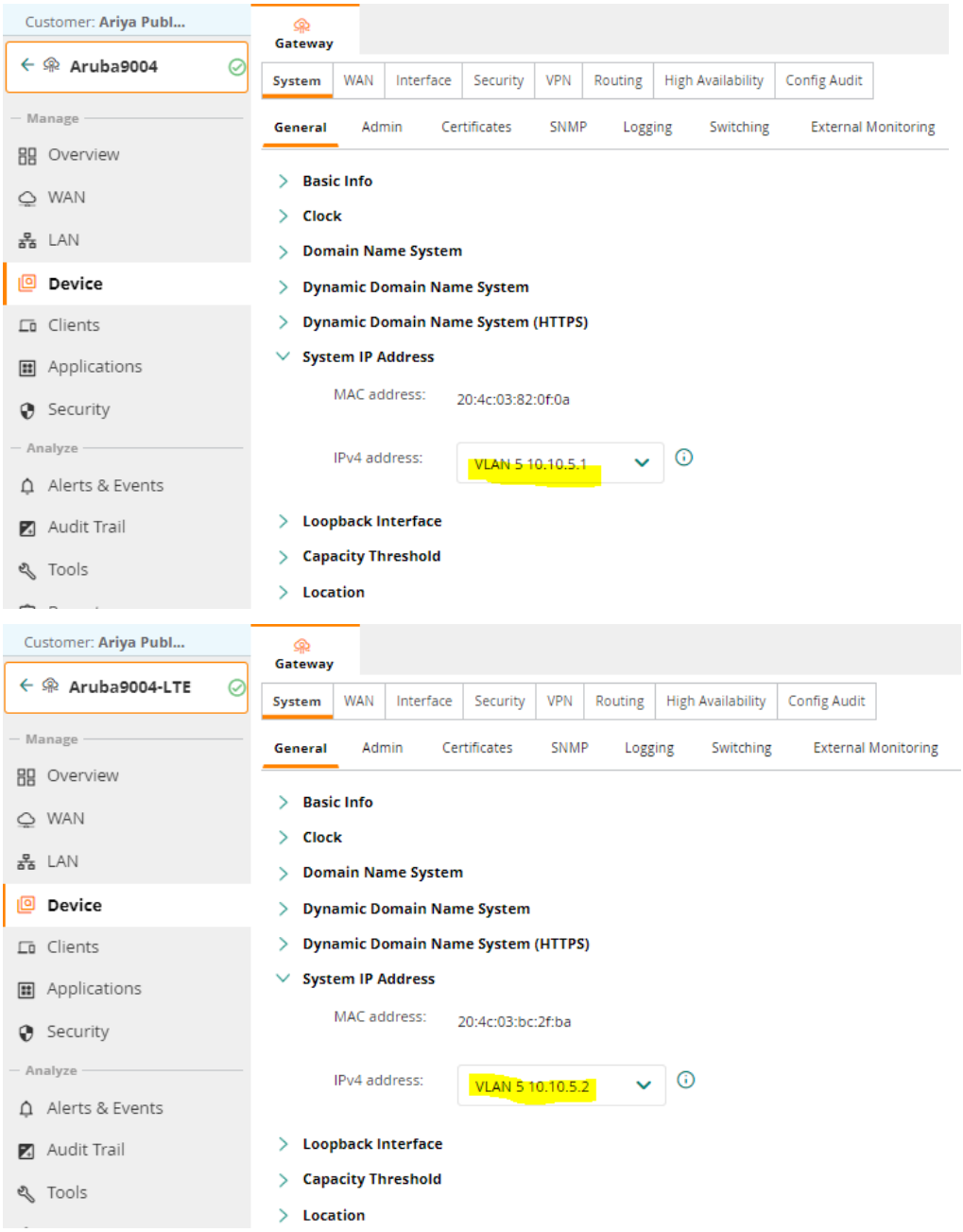


Here we are not showing the rest of the workflow but once it is completed you should get the following when you move the gateways to this group.

2.4 System IP Configuration

Once the gateways are in the group you need to assign them their system-IP.

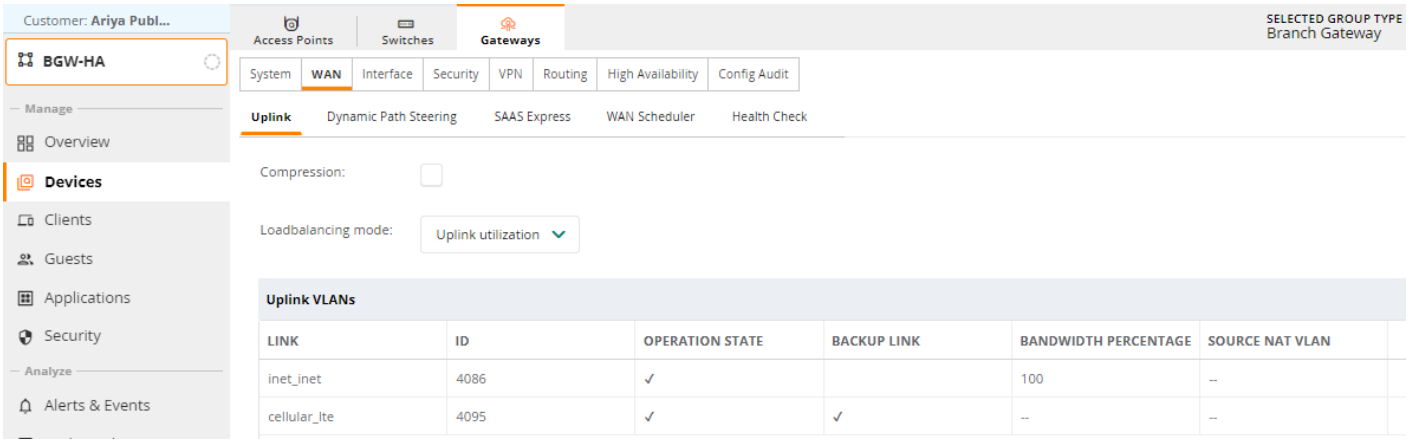
Its mandatory to have LAN mgmt subnet as the system IP of the gateways for HA branch GW Clustering to work as expected. So the gateways should not use the pool mgmt. as their system IP. This is done at the device level



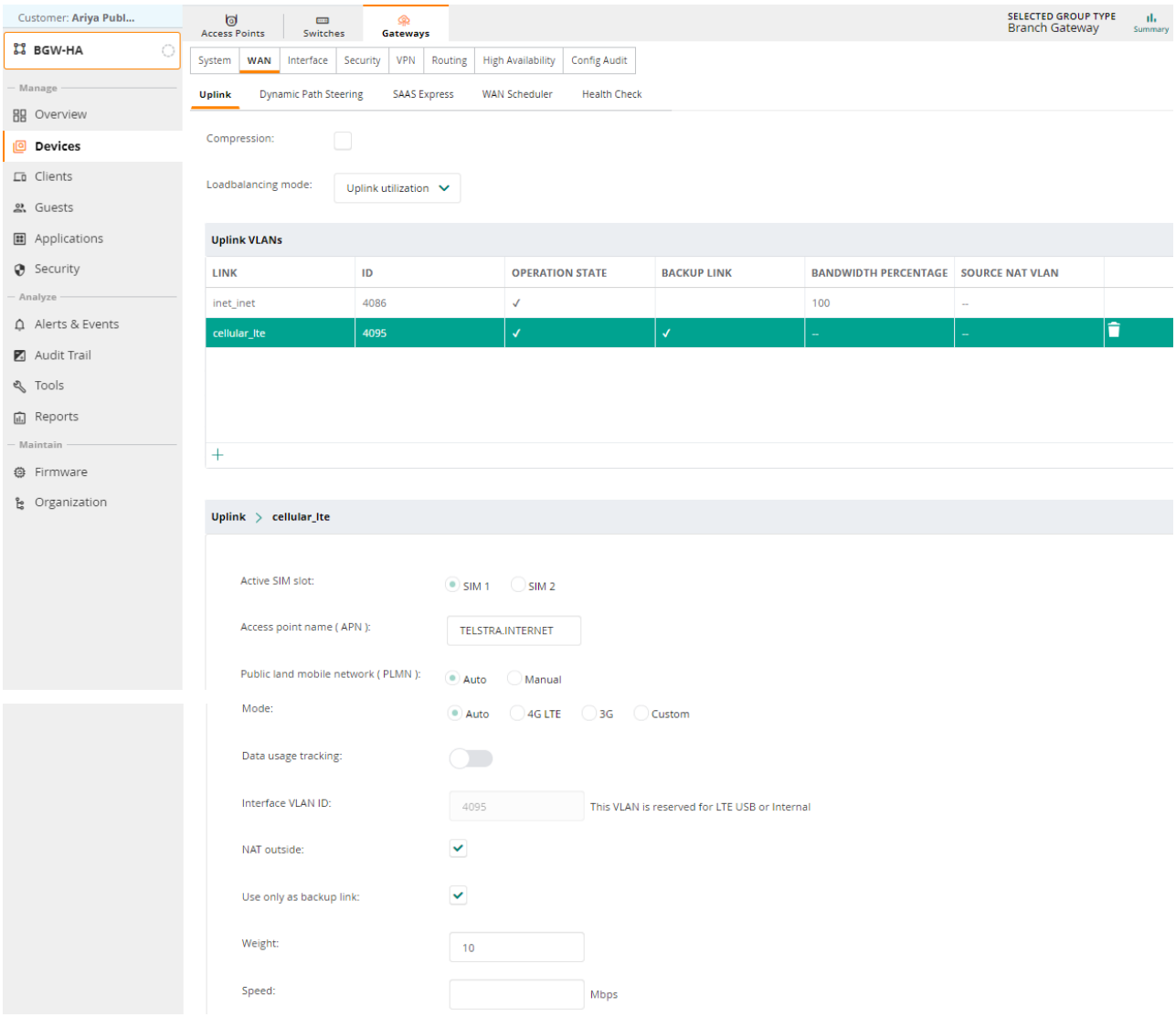
Note that changing the system-IP of gateways will cause them to reboot.

2.5 WAN Uplink Configuration

Now at the group level we'll configure the WAN uplinks.



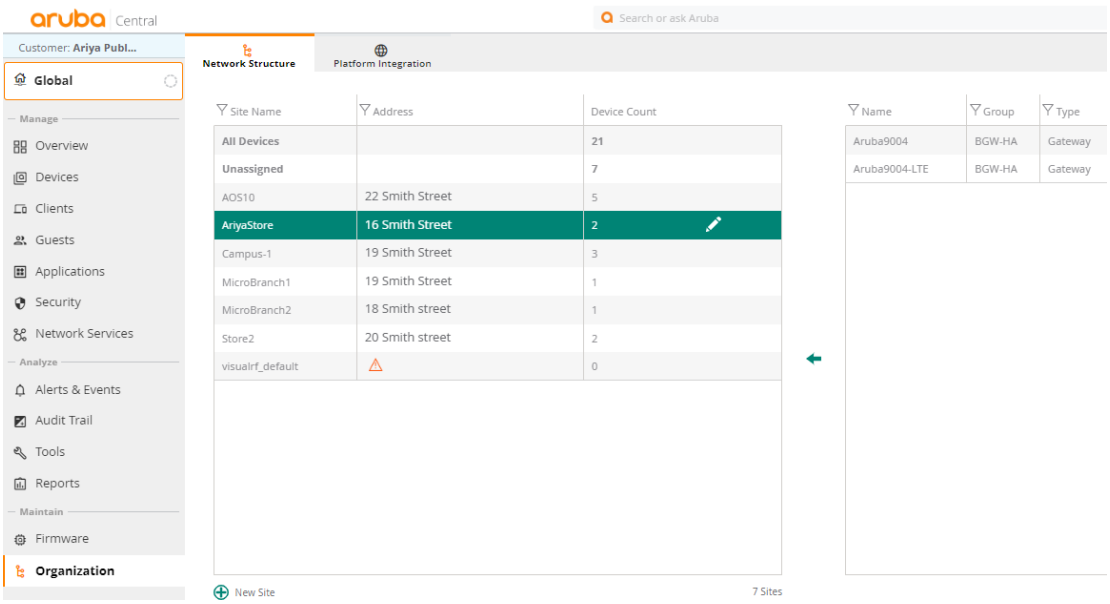
Note that the LTE interface is configured as backup only and it will always use internal VLAN 4095



Remember we will not make any changes to the WAN uplinks in the device level configuration.

