ExtremeWireless WiNG

Best Practices and Recommendations

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AP and Controller Deployment Guidelines

Access Point – Controller Discovery

DHCP Option 191 Syntax

One of the most important things is to make sure DHCP option 191 syntax is correct, including commas, semicolons etc. Below is an example of option 191 string that is pushed to the Access Point at remote site with 2 controller entries:

```
pool1=<primary-controller-ip-hostname>,<secondary-controller-ip-hostname>;level=2
```

To verify that Access Point has received correct DHCP option string the following command can be used:

```
nx9510#show ip dhcp-vendor-options on <AP hostname>
-------------------------------------------------------------------------------
               ITEM                          VALUE                INTERFACE
-------------------------------------------------------------------------------
  Server Info                       n/a                          vlan4000
  Firmware Image File               n/a                          vlan4000
  Config File                       n/a                          vlan4000
  Legacy Adoption Info              n/a                          n/a
  AP Adoption Info                  pool1=192.168.95.7           vlan4000
  AP Adoption Info                  level=2                      vlan4000
  Controller Adoption Info          n/a                          n/a
```

Refer to "*WING5X How To DHCP*" guide for detailed information on DHCP option 191 configuration and all available options

DHCP Client

One important thing to remember when using DHCP on Access Points for adoption is to make sure that the `ip dhcp client request options all` parameter is enabled on the Virtual IP interface (Native VLAN) in each Access Point profile. When this parameter is omitted the Access Points will obtain an IP address and subnet mask but not a default gateway / DHCP option 191 which will cause adoption to fail in layer 3 environments.

Note that in case the Native VLAN on the AP GE1 port is **untagged** we can safely leave it as VLAN 1, no matter which VLAN will be actually configured as Native on wired switches.

Virtual IP Interface Configuration Example:

```
!
profile ap6532 stores-ap6532
 no autoinstall configuration
 no autoinstall firmware
 interface radio1
 interface radio2
 interface ge1
  description Uplink
  switchport mode trunk
  switchport trunk native vlan 1
  no switchport trunk native tagged
  switchport trunk allowed vlan 1,21-25
 interface vlan1
  ip address dhcp
  ip dhcp client request options all
 use management-policy stores
 use firewall-policy default
 service pm sys-restart
!
```

DNS Adoption

WING 5 Access Points may be adopted using FQDN of the Wireless Controller. By default, every Access Point doing Layer 3 adoption will try DNS adoption in case no Controller IP addresses were received via either DHCP option 191 or statically.

Default controller hostname that AP will try to resolve is motorola-wlc for all firmware versions pre-5.5.6 / pre-5.7.0. Starting 5.5.6 / 5.7.0 the default controller hostname has been changed to wing-wlc.

It is also possible to configure custom FQDNs for adoption in the Access Point profile, although it is not recommended to mix IP and DNS controller host entries into one single pool. If redundant configuration is required split DNS and IP controller host entries into different pools. This will provide failover from DNS to IP adoption for example in a situation when DNS server will become unreachable:

Access Point Profile Example:

```
!
profile ap81xx 8132-BRANCH
 no mint mlcp vlan
 no autoinstall configuration
 no autoinstall firmware
 !
 ! Configuration removed for brevity
 !
 interface ge1
  switchport mode trunk
  switchport trunk native vlan 1
  no switchport trunk native tagged
  switchport trunk allowed vlan 1,10,70,999
 interface ge2
 interface vlan1
  ip address dhcp
  ip dhcp client request options all
 use firewall-policy default
 controller host vx9k-1.lab.local pool 1 level 2
 controller host vx9k-2.lab.local pool 1 level 2
 controller host 192.168.10.215 pool 2 level 2
 controller host 192.168.10.216 pool 2 level 2
 !
 ! Configuration removed for brevity
 !
!
```

Static Controller Host Entries

In a situation where it is required to use static controller host entries instead of DHCP option 191 or DNS adoption it is important to ensure that those entries will be present under the AP profile on the adopting controller, not under the device override. It is a common mistake to pre-stage an AP with the static controller host entries, but not configure them on the AP profile on the controller.

In such cases with auto-learn-staging-config disabled Access Points will unadopt upon initial configuration push, reboot and fallback to previous known working configuration and after will stay in “error” adoption state.

Controller – Provisioning & Configuration of Access Points

Auto Provisioning Policy

For automatic touchless AP provisioning it is always recommended to use auto provisioning policy to ensure correct Profile and RF-domain will be assigned to the Access Points upon first adoption attempt. Many different matching criteria can be utilized depending on specific environments. It is also a good way to mitigate possible mistakes when configuring each AP manually, not to mention saving huge amount of time when deploying new sites.

By default, with no auto provisioning policy assigned the device that will come in for adoption will get default profile and default RF Domain. In case when auto provisioning policy is assigned to a controller, but no matching rules present, incoming adoption request will be denied, unless default-adoption parameter will be configured in the auto provisioning policy.

Example Auto Provisioning Policy based on different Matching Criteria:

```
!
auto-provisioning-policy AP-Policy
 adopt rfs4000 precedence 10 profile BRANCH-1-RFS4000 rf-domain BRANCH-1 ip 10.34.50.22/24
 adopt ap7532 precedence 11 profile BRANCH-$FQDN[4:5]-AP7532 rf-domain BRANCH-$FQDN[4:5] any
 adopt ap81xx precedence 21 profile WAREHOUSE-$CDP[7:8]-AP8132 rf-domain WAREHOUSE-$CDP[9:12] any
 adopt ap7532 precedence 31 profile EXT-ANTENNA-7532 rf-domain WAREHOSE-$DCHP[9:12] model AP-7532-67040-EU
 adopt ap7532 precedence 32 profile INT-ANTENNA-7532 rf-domain WAREHOSE-$DHCP[9:12] model AP- 7532-67030-EU
!
```

Please refer to "*WiNG_5.X_Auto-Provisioning&Wildcards*" How To Guide for further details.

Pre-Staging

In a lot of cases Access Points will fail to adopt due to pre-staged with configuration that contradicts the Profile or Override configuration define on the Wireless Controllers. To address this problem, disable the auto-learn-staging-config parameter on the Wireless Controllers profile which will override the pre- staged configuration with the configuration defined on the Wireless Controllers and allow the Access Points to adopt properly

Wireless Controller Profile Example:

```
!
profile nx9000 tmelabs-nx9510
 ip name-server 192.168.10.6
 ip domain-name tmelabs.local
 !
 ! Configuration removed for Brevity
 !
 use management-policy NOC
 use firewall-policy default
 use auto-provisioning-policy NOC
 ntp server 192.168.10.6
 no auto-learn-staging-config
 service pm sys-restart
!
```

The Auto Learn Staging configuration allows pre-defined configuration related to Ethernet port, SVIs, hostnames, default route etc. to be merged into the Wireless Controller's configuration when the Access Points initially adopt (i.e. Access Points are not defined in the Wireless Controllers configuration). The pre-staged configuration is added to the Access Points device configuration.

If the Access Points are using DHCP for network addressing and Wireless Controller discovery, the Access Points pre-staged configuration does not need to be learned thus this parameter can be safely disabled. This feature is primarily intended for adopting Access Points that have been pre-staged with static IP addressing or have pre-existing parameters defined in WiNG 4 which need to be maintained upon upgrading to WiNG 5.

Profile vs Device Overrides configuration

In WiNG 5 device override level configuration always supersedes configuration done at the profile level. As a best practice it is recommended to keep most of the configuration as part of the profile, instead of device overrides. Device Overrides should be used only in cases unique configuration must be provisioned to a particular device, for example configuration such as hostname or static IP address, clustering etc. Rest of the objects that are common to a certain group of devices should always be assigned as part of the profile.

Controller <--> AP Communication – MiNT Design

MINT MTU

For certain centrally managed deployments using MPLS or VPN technologies for the wide area network, the default MINT MTU might need to be reduced to accommodate the lower MTU path between the remote Access Points and the Controllers in the Data Center.

By default, the MINT policy assigned to all Controllers and Access Points defines an MTU of 1500 bytes which suffices for most local area network and wide area network deployments. However, when the wide area network leverages MPLS (usually value of 1460 will cover most of such scenarios) or VPN technologies (MTU should be lowered to 1372), the MTU path between the remote sites and the Data Center is often reduced below 1500 bytes. MINT packets that are larger than the MTU path have to be fragmented by the intermediate layer 3 devices to accommodate the lower MTU between the sites.

While the MINT protocol is designed to accommodate IP fragmentation, not all intermediate layer 3 devices fragment packets the same way which can result in various issues. Symptoms of an MTU path issues include remote Access Points not adopting, configuration not being successfully applied to one or more remote Access Points or statistics from remote sites not being received by the Controller. You may also experience Access Point firmware upgrade failures.

To remediate an MTU path issue it is recommended that the MINT MTU be lowered in the MINT policy so that the IP fragmentation is performed by the Controllers and the Access Points rather than by the intermediate layer 3 devices.

The MTU value defined in the global MINT policy will vary depending on the specific network environment. You can quickly determine the MTU path of the intermediate network by issuing a ping from the Controller to a remote Access Point at various sizes with the dont-fragment option set. ICMP packets with sizes that receive replies fall within the MTU path while packets that fail to receive replies require fragmentation to be passed and thus fall outside the minimum MTU path.

```
nx9000-1#ping <remote-ap-ip-address> size <value> dont-fragment
```

It is recommended that you start your testing using 1500 byte ICMP packets and reduce the size in increments of 8 (1484, 1476, 1468, 1460 etc.) until you receive a reply. Once you determine the minimum MTU it is recommended to repeat the test using the determined MTU value against Access Points at multiple remote sites to ensure that the MTU path is consistent across all your sites. It is possible that the MTU paths are different between sites especially when multiple service provider networks are utilized.

Example below should be safe enough for most of the deployments:

Global MINT Policy with MINT MTU defined:

```
!
mint-policy global-default
 mtu 1372
!
```

MINT Router Packet Priority

In rare cases with multiple remote sites deployments, ISP may not allow certain priority values passing their network (or simply requiring additional service plan to allow them). In case this is identified it is possible to adjust MiNT packet priority value in the global mint policy. Default value of 5 might not be allowed and eventually will be dropped by the Service Provider:

Changing MINT Packet Priority:

```
!
mint-policy global-default
 mtu 1372
 router packet priority 0
!
```

MINT Link Levels and RF Domains

When MINT links are established between two or more WiNG 5 devices, the WiNG 5 devices exchange link state packets (LSPs). LSP contains each WiNG 5 devices MINT ID, hostname, and number of adjacent MINT neighbors. This information is used by each WiNG 5 device for routing MINT packets when management / control traffic is exchanged or user traffic that is encapsulated and forwarded between two WiNG 5 devices.

The MINT routing level for each link determines the LSP information that is exchanged between the WiNG 5 devices over the established MINT link. Level 2 links provide isolation, so LSP are not forwarded across level 2 boundaries, making mint routing tables short and efficient. VLAN based MINT links only support MINT routing Level 1 where IP based MINT links can support MINT routing Level of 1 or Level 2.

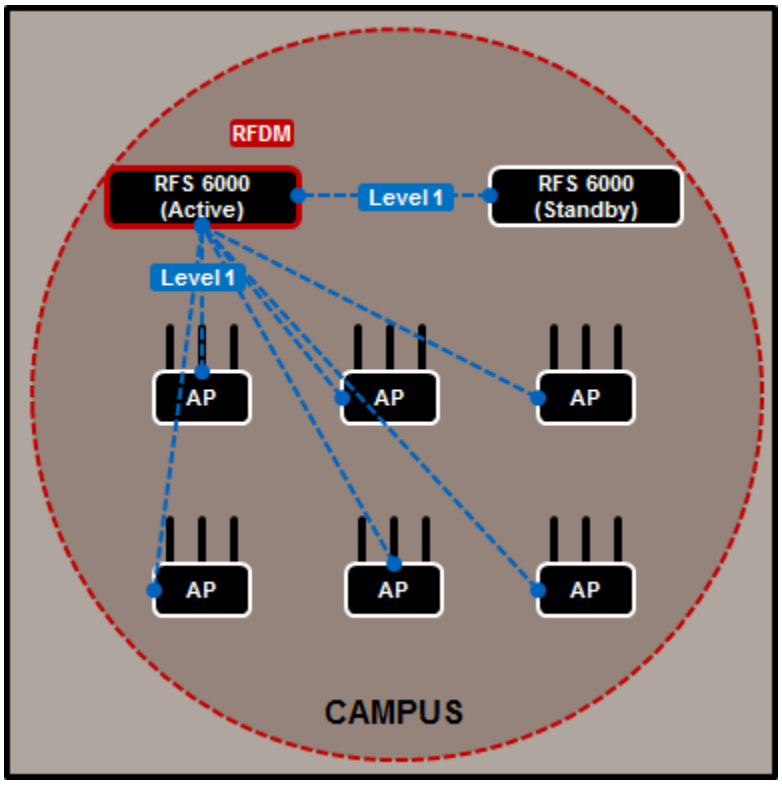
Level 1 MINT links Use Cases:

- Small campus environments with one single RF Domain (all or some of the WLANs tunneling traffic to the Wireless Controllers). In this case the Controller will be the elected RF Domain Manager for the site so a level 1 MINT links have to be utilized.
- Large campus environments with 500 to 1000 Access Points depending on the Controller platform (all WLANs using local bridging). In this case there are several possible scenarios:

Single RF Domain

The Wireless Controller will be the elected RF Domain Manager for the site. Level 1 MiNT links have to be utilized.

Please note that if more than 100 Access Points has to be deployed, it is not recommended to use VLAN links, but rather IP based links. In case IP based links will be used, it is recommended to disable MINT MLCP over VLAN under both AP and Controller Profile.