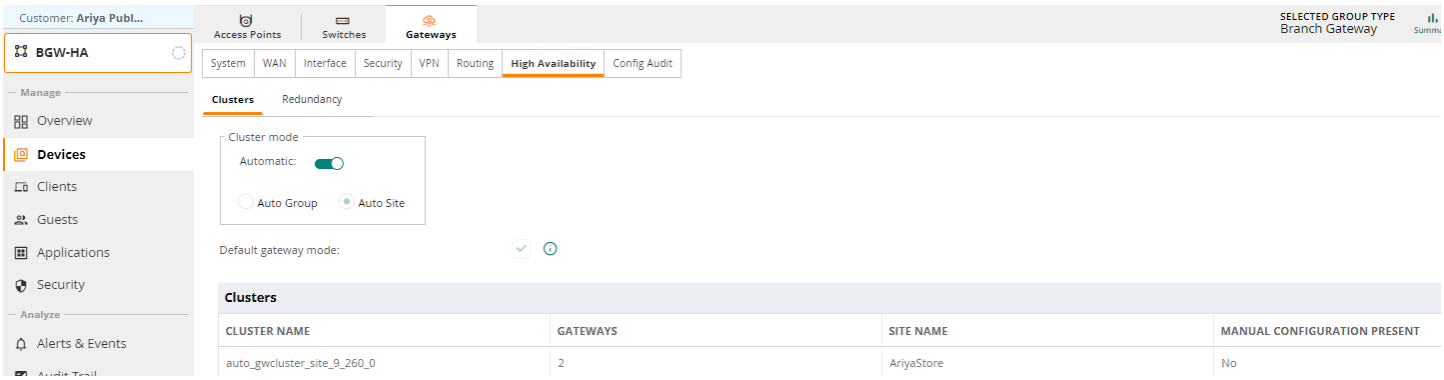
Once this is done add the BGWs to a site, that refers to a physical location where a set of devices are installed. Aruba Central allows you to use sites as a primary navigation element.

Organization -> Network Structure -> Sites

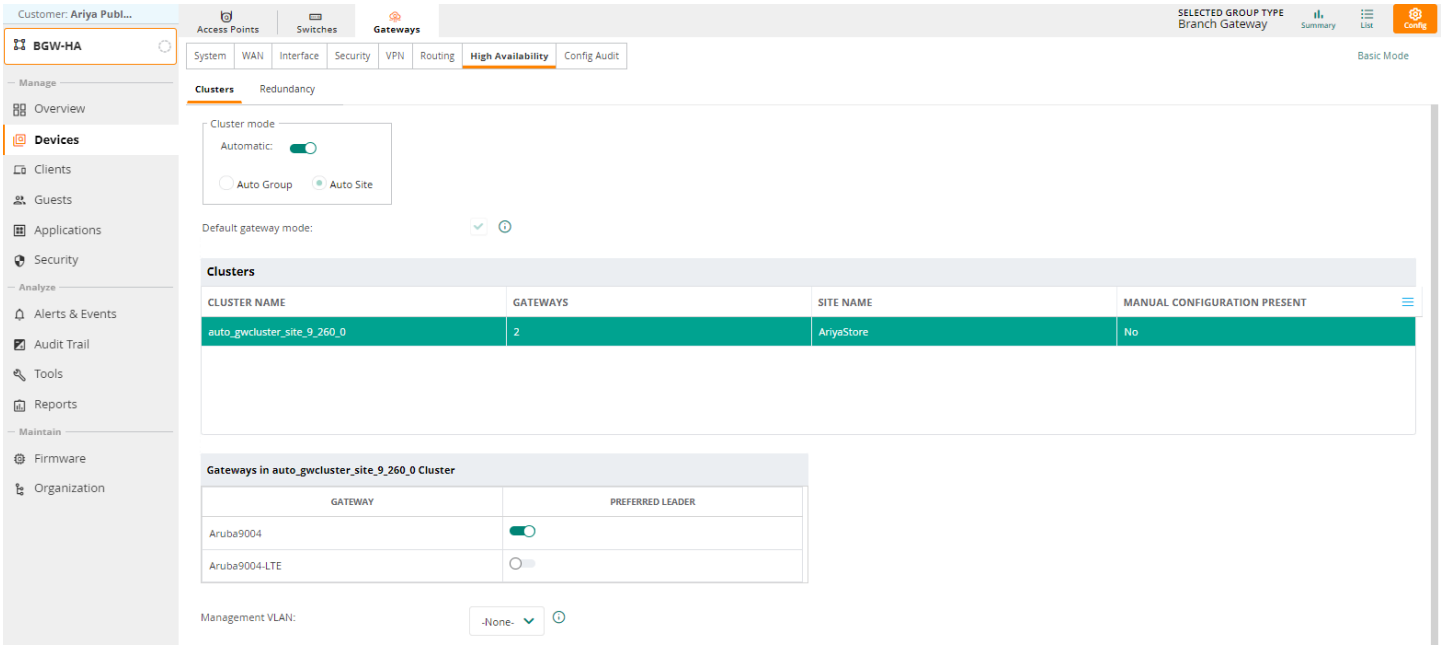


2.6 High Availability Clustering Group Configuration

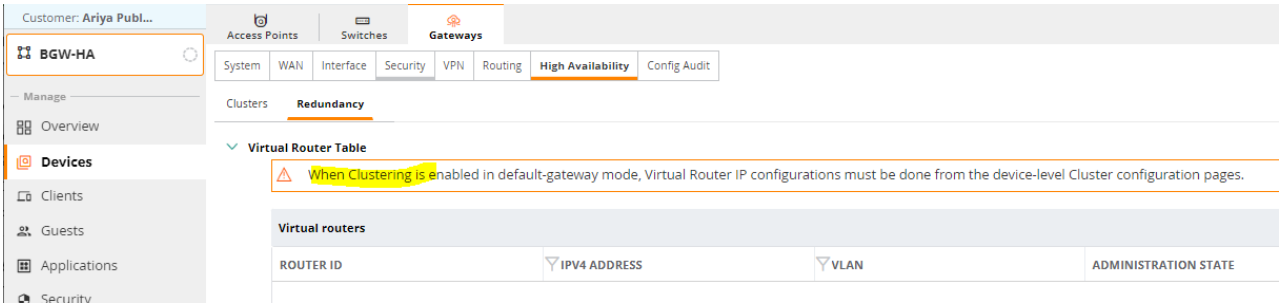
With AOS10 firmware we'll be using the clustering function that comes with it.



Note that the auto-clustering will happen only when you have assigned the gateways to a site. Then you can select the cluster name and choose one of the gateways to be preferred leader.

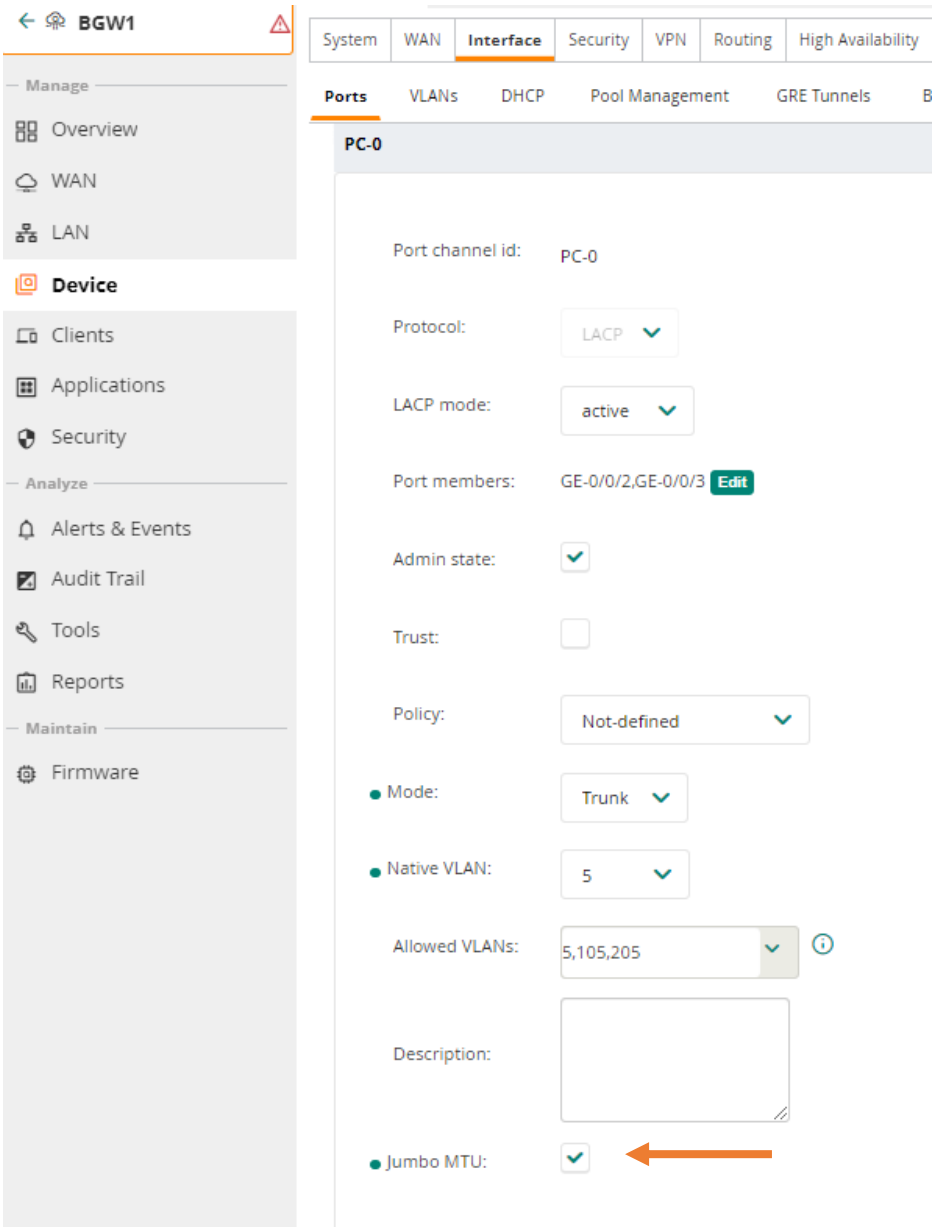


Note that mgmt. VLAN is important when you want to do CoA from the VRRPs. All the VRRP configuration for different LAN side VLANs are done at the device level not at the group level.



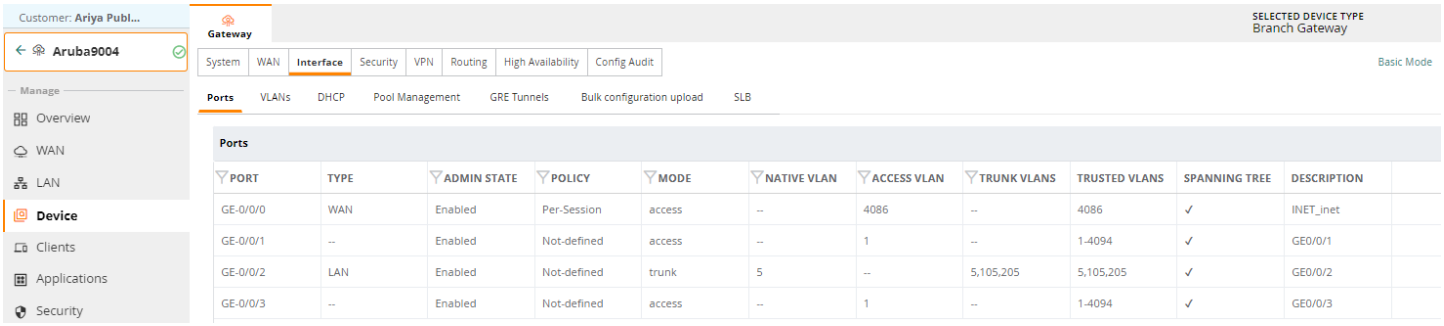
2.7 Link Aggregation

I won't be covering this specific setup here but If you need to enable link aggregation for the LAN interfaces of each BGW, then ensure that that you have enabled Jumbo frames.



2.8 Device Level Interface Configuration

Before proceeding with VRRP for the LAN side interfaces, you need to configure the IP address for the relevant VLANs.



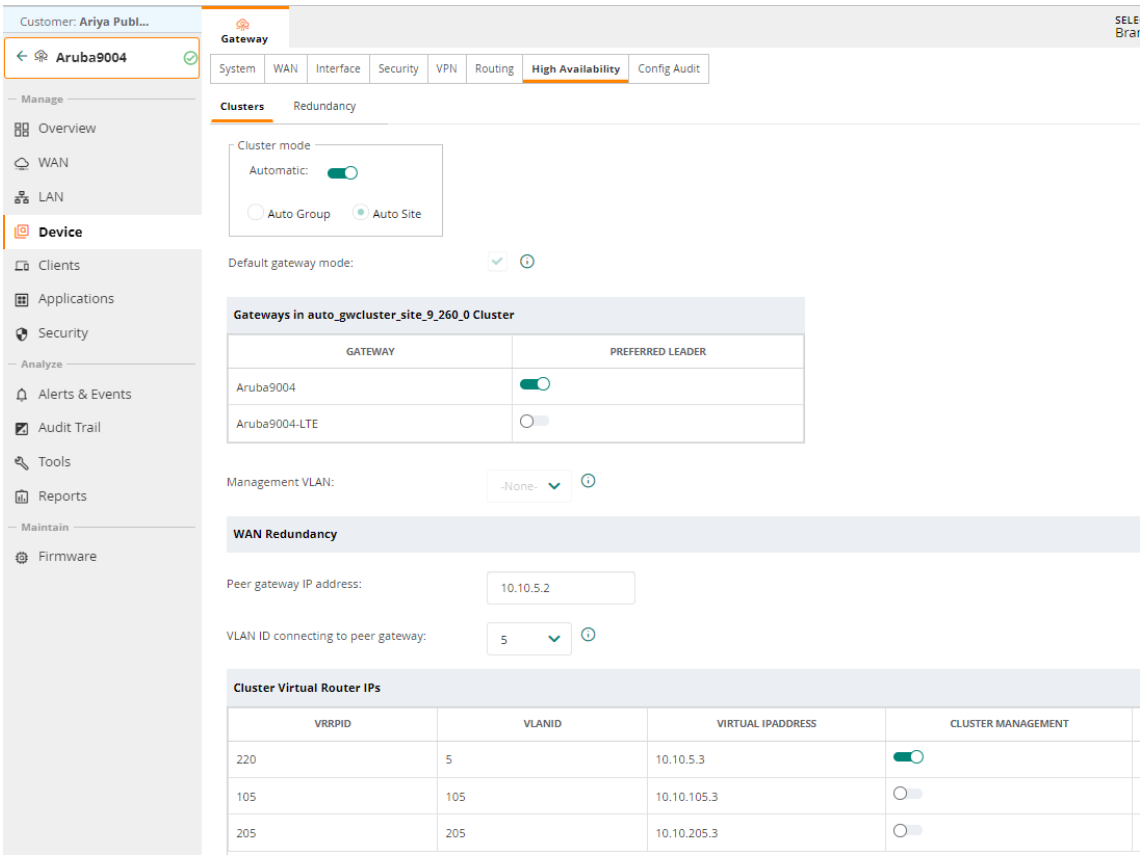
This table shows the IP address

	VLAN5	VLAN105	VLAN205
Aruba9004	10.10.5.1/24	10.10.105.1/24	10.10.205.1/24
Aruba9004-LTE	10.10.5.2/24	10.10.105.2/24	10.10.205.2/24

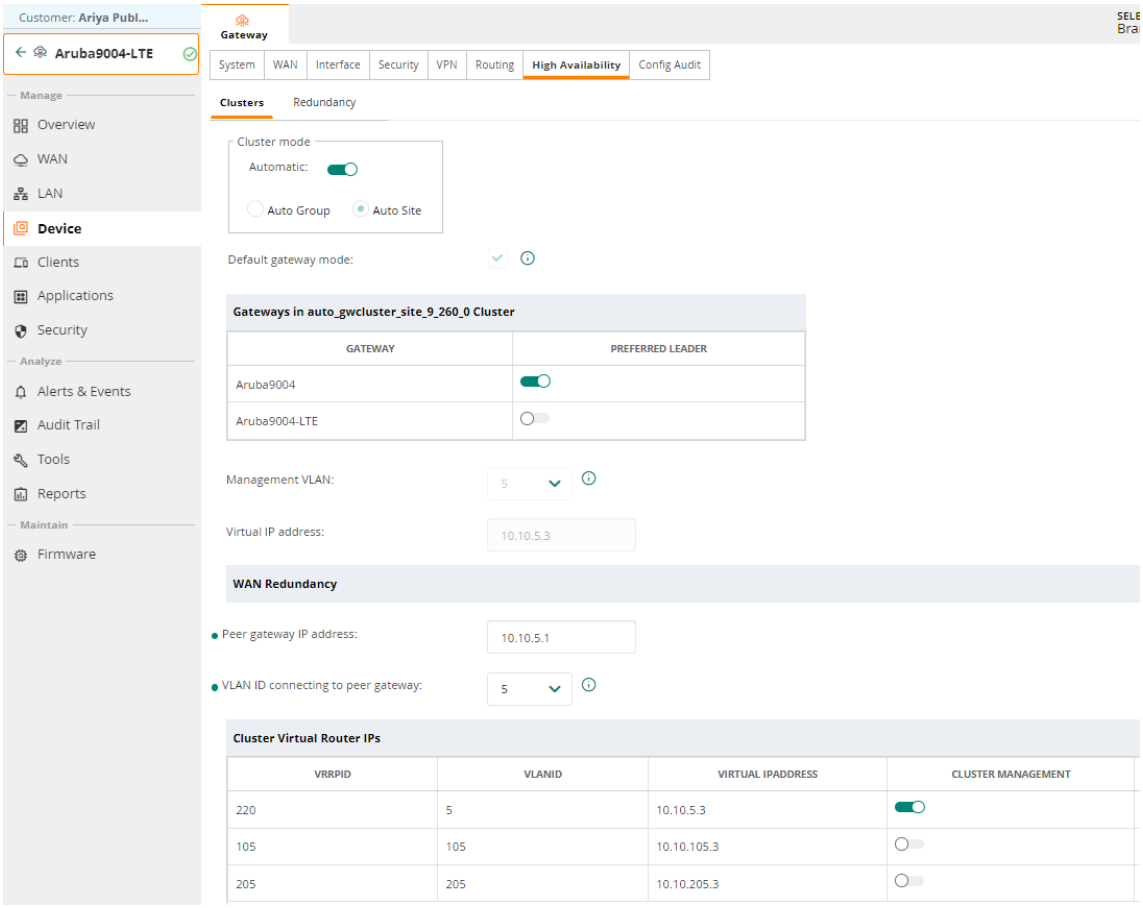
The general recommendation is to set LAN interfaces to be “untrusted” so that all devices in the branch get tracked by the role-based firewall. Make sure the peer gateway is placed in a role where VRRP and GRE communication is allowed.

2.9 Device Level VRRP and WAN Redundancy Configuration

We’ll start with the first gateway.

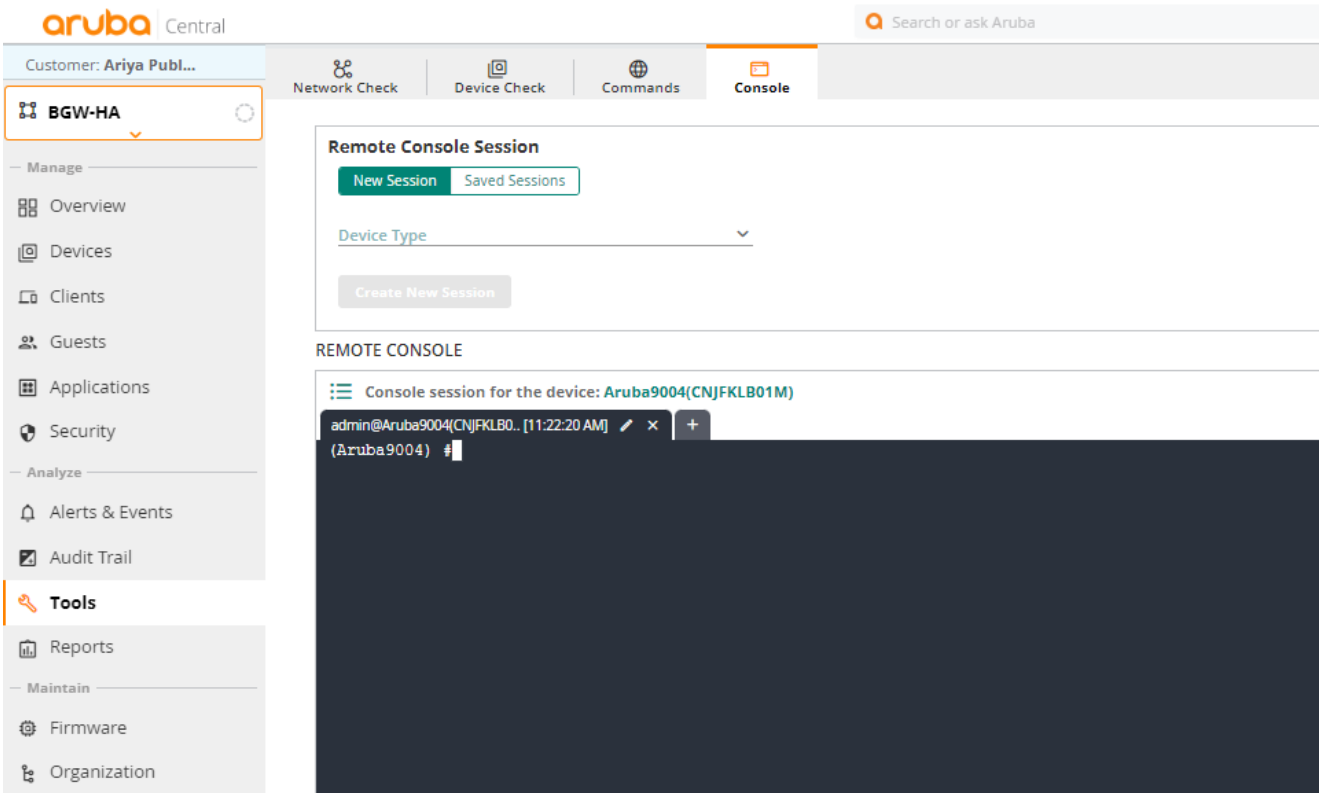


And here is the other LTE gateway.



2.10 Checking VRRP Configuration

For all thew CLI commands in this guide, we are using the console access that is available from Aruba Central.