Single Site Local Deployment:

Maximum Access Points / Site:

- Dependent on the adoption capacity of the deployed Controllers

Supported MINT Links:

- Level 1 (Layer 2 or Layer 3)

Maximum Number of RF Domains:

- 1

Supported RF Domains Types:

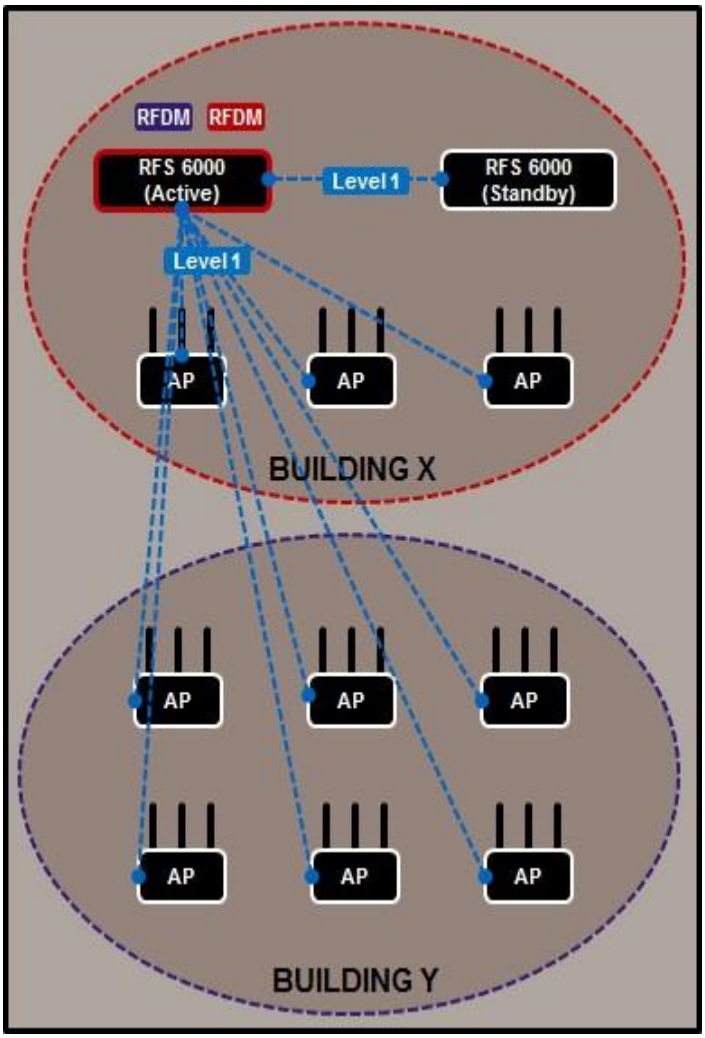
- System default or user defined

Elected RF Domain Manager:

- *Standalone* – The standalone Controller
- *Cluster* – The Controller with the lowest MINT ID

Multiple RF domains representing several buildings inside one small/medium campus

The Wireless Controller may act as a Virtual RF Domain Manager ("controller-managed" setting under RF-domain). Level 1 links will be utilized. This is useful in a situation where logical separation between buildings is required using the concept of the RF-domain.



Medium Campus Multiple Buildings Deployment:

Maximum Access Points / Site:

- Dependent on the adoption capacity of the deployed Controllers or Network Services Platforms

Supported MINT Links:

- Level 1 (Layer 3)

Maximum Number of RF Domains:

- Dependent on the controller platform capacity of maximum number of controller-managed RF Domains.

Supported RF Domains Types:

- 1 RF Domain per building (Controller Managed)

Elected RF Domain Manager:

- Standalone – The standalone Controller or Network Services Platform
- Cluster – The Controller or Network Services Platform with the lowest MINT ID

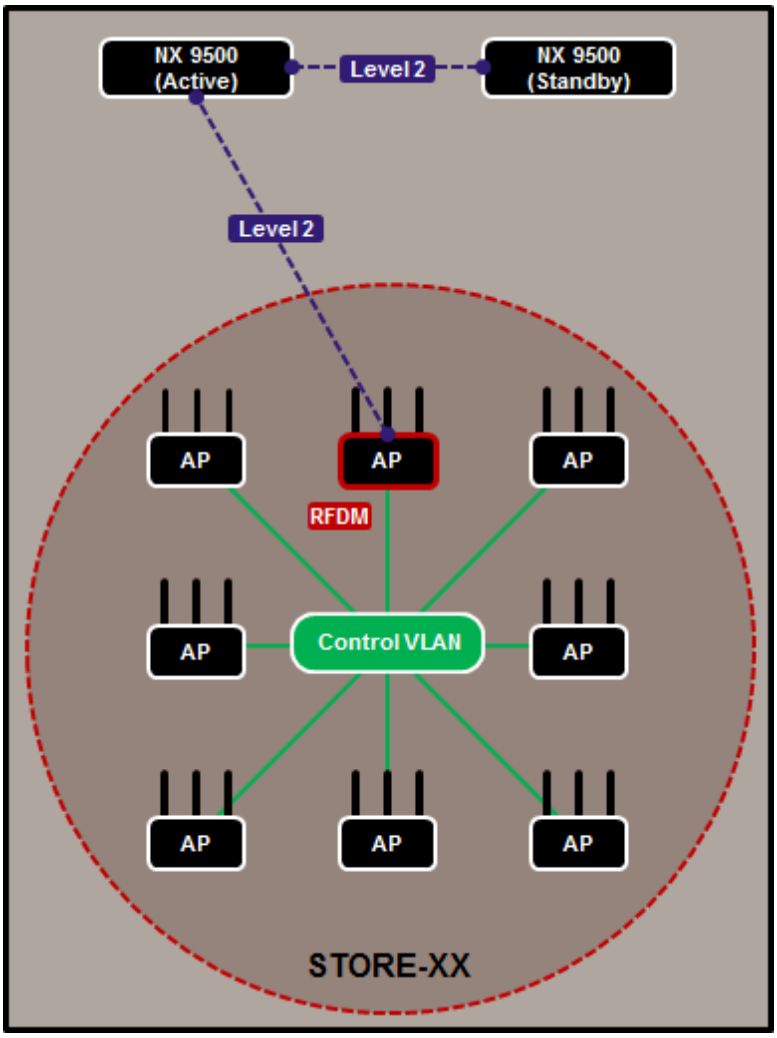
Note
MINT links levels should be maintained across the whole deployment, mixing MiNT level 1 and MiNT level 2 links on the same controller is not recommended and not supported.

Level 2 MiNT links Use Cases:

Distributed deployments with centralized Wireless Controllers and remote Access Point.

For scaling remote Access Points at each site have to be MINT isolated form Access Points at other sites. In most distributed environments (multiple retail stores, branch offices, distribution centers etc.) with up to 256 x Access Points we must utilize level 2 MINT links.

At each AP-only remote site (i.e. RF Domain) Control VLAN must be defined for the Access Points to be able to discover neighbor Access Points at Layer 2 and elect the RF Domain Manager.



Distributed Deployment with Remote AP-only Sites

Maximum Access Points / Site:

- Dependent on the RF Domain Manager capacity, typically 128x or 256x APs per RF Domain

Supported MINT Links:

- Level 2 (Layer 3)

Maximum Number of RF Domains:

- Dependent on the controller platform capacity of maximum number of RF Domains.

Supported RF Domains Types:

- 1 RF Domain per site. For AP-only sites Control-VLAN must be defined.

Elected RF Domain Manager:

- One of the Access Points at a site with lowest MiNT ID and highest model number, e.g. AP7532 will always have precedence over AP6521

Large Campus Networks where each building will be represented as a separate RF Domain.

No Control VLAN should be defined under the RF Domain. Wireless Controller will assume the role of the RF Domain Manager. MiNT level 2 in this case will provide isolation/segmentation at each Access Point, so AP will have only a single entry in their MiNT LSP-DB table. This is useful in case too many APs will be deployed at the same site (>500), as having short LSP Database will conserve resources on the APs, while Wireless Controller will do the job of maintaining all the MiNT links, aggregating statistic, working as Smart RF master etc. In this case we assume that the Controller is on the same LAN as the Access Points.