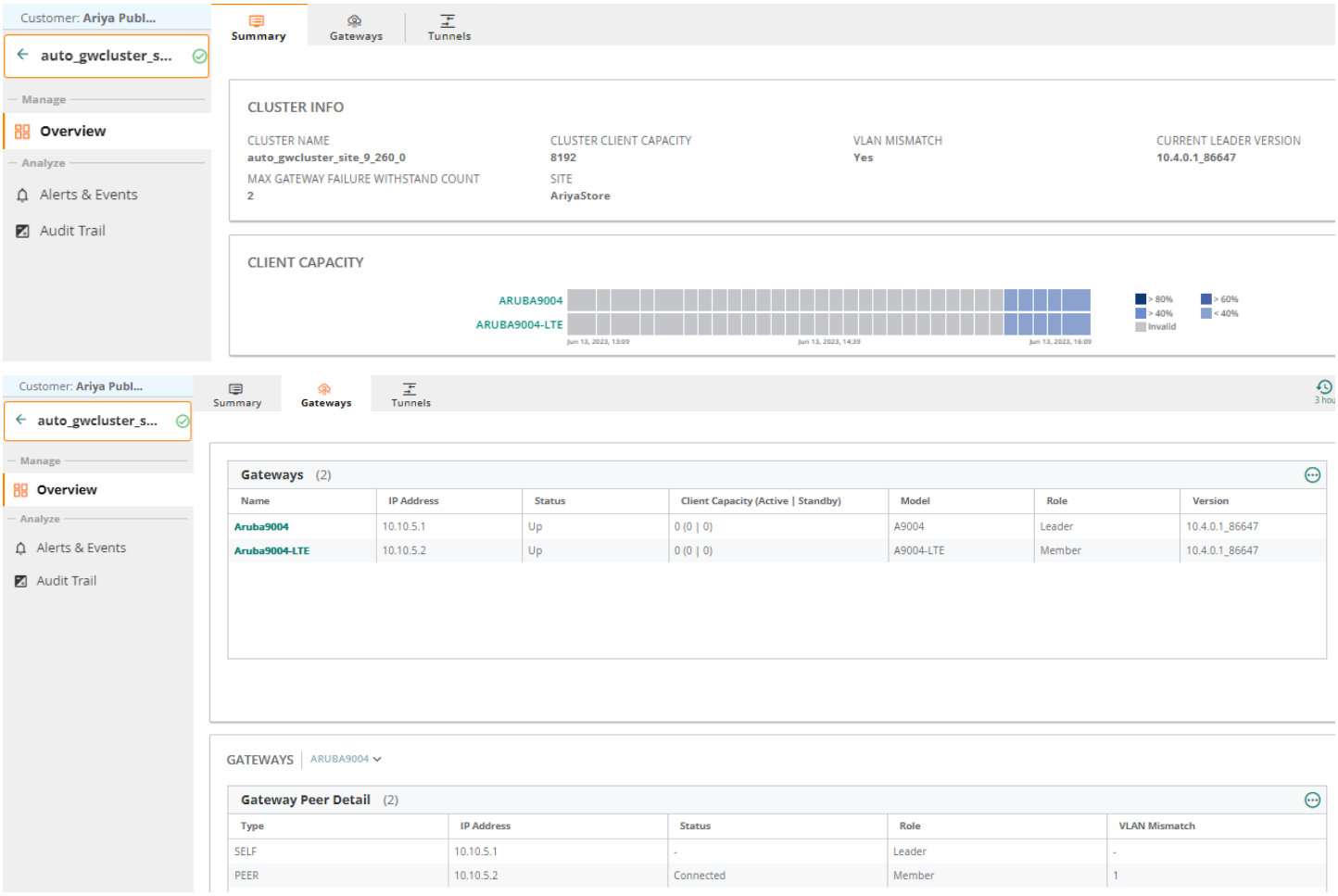
Now checking the configuration for the Aruba9004

```
(Aruba9004) #show vrrp

Virtual Router 105:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.105.3, MAC Address 00:00:5e:00:01:69, vlan 105
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 205:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.205.3, MAC Address 00:00:5e:00:01:cd, vlan 205
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 220:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.5.3, MAC Address 00:00:5e:00:01:dc, vlan 5
    Priority 255, Advertisement 1 sec, Preemption Enable Delay 0
    Auth type NONE ********
    tracking is not enabled
(Aruba9004) #
```

Here is the configuration for the Aruba9004-LTE

```
(Aruba9004-LTE) #show vrrp

Virtual Router 105:
    Description
    Admin State UP, VR State BACKUP
    IP Address 10.10.105.3, MAC Address 00:00:5e:00:01:69, vlan 105
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 205:
    Description
    Admin State UP, VR State BACKUP
    IP Address 10.10.205.3, MAC Address 00:00:5e:00:01:cd, vlan 205
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 220:
    Description
    Admin State UP, VR State BACKUP
    IP Address 10.10.5.3, MAC Address 00:00:5e:00:01:dc, vlan 5
    Priority 235, Advertisement 1 sec, Preemption Enable Delay 0
    Auth type NONE ********
    tracking is not enabled
```

At this point the clustering should also be formed as indicated in the WebUI



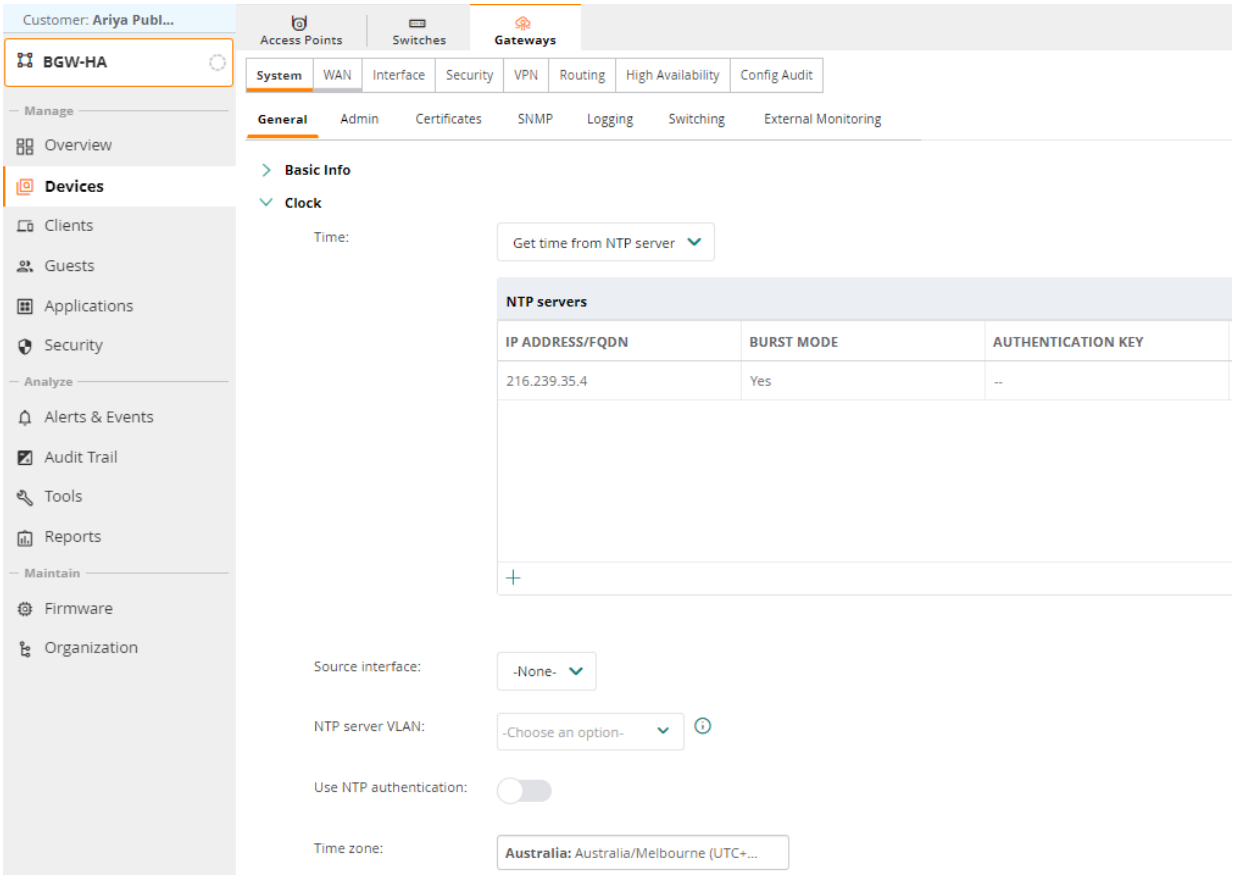
And here is the CLI command for checking it.

```
(Aruba9004) #show lc-cluster group-membership

Cluster Enabled, Profile Name = "auto_gwcluster_site_9_260_0"
One-to-one-redundancy Enabled
Heartbeat Threshold = 900 msec
Cluster Info Table
------------------
Type IPv4 Address    Priority Connection-Type STATUS
---- --------------- -------- --------------- ------
self       10.10.5.1      255             N/A CONNECTED (Leader)
peer       10.10.5.2      128    L2-Connected CONNECTED (Member)
(Aruba9004) #
```

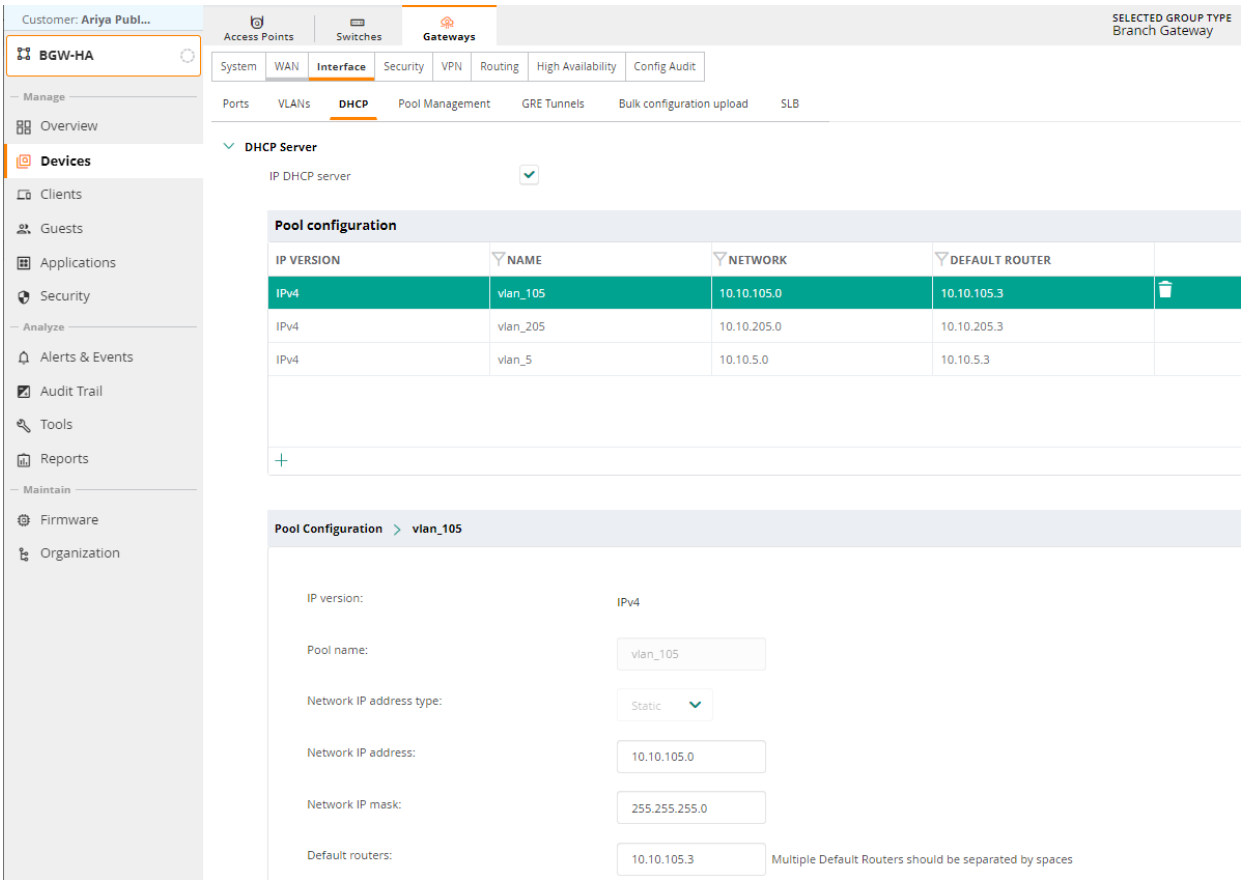
```
(Aruba9004-LTE) #show lc-cluster group-membership

Cluster Enabled, Profile Name = "auto_gwcluster_site_9_260_0"
One-to-one-redundancy Enabled
Heartbeat Threshold = 900 msec
Cluster Info Table
------------------
Type IPv4 Address    Priority Connection-Type STATUS
---- --------------- -------- --------------- ------
peer       10.10.5.1      255    L2-Connected CONNECTED (Leader)
self       10.10.5.2      128             N/A CONNECTED (Member)
(Aruba9004-LTE) #
```

2.11 DHCP Configuration

As most of the BGWs will also provide DHCP services for the branches, we need to configure the scope for the HA pair at group level. First, we need to configure NTP.