It is recommended to reload the Access Points when changing MiNT links levels.

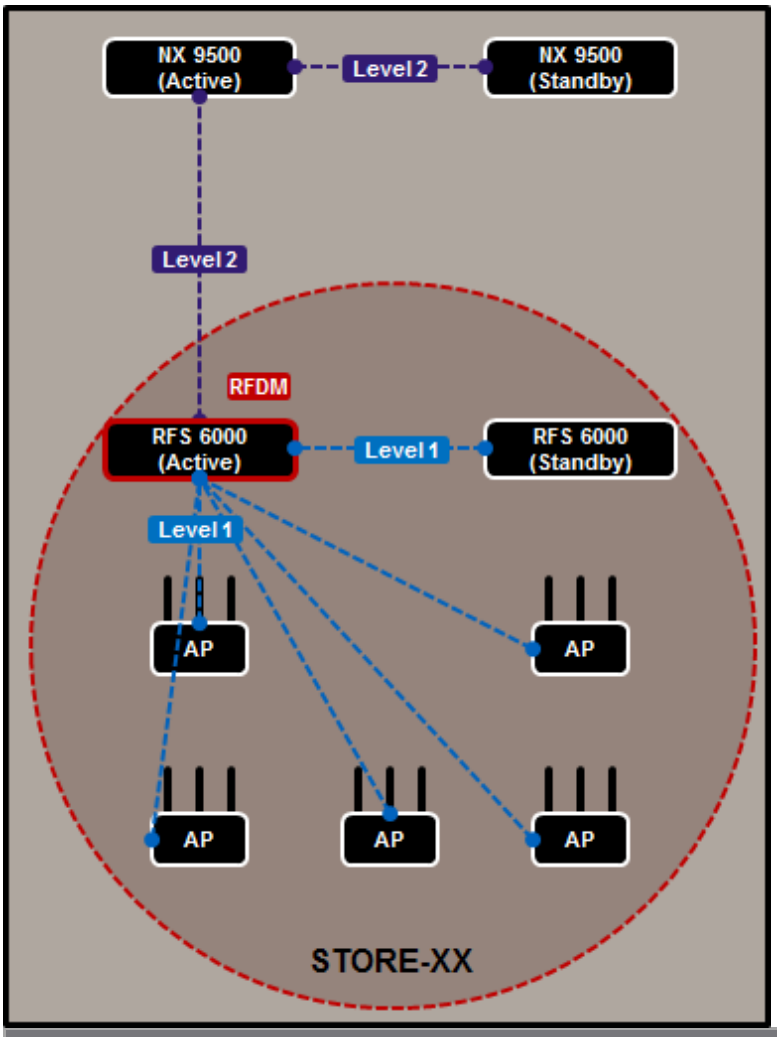
Note
If support for extended VLANs over level 2 MiNT is required, additional configuration must be added to the Controller and Access Point profiles.

It is recommended to leverage Level 2 MINT links when building out large multi-site deployments. This is a common issue when scaling large deployments. WiNG 5 uses Level 1 MINT links by default. There is direct communication between all Level 1 MINT neighbors increasing network traffic and database sizes on the WiNG nodes. Using level 2 MINT links summarizes this information, thereby creating a much more efficient network design.

Please refer to "*WiNG5X Reference RF Domains Guide*" for the list of currently supported deployments.

Hierarchical Management – ONEVIEW

In Hierarchical Management it is possible to have a mix of AP-only sites as well as larger sites with local Site Controllers, all being adopted and managed by centralized controllers in the NOC. This is supported starting from WiNG 5.5 onwards. For those larger sites APs at the remote site will adopt to their respective Site Controllers via MiNT level 1 links, while Site Controllers will be adopted by the NOC controllers via MiNT level 2.



In such scenario local Access Points must be placed into the same RF Domain as the Site Controller and use VLAN or IP based MiNT level 1 links for adoption. One of the Site Controllers will act as an RF Domain manager for that site and will have a MiNT level 2 link established back to the NOC controller.

Please note that Control VLAN must not be defined under the RF domain with Site Controllers.

Note

If support for extended VLANs over level 2 MiNT is required, additional configuration must be added to the Controller and Access Point profiles.

Control VLAN vs Controller VLAN

The **Control VLAN** defines the VLAN id which is used by Access Points at a site to communicate statistics and other RF Domain related information with the elected RF Domain Manager at the site. The Controller VLAN defines the preferred VLAN id the Access Point uses to communicate with the Wireless Controller for adoption purposes.

The Control VLAN definition under the RF Domain is required only for distributed deployments using level 2 MINT links where the Access Points at a remote site discover each-other, elect an RF Domain Manager and perform functions such as Smart RF locally. Having a Control VLAN requires that all the APs at the site have one common broadcast domain, otherwise they will fail to properly elect the RF Domain manager, causing issues with adoption, roaming, getting statistics etc.

Control VLAN Configuration Example

```
!
rf-domain store100
 country-code us
 use smart-rf-policy <smart-rf-policy-name>
 control-vlan 1
!
```

For campus based deployments the Wireless Controller will be the elected RF Domain Manager and the Access Points will have level 1 MINT links to the Wireless Controller. As such Control VLAN configuration must not be used for this kind of deployments.

The **Controller VLAN** configuration is required only if Access Points and Controllers share more than one common VLAN (i.e. Access Points can reach the Wireless Controllers over multiple VLANs) and APs are adopted over Layer 2 using VLAN MINT links. In such deployments the Controller VLAN parameter can be defined in the Access Points profile to force the Access Points to form a level 1 MINT link to the Wireless Controllers using a specific VLAN id vs. selecting a random VLAN. Such deployment scenarios are rare hence the usage of Controller VLAN configuration is also rare.

*Specified use-case above is **the only** occasion where controller VLAN is needed*. Since Access Points and Controllers by default run MLCP over VLAN, they will establish VLAN based links automatically without any additional configuration. Controller VLAN in the Access Point profile will supersede any IP based adoption by creating a static VLAN MiNT link.

Access Point Profile Example

```
!
profile ap6532 tmelabs-ap6532
...
 interface ge1
  switchport mode trunk
  no switchport trunk native tagged
  switchport trunk native vlan 1
  switchport trunk allowed vlan 1,11-14
 use firewall-policy default
 controller vlan 1
!
```

MINT Level 1 Area-IDs

In rare cases when Access Points on different RF Domains share one common broadcast domain, using MiNT level 1 area IDs is required, otherwise it might introduce a network loop. Example of such scenario would be a shopping center use-case where each RF Domain will represent one different store brand within the same building, where all Access Points will be on a common LAN segment.

In such scenario it is possible to separate Access Points on the same Broadcast Domain using different MiNT Level 1 Area IDs. Use of Aliases additionally allows having one common device profile, while specifying area-id number under each RF Domain.

Note
MINT Area IDs should only be used with the above specified use-case scenario.