The next step is to create DHCP scopes for VLAN 5, 105 and 205, here we'll show VLAN 105.



2.12 DHCP Sync Monitor

This is how we can check if DHCP is in sync between the BGWs

```
(Aruba9004) #show ip dhcp binding failover-peer

failover peer "hpe-aruba-failover-partner" state {
  my state normal at epoch 1686634193; # Tue Jun 13 15:29:53 2023
  partner state normal at epoch 1686634229; # Tue Jun 13 15:30:29 2023
}

WARNING: Normal functioning of a DHCP server is dependent on NTP clock synchronization and
network reachability between branch-gateway peers in a HA setup.
Please ensure that both the peers are running and have connectivity.
(Aruba9004) #
```

And here is the current DHCP database

```
(Aruba9004) #show ip dhcp database

DHCP enabled

# Failover peer profile
failover peer "hpe-aruba-failover-partner" {
        primary;
        address 10.10.5.1;
        port 647;
        peer address 10.10.5.2;
        peer port 647;
        max-response-delay 60;
        max-unacked-updates 10;
        mclt 3600;
        split 128;
        load balance max seconds 3;
}
# vlan_5
subnet 10.10.5.0 netmask 255.255.255.0 {
        option domain-name-servers 8.8.8.8;
        option routers 10.10.5.3;
        pool {
                failover peer "hpe-aruba-failover-partner";
                range 10.10.5.4 10.10.5.254;
        }
        authoritative;
}
# vlan_205
subnet 10.10.205.0 netmask 255.255.255.0 {
        option domain-name-servers 8.8.8.8;
        option routers 10.10.205.3;
        pool {
                failover peer "hpe-aruba-failover-partner";
                range 10.10.205.2 10.10.205.2;
                range 10.10.205.4 10.10.205.254;
        }
        authoritative;
}
# vlan_105
subnet 10.10.105.0 netmask 255.255.255.0 {
        option domain-name-servers 8.8.8.8;
        option routers 10.10.105.3;
        pool {
                failover peer "hpe-aruba-failover-partner";
                range 10.10.105.2 10.10.105.2;
                range 10.10.105.4 10.10.105.254;
        }
```

```
        authoritative;
}
(Aruba9004) #
```

The DHCP syncing happens between the system IPs (VLAN5) on port 647

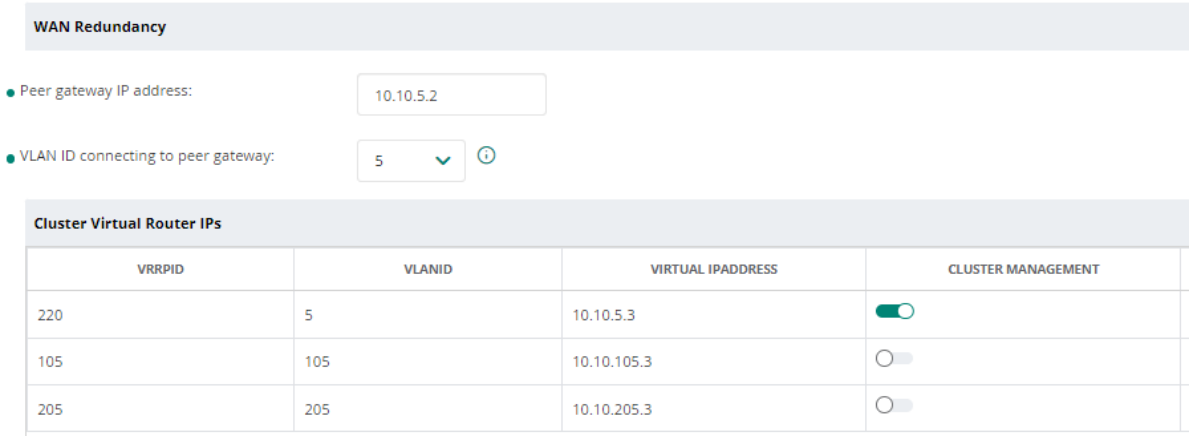
```
(Aruba9004) #show datapath session | include 647
10.10.5.2          10.10.5.1        6    54171 647    0/0      0    0    0    tunnel 11    f68   391
22993      C                 1
10.10.5.1          10.10.5.2        6    647   54171  0/0      0    0    1    tunnel 11    f68   426
25192                        1
(Aruba9004) #
```

2.13 WAN Uplink Sharing

In the previous configuration we enabled WAN redundancy. So, there is no configuration to be done for it here, but it is important to understand the tunnels that gets established for it.

- Aruba9004 will build 1x IPSec to Aruba9004-LTE for clustering over VLAN 5
- Aruba9004 will build 1x GRE to BGW-LTE-2 for VLAN 4095 as virtual uplink
- Aruba9004-LTE will build 1x GRE to Aruba9004 for VLAN 4086 as virtual uplink
- Each GW will build 1x IPSec tunnel over each configured Uplink (Physical or Virtual/Shared) to each configured VPNC. (but in this topology we don't have VPNCs)

Just for reference this was configured on Aruba9004



From the CLI we can check the communication between gateways

```
(Aruba9004) #show branch-gateway-peer

IP Address of Transit VLAN in Peer: 10.10.5.2
Transit VLAN Interface: 5
Transit VLAN ip: 10.10.5.1
Peer Mac Address: 20:4c:03:bc:2f:ba
Peer Serial: CNK7KSP05H
(Aruba9004) #
```

```
(Aruba9004-LTE) #show branch-gateway-peer

IP Address of Transit VLAN in Peer: 10.10.5.1
Transit VLAN Interface: 5
Transit VLAN ip: 10.10.5.2
Peer Mac Address: 20:4c:03:82:0f:0a
Peer Serial: CNJFKLB01M
(Aruba9004-LTE) #
```

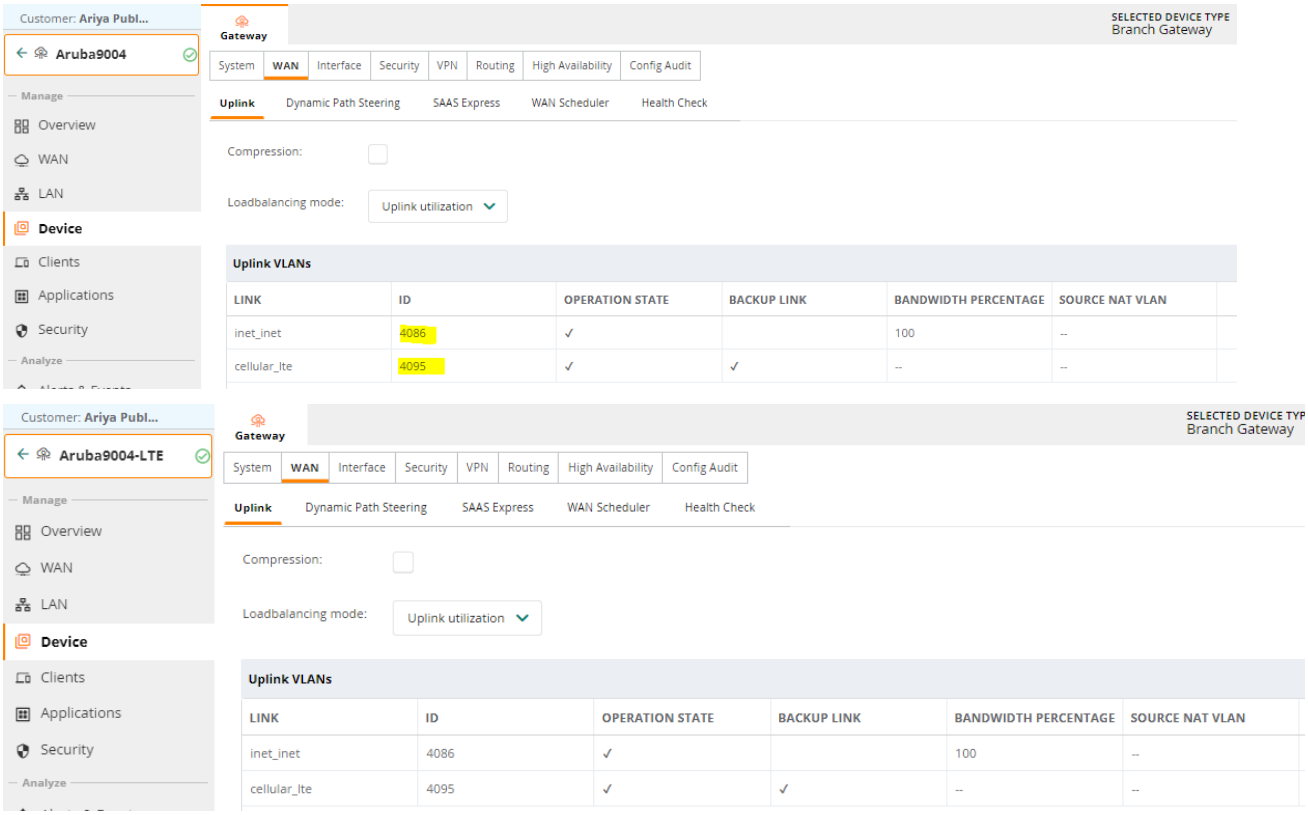
Once the peer gateways is configured, there will be a GRE tunnel created between the BGWs which then will look at the type of uplinks being WAN that will then be shared with the peer gateways.

```
(Aruba9004) #show datapath session | include 10.10.5.2 | include  10.10.5.1
10.10.5.1         10.10.5.2         17   8212  8211  0/0     0    0   0    tunnel 11    15   4          2464        FI
10.10.5.2         10.10.5.1         6    9190  9199  0/0     0    0   0    tunnel 11    131f 326        17081       C
10.10.5.2         10.10.5.1         6    54171 647   0/0     0    0   0    tunnel 11    12fd 482        28344       C
10.10.5.2         10.10.5.1         17   8211  8211  0/0     0    46  0    0/0/2        1336 102657     11745334    FCI
10.10.5.1         10.10.5.2         6    9199  9190  0/0     0    0   0    tunnel 11    131f 324        19275
10.10.5.2         10.10.5.1         17   8211  8498  0/0     0    0   0    0/0/2        1336 0          0           CIB
10.10.5.1         10.10.5.2         17   8498  8211  0/0     0    0   0    0/0/2        1336 160        43309       IB
10.10.5.2         10.10.5.1         50   0     0     0/0     0    48  0    0/0/2        1325 26328      4469088     FC
10.10.5.1         10.10.5.2         47   0     0     0/0     0    48  0    local        132a 62719      66625620    FC
10.10.5.2         10.10.5.1         17   8211  9212  0/0     0    0   1    tunnel 11    15   0          0           FYCI
10.10.5.1         10.10.5.2         17   9212  8211  0/0     0    0   1    tunnel 11    15   0          0           FYI
10.10.5.1         10.10.5.2         50   0     0     0/0     0    0   43   0/0/2        1325 0          0           FY
10.10.5.1         10.10.5.2         6    647   54171 0/0     0    0   0    tunnel 11    1300 517        30484
10.10.5.2         10.10.5.1         47   0     0     0/0     0    48  0    local        132d 24510      2338937     F
10.10.5.1         10.10.5.2         17   8211  8211  0/0     0    0   45   0/0/2        1339 0          0           FYI
10.10.5.2         10.10.5.1         17   8211  8212  0/0     0    0   2    tunnel 11    18   0          0           FYCI
10.10.5.1         10.10.5.2         6    9190  9199  0/0     0    0   1    local        1327 323        16925       C
10.10.5.2         10.10.5.1         6    9199  9190  0/0     0    0   1    local        1327 321        16821
(Aruba9004) #
```

In the above session table, we can see the

- GRE tunnels, protocol 47 (highlighted yellow)
- IPSEC ESP, tunnel protocol 50 (highlighted blue)
- Port 647 for DHCP synching (highlighted green)

For WAN uplink sharing to work, the uplink and its associated VLAN should not be present in the other gateway or if configured, the actual port should be disconnected. Here we have both the WAN VLANs present, and this is configuration is inherited from the group level.