Access Point Profiles with different MiNT Level 1 Area ID Configuration Example:

```
!
profile ap7532 STORES
 mint level 1 area-id $AREA-ID
 no autoinstall configuration
 no autoinstall firmware
 interface radio1
 interface radio2
 interface ge1
  switchport mode trunk
  switchport trunk native vlan 1
  no switchport trunk native tagged
  switchport trunk allowed vlan 1,10,20,70
 interface vlan 1
  ip address dhcp
  ip dhcp client request options all
 interface pppoe1
 use firewall-policy default
!
rf-domain STORE-BRAND-A
 timezone CET
 country-code de
 use smart-rf-policy CAMPUS-SMART-RF
 control-vlan 1
 alias number $AREA-ID 1
!
rf-domain STORE-BRAND-B
 timezone CET
 country-code de
 use smart-rf-policy CAMPUS-SMART-RF
 control-vlan 1
 alias number $AREA-ID 2
!
```

RF Domain Manager in Mixed AP environment

In a scenario when different AP models are present at the site, the highest CPU/Memory Access Point will be automatically elected to become an RF Domain Manager.

It is recommended not to assign static RF Domain Manager Priorities and leave automatic RFDM election.

Low Bandwidth High Latency WAN links

In case any low bandwidth WAN links are present between the remote sites with high latency and packet loss, it is recommended to increase the default MiNT Hello Interval and Adjacency Hold Timer on both AP and Controller Profile. Usually hello interval value of 60 with adjacency hold-time of 180 should suffice on high latency links, but in some rare cases it may be extended to 120 hello interval and 360 adjacency hold-time.

Access Point Profile Example:

```
!
profile ap7532 default-ap7532
 autoinstall configuration
 autoinstall firmware
 interface radio1
 interface radio2
 interface ge1
 interface vlan1
  ip address dhcp
  ip address zeroconf secondary
 ip dhcp client request options all
 interface pppoe1
 use firewall-policy default
 use client-identity-group default
 controller hello-interval 60 adjacency-hold-time 180
 service pm sys-restart
 router ospf
!
```

Virtual Controller Deployments

An Access Point operating as a Virtual Controller only provides management / configuration functions for other Access Points. This deployment mode is designed to be used in small single site environments with up to 64x APs managed by the same Virtual Controller AP.

An Access Point operating as a Virtual Controller provides:

- Client Access services on all data radios like any other Access Point
- RF Management (Smart-RF) and WIPS coordination
- Firmware Updates of adopted Access Points
- Configuration Management for adopted Access Points (24x for legacy 802.11n APs and low-tier 802.11ac APs / 64x for other 802.11ac platforms)
- Statistics Collection and Aggregation
- Troubleshooting adopted Access Points.

Starting from WiNG 5.9.0 release Virtual Controller supports dynamic failover and redundancy via ***Dynamic Virtual Controller*** feature, which provides automatic Virtual Controller role failover based on RF Domain Manager election process. In addition, Dynamic Virtual Controller feature provides virtual management IP address that migrates automatically to the new Virtual Controller as a secondary IP address.

```
!
profile anyap EXTR-LAB-AP
 ...
 use auto-provisioning-policy VC
 ntp server time.nist.gov
 virtual-controller auto
 virtual-controller management-interface ip address 192.168.7.254/24
 virtual-controller management-interface vlan 1
 rf-domain-manager capable
!
```

Beginning from WING 5.9.1 release, high tier AP models such as **AP 8432 and AP8533** have the ability to manage following AP types in Virtual Controller environment. This feature is called ***Heterogeneous Virtual Controller*** or ***HetVC***:

High-Tier APs – AP8432 & AP8533 - will have an ability to manage same AP family:

- AP 7602 / AP 7622
- AP 7612 / AP 7632 / AP 7632
- AP 7522 / AP 7532 / AP 7562
- AP 8432 / AP 8533

Mid-Tier APs will have an ability to manage same AP family:

- AP 7522 / AP 7532 / AP 7562 can manage any mix of AP 7522 / AP 7532 / AP 7562
- AP 7632 / AP 7662 can manage any mix of AP 7612 / AP 7632 / AP 7662

Notes:

- If any other Access Point type not mentioned above is acting as a Virtual Controller, it will only be able to manage Access Points of the same model.
- When using HetVC feature ‘anyap’ profiles must be used to configure Access Points which are not the same model as the Virtual Controller. These profiles must exist on the Virtual Controller prior to the Virtual Controller adopting and managing other Access Point models. You will need to create suitable auto provisioning rules for the other Access Point models to automatically assign custom ‘anyap’ profiles. To automatically assign RF Domain use $AUTO-RF-DOMAIN tag, which will assign the same RF Domain name that Virtual Controller is currently using:

```
!
auto-provisioning-policy VC
 adopt anyap precedence 1 profile EXTR-LAB-AP rf-domain $AUTO-RF-DOMAIN any
```

```
!
profile anyap EXTR-LAB-AP
 ...
 use auto-provisioning-policy VC
 ntp server time.nist.gov
 virtual-controller auto
 virtual-controller management-interface ip address 192.168.7.254/24
 virtual-controller management-interface vlan 1
 rf-domain-manager capable
!
```

- While no tunneled VLANs are supported using native MINT tunneling, it is possible to tunnel user traffic to an external concentrator via L2TPv3 (which can be a zero-license NX controller or any 3rd party device compliant with L2TPv3 RFC using dynamic tunnels) either via Virtual Controller or from each Access Point.

Controller Clustering

Access Point Failover & Recovery

By default, in an Active / Standby cluster environment during an Active Controller failure, the Access Points will stay adopted to the Standby Controller after the Active Controller has recovered. Reverting the Access Points requires the Access Points to be manually un-adopted using the no adoption command on the Standby Controller.

Automatic reversion of the Access Points to the Active Controller can be optionally enabled by defining the cluster force-configured-state and cluster force-configured-state-delay <time-in-mins> parameters in the Controller Profiles or directly on the Controllers device configuration as Overrides. It is recommended however that the cluster force-configured-state-delay value be set to a conservative value to prevent flapping in the event that the Active Controller is repeatedly loosing connectivity or goes offline.

MINT Levels in Cluster and Cluster Modes

When defining a cluster of Wireless Controllers, all members of the cluster MUST be configured to use the same MINT level. Do not define cluster members at different MINT levels! Select level 1 or level 2 depending on your specific deployment:

1. For campus based local deployments the cluster should be formed using level 1 MiNT links. Cluster mode may be Active/Active for load-balancing or Active/Standby for redundancy. Active/Standby is preferred.
2. For distributed deployments over a WAN (locally bridged or tunneled VLANs), the cluster must be formed using level 2 MiNT links. Only Active/Standby cluster mode is supported.

As a best practice avoid using VLAN based MiNT links to form a cluster and utilize IP based MiNT links instead. Mixing VLAN and IP based links for clustering is not supported and will pollute MiNT routing tables causing adoption, stability and clustering issues.

Cluster Configuration Synchronization

When running in Cluster mode all the configuration must be done at the Cluster Master. Once configuration is committed on the Master, it will push new configuration revision to the Cluster Slave controller to keep configuration in sync.

In case static cluster priorities are in use along with “cluster force-configured-state” in the event of cluster master failure, any changes that will be made on slave controller while it is in active role will be overridden once cluster master will come back online and cluster is restored.

To avoid this situation, it is recommended to follow the steps below:

1. Once cluster master is unavailable and configuration changes must be done at the slave, temporarily increase cluster master priority on the secondary controller:

```
Secondary(config-device-00-15-70-38-02-DE)#cluster master-priority 255
Secondary(config-device-00-15-70-38-02-DE)#commit write
```

2. When cluster master is back up online and cluster is restored, configuration changes made on the secondary while master was offline will be saved.
3. Now you may revert original master-priority on the secondary controller:

```
Secondary(config-device-00-15-70-38-02-DE)#remove-override cluster master-priority
Secondary(config-device-00-15-70-38-02-DE)#commit write
```

Cluster Failover

When using tunneled VLANs and clustering it is recommended that the cluster communication / Access Point adoption and user VLANs NOT be assigned to different physical ports on the Wireless Controllers (i.e. Access Point adoption, cluster communications and management VLANs on Ge1 and extended VLANs on Ge2).