But when you check the port status, we see that 0/0/0 is up in Aruba9004 and down in Aruba9004-LTE

```
(Aruba9004) #show port status

Port Status
-----------
```

```
Slot-Port  PortType  AdminState  OperState  PoE  Trusted  SpanningTree  PortMode  Speed   Duplex
PortError
---------  --------  ----------  ---------  ---  -------  ------------  --------  -----   ------  ---
0/0/0      GE        Enabled     Up         N/A  Yes      Disabled      Access    1 Gbps  Full    -
0/0/1      GE        Enabled     Down       N/A  Yes      Disabled      Access    Auto    Auto    -
0/0/2      GE        Enabled     Up         N/A  Yes      Disabled      Trunk     1 Gbps  Full    -
0/0/3      GE        Enabled     Up         N/A  Yes      Disabled      Trunk     1 Gbps  Full    -

(Aruba9004) #
```

```
(Aruba9004-LTE) #show port status

Port Status
-----------
Slot-Port  PortType  AdminState  OperState  PoE  Trusted  SpanningTree  PortMode  Speed   Duplex
PortError
---------  --------  ----------  ---------  ---  -------  ------------  --------  -----   ------  ---
0/0/0      GE        Enabled     Down       N/A  Yes      Disabled      Access    Auto    Auto    -
0/0/1      GE        Enabled     Down       N/A  Yes      Disabled      Access    Auto    Auto    -
0/0/2      GE        Enabled     Up         N/A  Yes      Disabled      Trunk     1 Gbps  Full    -
0/0/3      GE        Enabled     Up         N/A  Yes      Disabled      Access    1 Gbps  Full    -
(Aruba9004-LTE) #
```

The key thing in the above screenshot is that each BGW should have 1x WAN uplinks that needs to be shared not 2. Make sure the uplink interfaces used by both gateways are tied to different VLANs, or the uplinks won't be shared as we have done here.

2.14 WAN Uplink Sharing Testing

Now let's check to see of the configuration has worked by checking first to see of the virtual tunnels between the BGWs is up and running. Checking the LTE gateway.

```
(Aruba9004-LTE) #show ip interface brief

Interface                    IP Address / IP Netmask        Admin   Protocol   VRRP-IP
vlan 5                        10.10.5.2 / 255.255.255.0     up      up         10.10.5.3
vlan 2                   192.168.255.2 / 255.255.255.255    up      up
vlan 90                     unassigned / unassigned         up      down
vlan 105                   10.10.105.2 / 255.255.255.0      up      up         10.10.105.3
vlan 205                   10.10.205.2 / 255.255.255.0      up      up         10.10.205.3
vlan 4086                   unassigned / unassigned         up      down
loopback                    unassigned / unassigned         up      up
tunnel 12 (INT)            172.16.50.9 / 255.255.255.255    up      up

DHCP is enabled on VLAN(s) 90, 4086
(Aruba9004-LTE) #
```

Now let's check to ensure we have 2x uplinks on Aruba9004-LTE. Note that the LTE uplink is down because we have put it in backup mode. So, it'll be Up only when the uplink on the Aruba9004 gateways is not operational.

```
(Aruba9004-LTE) #show uplink

Uplink Manager: Enabled
Uplink Health-check: Enabled  FQDN: pqm.arubanetworks.com(3.104.166.215)
Uplink Load-balancing:Enabled  Mode: Uplink-utilization

Uplink Management Table
-----------------------
Uplink Type  Properties             Uplink-id     State                  Gateway       Reachability
WAN Type   Speed     Weight  B/w utiln  Max b/w
-----------  ----------             ---------     -----                  -------       ------------
Cellular     Internal-LTE (Backup)  cellular_lte  Disconnected from ISP  --            Not Established
LTE  100 Mbps     10   0.00%        100%
Virtual      tunnel 12              inet_inet     Connected              10.224.254.1  Reachable
Internet  50 Mbps     100   0.00%        100%

(Aruba9004-LTE) #
```

Now on Aruba9004 we should see only 1x uplink which is local to it.

```
(Aruba9004) #show ip interface brief

Interface                   IP Address / IP Netmask        Admin   Protocol   VRRP-IP
vlan 5                       10.10.5.1 / 255.255.255.0     up      up         10.10.5.3
vlan 2                    192.168.255.1 / 255.255.255.255  up      up
vlan 105                    10.10.105.1 / 255.255.255.0     up      up         10.10.105.3
vlan 205                    10.10.205.1 / 255.255.255.0     up      up         10.10.205.3
vlan 4086                 10.224.254.63 / 255.255.255.128   up      up
vlan 4094                    unassigned / unassigned        up      down
loopback                     unassigned / unassigned        up      up

DHCP is enabled on VLAN(s) 4086, 4094
(Aruba9004) #show uplink

Uplink Manager: Enabled
Uplink Health-check: Enabled  FQDN: pqm.arubanetworks.com(13.239.61.151)
Uplink Load-balancing:Enabled  Mode: Uplink-utilization

Uplink Management Table
-----------------------
Uplink Type  Properties  Uplink-id  State      Gateway       Reachability  WAN Type   Speed    Weight
B/w utiln  Max b/w
-----------  ----------  ---------  -----      -------       ------------  --------   -----    ------
Wired        vlan 4086   inet_inet  Connected  10.224.254.1  Reachable      Internet  50 Mbps    100
0.00%        100%
(Aruba9004) #
```

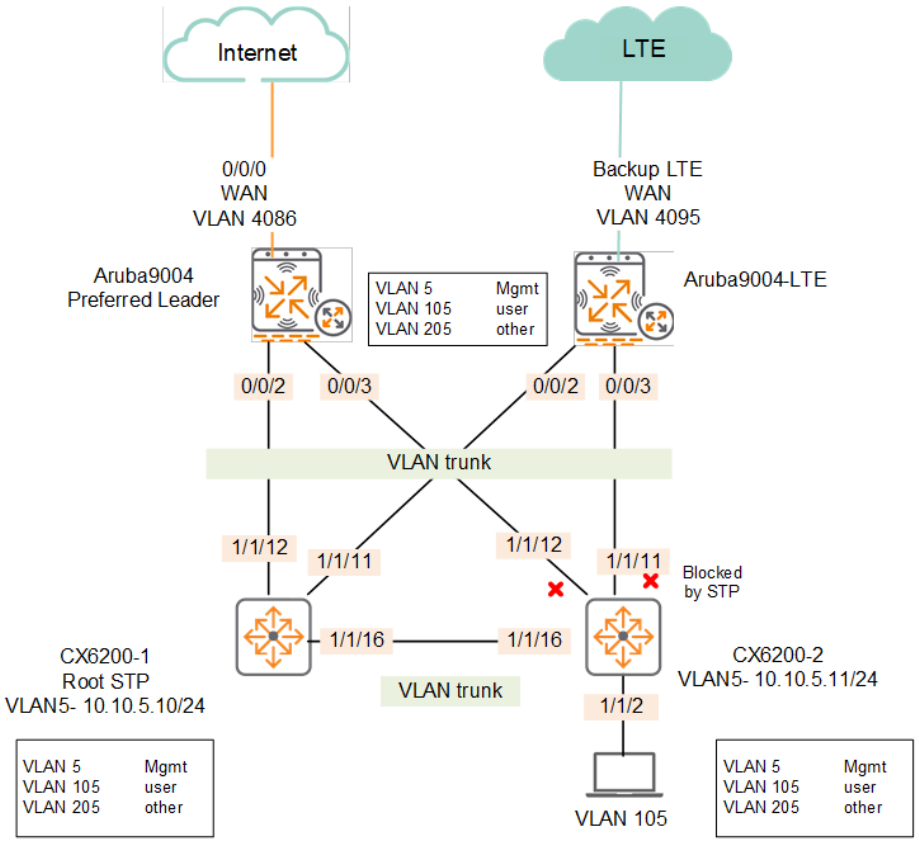
You will only see the INT tunnel on this gateway when the current uplink is down.

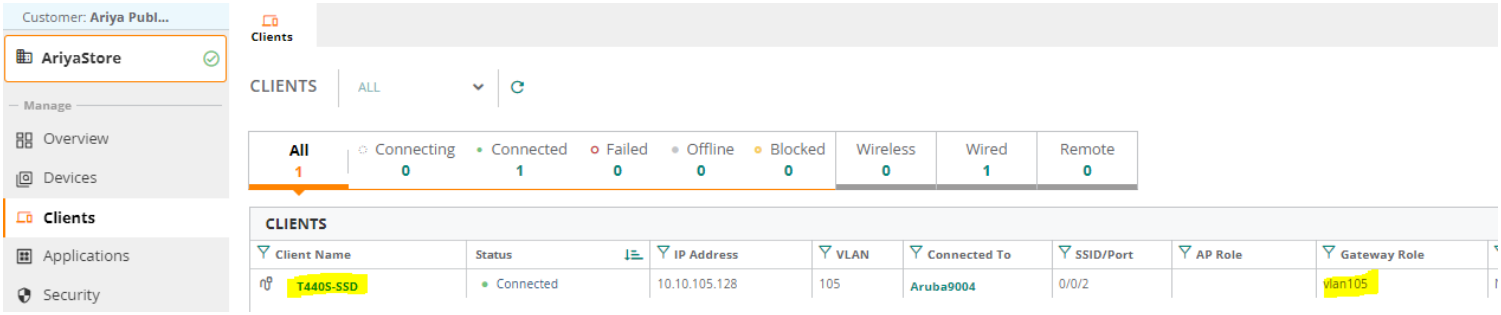
3 HA Failover Timing

In this section I'll explore the general time it takes for

1. 9004-LTE BGW to bring up its LTE interface when WAN uplink 0/0/0 is disconnected
2. Reconnected WAN uplink on 0/0/0 to become active for the user traffic
3. Backup LTE BGW to be the active gateway when the LAN interfaces on 9004 Gateway is disconnected.
4. The pre-emption of the preferred leader(9004 BGW) when it's LAN interfaces are reconnected

Here is the topology, the User (VLAN105) is connected to switch2 and does continuous ping to 1.1.1.1 with -w 1000





3.1 Baseline

First we'll take a baseline before we start our tests.

Aruba9004 Gateway

```
(Aruba9004) #show uplink
```

```
Uplink Manager: Enabled
Uplink Health-check: Enabled  FQDN: pqm.arubanetworks.com(13.239.61.151)
Uplink Load-balancing:Enabled  Mode: Uplink-utilization

Uplink Management Table
-----------------------
Uplink Type  Properties  Uplink-id  State      Gateway       Reachability  WAN Type   Speed    Weight
B/w utiln  Max b/w
-----------  ----------  ---------  -----      -------       ------------  --------   -----    ------
Wired        vlan 4086   inet_inet  Connected  10.224.254.1  Reachable      Internet  50 Mbps    100
0.00%        100%
(Aruba9004) #
```

```
(Aruba9004) #show ip interface b

Interface                    IP Address / IP Netmask        Admin   Protocol   VRRP-IP
vlan 5                        10.10.5.1 / 255.255.255.0     up      up         10.10.5.3
vlan 2                   192.168.255.1 / 255.255.255.255   up      up
vlan 105                   10.10.105.1 / 255.255.255.0     up      up         10.10.105.3
vlan 205                   10.10.205.1 / 255.255.255.0     up      up         10.10.205.3
vlan 4086                10.224.254.63 / 255.255.255.128   up      up
vlan 4094                   unassigned / unassigned        up      down
loopback                    unassigned / unassigned        up      up

DHCP is enabled on VLAN(s) 4086, 4094
(Aruba9004) #
```

```
(Aruba9004) #show  lc-cluster group-membership

Cluster Enabled, Profile Name = "auto_gwcluster_site_9_260_0"
One-to-one-redundancy Enabled
Heartbeat Threshold = 900 msec
Cluster Info Table
------------------
Type IPv4 Address    Priority Connection-Type STATUS
---- ---------------- -------- --------------- ------
self       10.10.5.1      255             N/A CONNECTED (Leader)
peer       10.10.5.2      128    L2-Connected CONNECTED (Member)
(Aruba9004) #
```

```
(Aruba9004) #show vrrp

Virtual Router 105:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.105.3, MAC Address 00:00:5e:00:01:69, vlan 105
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 205:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.205.3, MAC Address 00:00:5e:00:01:cd, vlan 205
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 220:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.5.3, MAC Address 00:00:5e:00:01:dc, vlan 5
    Priority 255, Advertisement 1 sec, Preemption Enable Delay 0
    Auth type NONE ********
    tracking is not enabled

(Aruba9004) #
```

Aruba9004-LTE Gateway

```
(Aruba9004-LTE) #show uplink

Uplink Manager: Enabled
Uplink Health-check: Enabled  FQDN: pqm.arubanetworks.com(13.239.61.151)
Uplink Load-balancing:Enabled  Mode: Uplink-utilization

Uplink Management Table
-----------------------
Uplink Type  Properties             Uplink-id     State                  Gateway       Reachability
WAN Type   Speed     Weight  B/w utiln  Max b/w
-----------  ----------             ---------     -----                  -------       ------------
--------   -----     ------  ---------  -------
Virtual      tunnel 12              inet_inet     Connected              10.224.254.1  Reachable
Internet  50 Mbps     100   0.00%        100%
Cellular     Internal-LTE (Backup)  cellular_lte  Disconnected from ISP  --            Not Established
LTE  100 Mbps     10   0.00%        100%

(Aruba9004-LTE) #
```

```
(Aruba9004) #show ip interface brief

Interface                    IP Address / IP Netmask        Admin   Protocol   VRRP-IP
vlan 5                        10.10.5.2 / 255.255.255.0     up      up         10.10.5.3
vlan 2                    192.168.255.2 / 255.255.255.255   up      up
vlan 90                     unassigned / unassigned         up      down
vlan 105                   10.10.105.2 / 255.255.255.0     up      up         10.10.105.3
vlan 205                   10.10.205.2 / 255.255.255.0     up      up         10.10.205.3
vlan 4086                   unassigned / unassigned         up      down
loopback                    unassigned / unassigned         up      up
tunnel 12 (INT)           172.16.50.10 / 255.255.255.255    up      up

DHCP is enabled on VLAN(s) 90, 4086
```

```
(Aruba9004-LTE) #show ip route

Codes: C - Connected, O - OSPF, IA - OSPF Inter Area, E1 - OSPF External Type 1, R - RIP
       E2 - OSPF External Type 2, N1 - OSPF NSSA External Type 1, N2 - OSPF NSSA External Type 2
       B I - BGP Interior, B E - BGP Exterior, S - Static
       U - BGW Peer Uplink, M - Management, Ru - Route Usable, * - Candidate Default
       V - RAPNG VPN/Branch, I - Crypto-Cfgset, N - Not Redistributed, Bc - Cloud Overlay Protocol

S*    0.0.0.0/0  [50/10] via 10.224.254.1
C     10.10.205.0/24 is directly connected, VLAN205
C     192.168.255.2/32 is directly connected, VLAN2
C     10.10.105.0/24 is directly connected, VLAN105
C     172.16.50.10/32 is directly connected, Loopback
C     10.10.5.0/24 is directly connected, VLAN5
(Aruba9004-LTE) #
```

```
(Aruba9004-LTE) #show lc-cluster group-membership

Cluster Enabled, Profile Name = "auto_gwcluster_site_9_260_0"
One-to-one-redundancy Enabled
Heartbeat Threshold = 900 msec
Cluster Info Table
------------------
Type IPv4 Address    Priority Connection-Type STATUS
---- ---------------- -------- --------------- ------
peer       10.10.5.1      255    L2-Connected CONNECTED (Leader)
self       10.10.5.2      128             N/A CONNECTED (Member)
(Aruba9004-LTE) #
```

```
(Aruba9004-LTE) #show vrrp

Virtual Router 105:
    Description
    Admin State UP, VR State BACKUP
```

```
    IP Address 10.10.105.3, MAC Address 00:00:5e:00:01:69, vlan 105
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 205:
    Description
    Admin State UP, VR State BACKUP
    IP Address 10.10.205.3, MAC Address 00:00:5e:00:01:cd, vlan 205
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 220:
    Description
    Admin State UP, VR State BACKUP
    IP Address 10.10.5.3, MAC Address 00:00:5e:00:01:dc, vlan 5
    Priority 235, Advertisement 1 sec, Preemption Enable Delay 0
    Auth type NONE ********
    tracking is not enabled
(Aruba9004-LTE) #
```

LAN Switch Spanning tree states

Here are the LAN switches Spanning tree states. Since 620012P-1 is the root for STP, all the interfaces will be in forwarding state.

```
6200-12P-1# sh spanning-tree
Spanning tree status      : Enabled Protocol: MSTP

MST0
  Root ID    Priority   : 4096
             MAC-Address: ec:67:94:d1:83:80
             This bridge is the root
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

  Bridge ID  Priority  : 4096
             MAC-Address: ec:67:94:d1:83:80
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

Port         Role           State      Cost           Priority   Type             BPDU-Tx    BPDU-Rx    TCN-Tx     TCN-Rx
------------ -------------- ---------- -------------- ---------- ---------------- ---------- ---------- ---------- ----------
1/1/1        Disabled       Down       20000          128        P2P              0          0          0          0
1/1/2        Disabled       Down       20000          128        P2P              0          0          0          0
1/1/3        Disabled       Down       20000          128        P2P              0          0          0          0
1/1/4        Disabled       Down       20000          128        P2P              0          0          0          0
1/1/5        Disabled       Down       20000          128        P2P              0          0          0          0
1/1/6        Disabled       Down       20000          128        P2P              0          0          0          0
1/1/7        Disabled       Down       20000          128        P2P              0          0          0          0
1/1/8        Disabled       Down       20000          128        P2P              0          0          0          0
1/1/9        Disabled       Down       20000          128        P2P              0          0          0          0
1/1/10       Disabled       Down       20000          128        P2P              0          0          0          0
1/1/11       Designated     Forwarding 20000          128        P2P              4909       7          12         5
1/1/12       Designated     Forwarding 20000          128        P2P              4642       8          14         0
1/1/13       Disabled       Down       20000          128        P2P              0          0          0          0
1/1/14       Disabled       Down       20000          128        P2P              0          0          0          0
1/1/15       Disabled       Down       20000          128        P2P              0          0          0          0
1/1/16       Designated     Forwarding 2000           128        P2P              4471       8          12         6

Number of topology changes    : 19
Last topology change occurred : 76 seconds ago

6200-12P-1#
6200-12P-1# sh lldp nei

LLDP Neighbor Information
=========================

Total Neighbor Entries          : 4
Total Neighbor Entries Deleted  : 3
Total Neighbor Entries Dropped  : 0
Total Neighbor Entries Aged-Out : 3
```

```
LOCAL-PORT  CHASSIS-ID         PORT-ID                   PORT-DESC                 TTL      SYS-NAME
-------------------------------------------------------------------------------------------------------
1/1/11      20:4c:03:bc:2f:ba  GE0/0/2                   GE0/0/2                   120      Aruba9004-LTE
1/1/12      20:4c:03:82:0f:0a  GE0/0/2                   GE0/0/2                   120      Aruba9004
1/1/16      ec:67:94:d4:79:c0  1/1/16                    1/1/16                    120      6200-12P-2

6200-12P-1#
```

And for the other switch

```
6200-12P-2# sh spanning-tree
Spanning tree status      : Enabled Protocol: MSTP

MST0
  Root ID    Priority   : 4096
             MAC-Address: ec:67:94:d1:83:80
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

  Bridge ID  Priority  : 32768
             MAC-Address: ec:67:94:d4:79:c0
             Hello time(in seconds):2  Max Age(in seconds):20
             Forward Delay(in seconds):15

Port         Role           State      Cost           Priority   Type            BPDU-Tx    BPDU-Rx    TCN-Tx
TCN-Rx
------------ -------------- ---------- -------------- ---------- --------------- ---------- ---------- ---------- -
---------
1/1/1        Disabled       Down       20000          128        P2P             0          0          0          0
1/1/2        Designated     Forwarding 20000          128        P2P             1019       0          0          0
1/1/3        Disabled       Down       20000          128        P2P             0          0          0          0
1/1/4        Disabled       Down       20000          128        P2P             0          0          0          0
1/1/5        Disabled       Down       20000          128        P2P             0          0          0          0
1/1/6        Disabled       Down       20000          128        P2P             0          0          0          0
1/1/7        Disabled       Down       20000          128        P2P             0          0          0          0
1/1/8        Disabled       Down       20000          128        P2P             0          0          0          0
1/1/9        Disabled       Down       20000          128        P2P             0          0          0          0
1/1/10       Disabled       Down       20000          128        P2P             0          0          0          0
1/1/11       Alternate      Blocking   20000          128        P2P Bound       10         4915       5          12
1/1/12       Alternate      Blocking   20000          128        P2P Bound       279        4597       0          14
1/1/13       Disabled       Down       20000          128        P2P             0          0          0          0
1/1/14       Disabled       Down       20000          128        P2P             0          0          0          0
1/1/15       Disabled       Down       20000          128        P2P             0          0          0          0
1/1/16       Root           Forwarding 2000           128        P2P Bound       9          4477       6
12

Number of topology changes    : 8
Last topology change occurred : 6849 seconds ago

6200-12P-2#
6200-12P-2# sh lldp neighbor-info

LLDP Neighbor Information
=========================

Total Neighbor Entries          : 5
Total Neighbor Entries Deleted  : 3
Total Neighbor Entries Dropped  : 0
Total Neighbor Entries Aged-Out : 3

LOCAL-PORT  CHASSIS-ID         PORT-ID                   PORT-DESC                 TTL      SYS-NAME
-------------------------------------------------------------------------------------------------------
1/1/2       28:d2:44:52:c2:38  28:d2:44:52:c2:38                                   3601
1/1/11      20:4c:03:bc:2f:ba  GE0/0/3                   GE0/0/3                   120      Aruba9004-LTE
1/1/12      20:4c:03:82:0f:0a  GE0/0/3                   GE0/0/3                   120      Aruba9004
1/1/16      ec:67:94:d1:83:80  1/1/16                    1/1/16                    120      6200-12P-1

6200-12P-2#
```

3.2 Failover Testing

This table captures the rough estimated time it takes for the backup link to be established when the main WAN links is disconnected. It also shows the time it takes for pre-emption to occur when the main WAN link is reconnected.