To prevent network loops only one Wireless Controller can be designated as the EVIS to forward tunneled VLAN traffic onto the wired network at a time. The Wireless Controllers are able to see each other (in most cases) over the tunneled VLANs and the alternative Wireless Controller will not take the EVIS role as long as it can see the first Wireless Controller over the tunneled VLAN(s).

If the cluster communication and tunneled VLANs are split between ports on the Wireless Controller you can run into issues during cluster failure scenarios. For example, during normal operation the primary Wireless Controller adopts the Access Points and is the EVIS for the tunneled WLANs. A network failure disables communications on the Ge port on the primary Wireless Controller where the Access Point adoption, cluster and management VLANs reside.

The cluster protocol will go down and the Access Points will failover to the alternate Wireless Controller, however as the Wireless Controllers can still see each other over the tunneled VLANs the EVIS will not failover. The wireless user traffic will still be forwarded to the primary Wireless Controller which may not have access to the backbone.

As a best practice for clustering and failover it is recommended that:

1. All VLANs (Access Point adoption, cluster, management and user VLANs) be assigned to a common physical port on each Wireless Controller.
2. If additional capacity or availability is required it is recommended that 802.3ad static Link Aggregation (i.e. Port Channel) be enabled with all the VLANs (Access Point adoption, cluster, management and user VLANs) assigned as members of the Link Aggregation Group (LAG).

Configuration & Management

Naming Conventions

When creating objects such as RF Domains, Profiles, Policies and ACLs within the Web-UI, it is strongly recommended that no spaces are used to name the objects. Using spaces adds control characters to the object name in the configuration which can be difficult to decipher and can cause errors in the configuration or operation of the system. As an alternative it is recommended that you use hyphens or underscore characters which will result in a cleaner configuration.

Note

When defining Hostnames of any WiNG device (APs or Controllers) in either GUI or CLI, please do not use underscore character, as this is not permitted by RFC and may cause adoption and stability issues, use hyphen as an alternative. Allowed characters are 0-9, a-z, dot "." and a hyphen '-'.

Aliases

In WiNG 5 deployment scenarios it is common for different sites to have configuration parameters which are similar with the exception of a small number of values, for example different IP networks, host IP addresses or VLAN IDs per site.

Instead of defining separate device Profiles, Policies, ACLs or Wireless LANs for each site to make these small adjustments, it is recommended to substitute them by an Alias Names which are then mapped to real values in Profiles, Devices, RF Domains or Globally.

This permits common configuration objects such as Policies, Profiles and Wireless LANs to be shared between sites yet permits site specific parameters to be applied to a subset of sites or each individual site. It is recommended to utilize Aliases in large scale deployments to simplify configuration, limit number of configuration objects needed allowing configuration re-use.

Alias Types Supported:

```
VLAN Alias: Maps a Name to VLAN ID (example: alias vlan $GUEST 101).
Substitute VLAN IDs in:
Bridged VLANs (Profile / Device)
IP Firewall Rules (Source VLAN)
L2TPv3 (Source VLAN, Native VLAN)
Switchport (Native / Allowed VLANs)
Wireless LANs (Static or Dynamic VLANs)
```

```
Network Alias: Maps a Name to a IP Subnet (example: alias network $GUEST 192.168.25.0/24)
Substitute IP Subnets in:
DHCP (Network)
IP Firewall Rules
```

```
Network Host Alias: Maps a Name to a Host IP (example: alias host $DNS-SERVER 8.8.8.8)
Substitute Host IP Addresses in:
DHCP (Start / End IPs, Server IPs)
IP Firewall Rules
```

```
Network Range Alias: Maps a Name to a Range of IPs (example: alias address-range $APP-SERVERS 192.168.10.10
192.168.10.20)
Substitute IP Address Ranges in:
IP Firewall Rules
```

```
String Alias: Maps a Name to a arbitrary String (example: alias string $DOMAIN-NAME extremenetworks.com)
Substitute Strings in:
```

```
DHCP (Domain Name)
```

```
Network Group Alias: Maps a name to a group of IP Subnets, Host IPs and/or Ranges (example: $DNS-SERVERS
host 8.8.8.8 8.8.4.4)
Substitute Hosts / Subnets / Ranges in:
IP Firewall Rules
```

```
Services Group Alias: Maps a name to a group of Protocols and Ports (example: alias network-service $WEB
proto tcp 80 proto tcp 443)
Substitute Protocols and Ports in:
IP Firewall Rules
```

Aliases can be defined at multiple levels:

```
Globally: If an alias is common between all the devices in the system
Profiles: If an alias is specific to a group of Controllers or Access Points or to override a global alias
RF Domains: If an alias is unique to a site or to overrides global and Profile aliases
Devices: If an alias is specific to a device or to overrides global, Profile and RF Domain aliases
```

Example with static VLAN assignment different at each site:

```
!
wlan CORP
 ssid CORP
 vlan $CORP
 bridging-mode local
 encryption-type ccmp
 authentication-type eap
 use aaa-policy EXTERNAL-AAA
!
profile ap7532 REMOTE-AP7532
 ...
 interface radio1
  wlan CORP bss 1 primary
 interface radio2
  wlan CORP bss 1 primary
 interface ge1
  switchport mode trunk
  switchport trunk native vlan 1
  no switchport trunk native tagged
  switchport trunk allowed vlan 1,$CORP
 interface vlan1
  ip address dhcp
  ip dhcp client request options all
!
rf-domain SITE1
 timezone CET
 country-code de
 control-vlan 1
 alias vlan $CORP 11
!
rf-domain SITE2
 timezone PST8PDT
 country-code us
 control-vlan 1
 alias vlan $CORP 21
!
rf-domain SITE3
 timezone PST8PDT
 country-code us
 control-vlan 1
 alias vlan $CORP 31
!
```

Example with IP Access List and Aliases configuration:

```
!
 ip access-list CORP-DEVICES
  permit tcp $CORP-DEVICES  $LOCAL-SERVER  rule-precedence 1
  permit udp any eq 67 any eq dhcpc rule-precedence 11 rule-description "permit DHCP replies"
!
wlan CORP
 ssid CORP
 vlan $CORP
 bridging-mode local
 encryption-type ccmp
 authentication-type eap
 use aaa-policy EXTERNAL-AAA
 use ip-access-list in CORP-DEVICES
!
rf-domain SITE1
 timezone CET
 country-code de
 control-vlan 1
 alias vlan $CORP 11
 alias host $LOCAL-SERVER 192.168.50.244
 alias network-group $CORP-DEVICES network 192.168.50.0/24
!
rf-domain SITE2
 timezone PST8PDT
 country-code us
 control-vlan 1
 alias vlan $CORP 21
 alias host $LOCAL-SERVER 172.16.23.20
 alias network-group $CORP-DEVICES network 172.16.1.0/24 172.16.3.0/24
!
rf-domain SITE3
 timezone PST8PDT
 country-code us
 control-vlan 1
 alias vlan $CORP 31
 alias host $LOCAL-SERVER 172.31.43.20
 alias network-group $CORP-DEVICES network 172.31.5.0/23
!
```

Switched Virtual Interface

When a Wireless Controller or Access Point bridges traffic on a VLAN it does not require a Switched Virtual Interface to be defined. One common mistake is to create a Virtual Interface for locally bridged VLANs on a device when it's not required. A Virtual Interface is only required for the following scenarios:

1. Layer 3 Access Point adoption.
2. Device Management.
3. When the Wireless Controller or Access Point is providing IPv4 routing services between multiple IPv4 interfaces.
4. When the Wireless Controller or Access Point is providing NAT.
5. When the Wireless Controller or Access Point is terminating IPsec VPN tunnels.
6. When DHCP services are running on the Wireless Controller or Access Point.