Also here is LTE signal strength for reference.

```
(Aruba9004-LTE) #show uplink cellular signal
```

```
Uplink Signal Stats
-------------------
Uplink Type  Properties             State                    Signal Type  Strength
-----------  ----------             -----                    -----------  --------
Cellular     Internal-LTE (Backup)  Disconnected from ISP    FDD LTE      -67 dBm

(Aruba9004-LTE) #
```

	BGW-1	BGW-LTE-2	Ping timeout	LTE return to backup state
Uplink	0/0/0 Wired Active	LTE backup		
LAN 0/0/1 – 0/0/2	Connected	Connected		
lc-cluster group-membership				
Self	CONNECTED (Leader)	CONNECTED (Member)		
peer	CONNECTED (Member)	CONNECTED (Leader)		
VRRP VLAN5	Master	Backup		
VRRP VLAN105	Master	Backup		
VRRP VLAN105	Master	Backup		
WAN main uplink failure test				
	Disconnect 0/0/0		6 sec	
	Reconnect 0/0/0 after 30 sec		6 sec	18 sec
	Disconnect 0/0/0 after 30 sec		6 sec	
	Reconnect 0/0/0 after 30 sec		4 sec	22 sec
	Disconnect 0/0/0 after 30 sec		6 sec	
	Reconnect 0/0/0 after 30 sec		5 sec	17 sec
	Disconnect 0/0/0 after 30 sec		7 sec	
	Reconnect 0/0/0 after 30 sec		5 sec	17 sec
One LAN Link failure test	Disconnect either 0/0/2 or 0/0/3	LTE backup link will not be established as there is link redundancy	NA	NA
Dual LAN Links failure test				
Uplink	0/0/0 Wired Active	LTE Active		
lc-cluster group-membership				
Self	ISOLATED (Leader)	ISOLATED (Leader)		
peer	DISCONNECTED	DISCONNECTED		
VRRP VLAN5	Master	Master		
VRRP VLAN105	Init	Master		
VRRP VLAN105	Init	Master		
	Disconnect 0/0/2-3		6 sec	
	Reconnect 0/0/2-3 after 30 sec		5 sec	11 sec
	Disconnect 0/0/2-3 after 30 sec		6 sec	
	Reconnect 0/0/2-3 after 30 sec		7 sec	10 sec
	Disconnect 0/0/2-3 after 30 sec		6 sec	
	Reconnect 0/0/2-3 after 30 sec		5 sec	12 sec
Uplink	0/0/0 Wired Active	LTE backup		
lc-cluster group-membership				
Self	CONNECTED (Leader)	CONNECTED (Member)		
peer	CONNECTED (Member)	CONNECTED (Leader)		
VRRP VLAN5	Master	Backup		
VRRP VLAN105	Master	Backup		
VRRP VLAN105	Master	Backup		

Here are the outputs of the relevant show commands after WAN uplink 0/0/0 was disconnected on Aruba9004.

```
(Aruba9004) #show ip interface b

Interface                 IP Address / IP Netmask        Admin   Protocol   VRRP-IP
vlan 5                     10.10.5.1 / 255.255.255.0     up      up         10.10.5.3
vlan 2                  192.168.255.1 / 255.255.255.255  up      up
vlan 105                 10.10.105.1 / 255.255.255.0     up      up         10.10.105.3
```

```
vlan 205                    10.10.205.1 / 255.255.255.0     up      up          10.10.205.3
vlan 4086                    unassigned / unassigned        up      down
vlan 4094                    unassigned / unassigned        up      down
loopback                     unassigned / unassigned        up      up
tunnel 12 (INT)             172.16.50.4 / 255.255.255.255   up      up

DHCP is enabled on VLAN(s) 4086, 4094
```

```
(Aruba9004) #show ip route

Codes: C - Connected, O - OSPF, IA - OSPF Inter Area, E1 - OSPF External Type 1, R - RIP
       E2 - OSPF External Type 2, N1 - OSPF NSSA External Type 1, N2 - OSPF NSSA External Type 2
       B I - BGP Interior, B E - BGP Exterior, S - Static
       U - BGW Peer Uplink, M - Management, Ru - Route Usable, * - Candidate Default
       V - RAPNG VPN/Branch, I - Crypto-Cfgset, N - Not Redistributed, Bc - Cloud Overlay Protocol

S*    0.0.0.0/0  [50/10] via 10.97.49.120
C     10.10.205.0/24 is directly connected, VLAN205
C     192.168.255.1/32 is directly connected, VLAN2
C     172.16.50.4/32 is directly connected, Loopback
S     10.3.8.2/32  [50/10] via 10.97.49.120
S     10.3.56.162/32  [50/10] via 10.97.49.120
C     10.10.105.0/24 is directly connected, VLAN105
C     10.10.5.0/24 is directly connected, VLAN5
(Aruba9004) #
```

```
(Aruba9004) #show uplink

Uplink Manager: Enabled
Uplink Health-check: Enabled  FQDN: pqm.arubanetworks.com(8.8.8.8)
Uplink Load-balancing:Enabled  Mode: Uplink-utilization

Uplink Management Table
-----------------------
Uplink Type  Properties  Uplink-id     State             Gateway       Reachability     WAN Type
Speed     Weight  B/w utiln  Max b/w
-----------  ----------  ---------     -----             -------       ------------     --------   ----
-     ------  ---------  -------
Wired        vlan 4086   inet_inet     Waiting for link  --            Not Established   Internet  50
Mbps     100   0.00%        100%
Virtual      tunnel 12   cellular_lte  Connected         10.97.49.120  Reachable              LTE  100
Mbps     10   0.00%        100%
(Aruba9004) #
```

```
(Aruba9004) #show lc-cluster  group-membership

Cluster Enabled, Profile Name = "auto_gwcluster_site_9_260_0"
One-to-one-redundancy Enabled
Heartbeat Threshold = 900 msec
Cluster Info Table
------------------
Type IPv4 Address    Priority Connection-Type STATUS
---- --------------- -------- --------------- ------
self       10.10.5.1      255             N/A CONNECTED (Leader)
peer       10.10.5.2      128    L2-Connected CONNECTED (Member)

(Aruba9004) #
```

```
(Aruba9004) #show vrrp

Virtual Router 105:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.105.3, MAC Address 00:00:5e:00:01:69, vlan 105
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled
```

```
Virtual Router 205:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.205.3, MAC Address 00:00:5e:00:01:cd, vlan 205
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 220:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.5.3, MAC Address 00:00:5e:00:01:dc, vlan 5
    Priority 255, Advertisement 1 sec, Preemption Enable Delay 0
    Auth type NONE ********
    tracking is not enabled

(Aruba9004) #
```

```
(Aruba9004) #show ip interface b

Interface                   IP Address / IP Netmask        Admin   Protocol   VRRP-IP
vlan 5                       10.10.5.2 / 255.255.255.0     up      up         10.10.5.3
CELL                      10.97.49.119 / 255.255.255.240   up      up
vlan 2                   192.168.255.2 / 255.255.255.255   up      up
vlan 90                     unassigned / unassigned        up      down
vlan 105                   10.10.105.2 / 255.255.255.0     up      up         10.10.105.3
vlan 205                   10.10.205.2 / 255.255.255.0     up      up         10.10.205.3
vlan 4086                   unassigned / unassigned        up      down
loopback                    unassigned / unassigned        up      up

DHCP is enabled on VLAN(s) 90, 4086
```

```
(Aruba9004-LTE) #show ip route

Codes: C - Connected, O - OSPF, IA - OSPF Inter Area, E1 - OSPF External Type 1, R - RIP
       E2 - OSPF External Type 2, N1 - OSPF NSSA External Type 1, N2 - OSPF NSSA External Type 2
       B I - BGP Interior, B E - BGP Exterior, S - Static
       U - BGW Peer Uplink, M - Management, Ru - Route Usable, * - Candidate Default
       V - RAPNG VPN/Branch, I - Crypto-Cfgset, N - Not Redistributed, Bc - Cloud Overlay Protocol

S*    0.0.0.0/0  [50/10] via 10.97.49.120
C     10.10.205.0/24 is directly connected, VLAN205
C     192.168.255.2/32 is directly connected, VLAN2
C     10.97.49.112/28 is directly connected, Loopback
S     10.3.8.2/32  [50/10] via 10.97.49.120
S     10.3.56.162/32  [50/10] via 10.97.49.120
C     10.10.105.0/24 is directly connected, VLAN105
C     10.10.5.0/24 is directly connected, VLAN5
```

```
(Aruba9004-LTE) #show uplink

Uplink Manager: Enabled
Uplink Health-check: Enabled  FQDN: pqm.arubanetworks.com(13.239.61.151)
Uplink Load-balancing:Enabled  Mode: Uplink-utilization

Uplink Management Table
-----------------------
Uplink Type  Properties             Uplink-id     State          Gateway       Reachability  WAN Type
Speed     Weight  B/w utiln  Max b/w
-----------  ----------             ---------     -----          -------       ------------  --------
-----     ------  ---------  -------
Cellular     Internal-LTE (Backup)  cellular_lte  * Connected *  10.97.49.120  Reachable           LTE
100 Mbps     10   0.01%        100%

(*) Backup Uplink is connected
```

```
(Aruba9004-LTE) #show lc-cluster group-membership
```

```
Cluster Enabled, Profile Name = "auto_gwcluster_site_9_260_0"
One-to-one-redundancy Enabled
Heartbeat Threshold = 900 msec
Cluster Info Table
------------------
Type IPv4 Address    Priority Connection-Type STATUS
---- --------------- -------- --------------- ------
peer       10.10.5.1      255    L2-Connected CONNECTED (Leader)
self       10.10.5.2      128             N/A CONNECTED (Member)
```

```
(Aruba9004-LTE) #show vrrp

Virtual Router 105:
    Description
    Admin State UP, VR State BACKUP
    IP Address 10.10.105.3, MAC Address 00:00:5e:00:01:69, vlan 105
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 205:
    Description
    Admin State UP, VR State BACKUP
    IP Address 10.10.205.3, MAC Address 00:00:5e:00:01:cd, vlan 205
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 220:
    Description
    Admin State UP, VR State BACKUP
    IP Address 10.10.5.3, MAC Address 00:00:5e:00:01:dc, vlan 5
    Priority 235, Advertisement 1 sec, Preemption Enable Delay 0
    Auth type NONE ********
    tracking is not enabled
(Aruba9004-LTE) #
```

Here are the outputs of the relevant show commands after LAN ports 0/0/2-3 were disconnected form Aruba9004

```
(Aruba9004) #show lc-cluster  group-membership

Cluster Enabled, Profile Name = "auto_gwcluster_site_9_260_0"
One-to-one-redundancy Enabled
Heartbeat Threshold = 900 msec
Cluster Info Table
------------------
Type IPv4 Address    Priority Connection-Type STATUS
---- --------------- -------- --------------- ------
self       10.10.5.1      255             N/A ISOLATED (Leader)
peer       10.10.5.2      128             N/A DISCONNECTED
```

```
(Aruba9004) #show vrrp

Virtual Router 105:
    Description
    Admin State UP, VR State INIT
    IP Address 10.10.105.3, MAC Address 00:00:5e:00:01:69, vlan 105
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 205:
    Description
    Admin State UP, VR State INIT
    IP Address 10.10.205.3, MAC Address 00:00:5e:00:01:cd, vlan 205
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled
```

```
Virtual Router 220:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.5.3, MAC Address 00:00:5e:00:01:dc, vlan 5
    Priority 255, Advertisement 1 sec, Preemption Enable Delay 0
    Auth type NONE ********
    tracking is not enabled
(Aruba9004) #
```

```
Aruba9004-LTE) #show uplink

Uplink Manager: Enabled
Uplink Health-check: Enabled  FQDN: pqm.arubanetworks.com(13.239.61.151)
Uplink Load-balancing:Enabled  Mode: Uplink-utilization

Uplink Management Table
-----------------------
Uplink Type  Properties             Uplink-id     State          Gateway       Reachability  WAN Type
Speed     Weight  B/w utiln  Max b/w
-----------  ----------             ---------     -----          -------       ------------  --------
-----     ------  ---------  -------
Cellular     Internal-LTE (Backup)  cellular_lte  * Connected *  10.97.49.120  Reachable           LTE
100 Mbps     10   0.00%        100%

(*) Backup Uplink is connected
```

```
(Aruba9004-LTE) #show lc-cluster group-membership

Cluster Enabled, Profile Name = "auto_gwcluster_site_9_260_0"
One-to-one-redundancy Enabled
Heartbeat Threshold = 900 msec
Cluster Info Table
------------------
Type IPv4 Address    Priority Connection-Type STATUS
---- --------------- -------- --------------- ------
peer       10.10.5.1      255             N/A DISCONNECTED
self       10.10.5.2      128             N/A ISOLATED (Leader)
(Aruba9004-LTE) #
```

```
(Aruba9004-LTE) #show vrrp

Virtual Router 105:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.105.3, MAC Address 00:00:5e:00:01:69, vlan 105
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 205:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.205.3, MAC Address 00:00:5e:00:01:cd, vlan 205
    Priority 100, Advertisement 1 sec, Preemption Disable Delay 0
    Auth type NONE ********
    tracking is not enabled
    cluster-preempt enabled

Virtual Router 220:
    Description
    Admin State UP, VR State MASTER
    IP Address 10.10.5.3, MAC Address 00:00:5e:00:01:dc, vlan 5
    Priority 255, Advertisement 1 sec, Preemption Enable Delay 0
    Auth type NONE ********
    tracking is not enabled

(Aruba9004-LTE) #
```