Please note that all routed IPv4 traffic is inspected by the stateful packet inspection firewall. When IPv4 routing doesn't work as expected with the defined Virtual IP interfaces, issue a **service pktcap on drop** command to see if any packets are being dropped by the stateful packet inspection firewall. Most firewall checks are enabled by default and can be disabled if needed.

Zero Config IPv4 Address

A Zero Config IPv4 address is assigned by default to new Access Points on VLAN 1 to provide a mechanism to configure the Access Points when no DHCP services are present on the network. It is important to note that the Zero Config IPv4 address will only apply to VLAN 1 and will not work on any other VLAN.

If no DHCP services are present, each Access Point will be automatically configured with a Zero Config IPv4 Address 169.254.**X**.**Y**/16 where:

- **X** = the decimal equivalent of the 5th octet of the MAC address
- **Y** = the decimal equivalent of the 6th octet of the MAC address

The Zero Config IPv4 address for an Access Point can be determined by converting the 5th and 6th octets of the Access Points MAC address from HEX to Decimal. For example, an Access Point with the MAC address 00-23-68-97-04-DC will use the Zero Config IPv4 Address 169.254.4.220.

Event System policies and SMTP notification

In WiNG5 by default newly created event system policy will have almost every event in each module set to value "default", which depends on the logging level enabled under device profile or device-override. For example, an event "`%DAEMON-6-INFO: udhcpc[1089]: Lease of <X.X.X.X> obtained, lease time <Y>`" is considered to be an informational log message (level 6), so it will only be shown if logging (`buffered | syslog | console | forward`) will be set to level 6 or higher (informational).

Event System Policy allows an administrator to enable or disable specific events irrespective of the logging level configured on the device (event can be manually set to be "on" or "off" instead of "default"). For large deployments it is highly recommended to limit the number of modules and number of events per module to forward to the logging host, otherwise too many events coming from too many devices might overload the controller's cfgd process, causing adoption and stability issues as a side effect.

Note
Starting from WiNG 5.5.6 onwards some events forwarding will be disabled by default. This will prevent situation when controller adopting many APs will receive too many events. Events for which forwarding to a controller will be disabled by default are: "dot11 client-associated", "dot11 client-disassociated", and "dot11 client-info".

For the NOC controller it is recommended to start with disabling all events for each and every module in the GUI and then enable only those critical events that will be required. It is also advisable to create a separate Event System Policy for the APs and/or Site Controllers at remote sites to control which events are being forwarded back to the NOC controller.

For tracking adoption issues it is highly recommended to limit the events only for **device offline** events instead of **device unadopted**. Furthermore, it is advised to limit events on the controller to device offline and critical messages from diag module like high CPU / memory usage, otherwise too many events at the NOC controllers with many APs adopted might put a heavy load on the system.

SNMP Polling Recommendations

Few things to keep in mind when working with WiNG 5 and any SNMP based management / monitoring tool. This also applies for Air Defense Security Platform, as it is using SNMP as a primary protocol to poll network infrastructure devices:

- **SNMP Timeout** – By default ADSP is using sub second timeout for SNMP responses. Depending on the size of the wireless network – we recommend increasing that number to 10 seconds.
- **Poll Interval** – We recommend setting poll interval to at least 30 minutes as a minimum value. Lower intervals are too short to walk the whole table and will overload the Wireless Controller with too many SNMP requests. If polling a controller with thousands of access points, poll interval should be set down to at least 24 hours. Polling Wireless Controllers from multiple SNMP hosts at the same time is not recommended.

It is not recommended that you poll the Access Points directly when adopted by the controller. The Wireless Controllers have all the required information and statistics so there is no need to query each Access Point individually.

Additionally, it is recommended to enable SNMP in the management policy servicing the Wireless Controllers and disable in the management policy servicing the Access Points.

Management Policy Examples:

```
!
management-policy noc
 https server
 ssh
 user admin password 0 <PWD> role superuser access all
 snmp-server user snmptrap v3 encrypted des auth md5 0 wingsecure
 snmp-server user snmpmanager v3 encrypted des auth md5 0 wingsecure
!
management-policy aps
 no https server
 ssh
 user admin password 0 <PWD> role superuser access all
 no snmp-server manager v3
!
```

Note

Current WiNG MIBs can be obtained by downloading latest firmware for a particular WiNG platform from support pages.

CDP / LLDP

By default, each WiNG device runs CDP and LLDP protocols, which are designed to help mitigate some of the issues with the wired infrastructure or help negotiate PoE power allocation. However, it has been identified that in rare cases when customers have mixed switching infrastructure with a mix of managed and unmanaged switches OR switches that understand both CDP and LLDP and switches that understand LLDP only - having CDP enabled might cause increased CPU load on the adopting controller. In such cases it is highly recommended to disable both CDP and LLDP on all AP profiles. You should also disable CDP even if you run managed switches that might not understand CDP protocol, such as for example Extreme or HP switches.

Disable CDP / LLDP on the AP profile:

```
!
 profile ap7532 BRANCH-1
 ...
 no cdp run
 no lldp run
!
```

Virtualized Controller Platform

Starting with WiNG 5.6 release new Virtualized Controller Platform – VX9000 – has been introduced. It is important to understand the advantages, as well as its limitations before deploying this kind of solution.

Since VX9000 platform does not have a dedicated dataplane, it is recommended not to use VX9000 to forward wireless client user traffic to the VX9000. As an alternative wireless user traffic may be tunneled either through MiNT from local APs to a Site Controller with dataplane or via alternative methods, like L2TPv3 or L2oGRE tunnels to a cluster of NX controllers in the POP or DMZ.

Virtualized Platform provides scalability “On Demand”, i.e. CPU and Memory resources can be assigned based on the current requirement to support X number of Access Points.

Note
After the VX controller is licensed management IP address must not be changed, since VX Serial Number is a combination of MAC and IP address.

Wireless & Radio

802.11 Data Rates

As a general best practice it is not recommended to only enable 11n/11ac rates. Some clients will not connect to an Access Point if only 11n or 11ac rates are enabled. Additionally, for the 2.4GHz radios try to avoid using the 1Mbps and 2Mbps rates as this significantly reduces the overall available throughput.

Typical Rate configuration to be used for the 2.4GHz band:

7. Retail Stores – Basic 5.5, Basic 11, 12, 18, 24, 36, 48, 54, mcs-1s
8. Distribution Centers – Basic 5.5, Basic 11, 12, 18, 24, 36, 48, 54 *
9. Campus – Basic 12, 18, 24, 36, 48, 54, mcs-1s **

**It has been identified that ENC devices with Jedi radios can have connectivity issues when 5.5 and 11 Mbps data rates configured on infrastructure. If there are no 802.11b devices on the SSID / band, it is recommended to set data-rates to "gn", "g-only" or custom rates with 5.5 and 11 Mbps rates excluded from supported rates. If 802.11b devices are present as well, recommendation is to set custom rates with 1 and 2 Mbps set as basic rates and exclude 5.5 and 11 Mbps from supported rates. This is client side issue and it is not specific to WING infrastructure. Devices impacted: MC17, MC5590, MC759X, MC75A, MC9590, MC3190, MC9190, VC609X, MT2090, MK3900, MK4900, MK590.*

*** configure 12 Mbps as basic data-rate only when site survey showed enough coverage. In lower density deployments lowest basic rate should be set to 6 Mbps or 11 Mbps if any 802.11b-only devices are present.*

Note
If you have older 802.11b only clients such as the 6846 or Mobile Companion older than 3.93 using Keyguard etc., it requires basic rates to be either 1Mbps or 2Mbps or both. In such situations, you can configure the data-rates under the Wireless LAN and map that Wireless LAN to a specific BSS. The recommended rate configuration would be: 'basic-2 5.5 11'.

Typical Rate configuration to be used for 5GHz band:

10. Typical Deployments – The default data-rate configuration is ideal.
11. High-Density Access Point Deployments – Basic 12, 18, Basic 24, 36, 48, 54, mcs-1s, mcs-2s, mcs-3s
12. VoIP Deployments – Basic 12, 18, Basic 24, 36, 48, 54, mcs-1s *

** configuring 12 Mbps as lowest basic data-rate should assume that enough coverage is in place. In lower density deployments lowest basic rate should be set to 6 Mbps.*

Note
When using lower power devices like tablets and smart phones it is recommended not to set basic rates above 24Mbps.

Another feature in WiNG 5 is to allow probe responses to be sent at a rate different than what the probe request is received. The configuration is under the radio configuration inside an Access Point profile. It is recommended to use the `probe-response rate lowest-basic` as the configuration as it will dynamically choose the rates depending on the data rate configuration.

Antenna Diversity

When using 802.11n/802.11ac Access Points and clients it is not recommended to configure antenna diversity. 802.11n/11ac already has a provision for diversity so enabling diversity will affect 802.11n transmissions.

WLAN to BSS mappings

When assigning WLANs to the Radio interface make sure that WLAN mapping is consecutive and BSS numbers are not skipped. It is recommended to keep at least first 4 WLANs in the same order mapped to BSS 1 to 4. When adding or removing WLANs make sure the BSS mapping order is kept intact:

Access Point Profile example:

```
!
profile ap8533 REMOTE-AP8533
 no mint mlcp vlan
 trustpoint https noc
 trustpoint radius-ca TMELABS-PKI
 trustpoint radius-server TMELABS-PKI
 use radius-server-policy ONBOARD-TLS
 ...
 interface radio1
  wlan handhelds bss 1 primary
  wlan ccast bss 2 primary
  wlan EGuest bss 3 primary
  wlan tls bss 4 primary
  no dynamic-chain-selection
  probe-response rssi-threshold -85
 interface radio2
  wlan Voice bss 1 primary
  wlan ccast bss 2 primary
  wlan EGuest bss 3 primary
  wlan tls bss 4 primary
  no dynamic-chain-selection
  probe-response rssi-threshold -85
 ...
!
```

Broadcast SSID vs. Answer Broadcast Probes

WING 5 supports the ability to enable / disable broadcast SSID and answer broadcast probes. These parameters are enabled / disabled per Wireless LAN:

13. Broadcast SSID – If enabled the Access Point radios includes the ESSID in the beacon. If disabled, the Access Point omits the ESSID from the beacon. When beacon doesn't include the ESSID mobile clients usually send probes on to the air to find suitable Access Points. Therefore, overall broadcast traffic is increased thus reducing total available airtime. When performance is an issue we don't recommend disabling the ESSID in the beacon.
14. Answer Broadcast Probes – If enabled the Access Point will send a probe-response when a wireless client sends a broadcast probe. A lot of clients even if configured for specific ESSID will still send broadcast probes (i.e. probe requests with no ESSID). This will cause the Access Point to respond on each BSS where Wireless LAN is set to answer broadcast probes. When performance is an issue we recommend disabling the feature and don't answer broadcast probes. The usual case where answering broadcast probes might be needed is guest access (i.e. captive portal).

In most cases, if broadcast SSID is enabled (i.e. the ESSID is advertised in the beacon) you can safely disable answer broadcast probes. It is recommended to disable answer broadcast probes as it helps reducing probe responses going out from Access Points at lower data rates for all probes sent out by client devices (including devices that are not part of the customer network).

For Apple and Android devices like tablets, smart-phones and PDAs, it is recommended that broadcast SSID be enabled as the broadcasting of the SSID in the beacon is a requirement on these devices for roaming to be reliable.

Wireless Client Load Balancing

Wireless client load-balancing is not enabled by default. It needs to be properly configured with full understanding of the exact needs and purpose for doing load-balancing.

There are two main ways to load-balance wireless clients:

15. Between Bands (Band Steering)
16. Between Access Points (Load-Balancing)

Band Steering

Band steering allows dual-band capable wireless clients to be steered to a particular band (typically the 5GHz band). Configuring load-balancing to prefer the 2.4GHz band is generally not a requirement as most wireless clients will naturally prefer the 2.4GHz band over the 5GHz band. The primary use of band steering is in campus environments with dual band clients where it is desirable to have dual-band 802.11a/b/g/n/ac devices associate to the 5GHz band to free up the 2.4GHz band for legacy clients.

It is mandatory to have sufficient coverage on 5GHz band to use band steering. It is also recommended to lower transmit power on 2.4GHz band in order to provide better signal metrics for clients in 5GHz band.

To enable band steering to move dual-band capable clients will move to 5GHz band the following configuration needs to be performed on the Wireless LAN and Access Point profile(s):

5Ghz Band Steering Wireless LAN and Access Point Profile Example:

```
!
wlan LABS-DOT1X
 ssid LABS-DOT1X
 vlan 23
 bridging-mode local
 encryption-type ccmp
 authentication-type eap
 client-load-balancing
 client-load-balancing max-probe-req 2.4ghz 10
 client-load-balancing band-discovery-intvl 5
 use aaa-policy external-aaa
!
profile ap6532 tmelabs-ap6532
 no autoinstall configuration
 no autoinstall firmware
 load-balancing balance-band-loads
 interface radio1
 wlan LABS-DOT1X bss 1 primary
 interface radio2
 wlan LABS-DOT1X bss 1 primary
!
```

Access Point Load Balancing

The primary use of load-balancing between Access Points is for auditorium and stadium environments with a high concentration of wireless clients. Load balancing is required to distribute the wireless clients between the Access Point radios to reduce overloading a single Access Point. It is also important to have a high Access Point density in the area where load-balancing is configured so wireless clients will have good signal connecting to any Access Point configured for load-balancing.

If load balancing needs to be configured in an auditorium it is mandatory that the load-balancing group- id parameter and value, be defined in the Access Point profile servicing the Access Points in the auditorium. Load-balancing also needs to be enabled in the Wireless LANs to indicate with Wireless LANs support load-balancing.

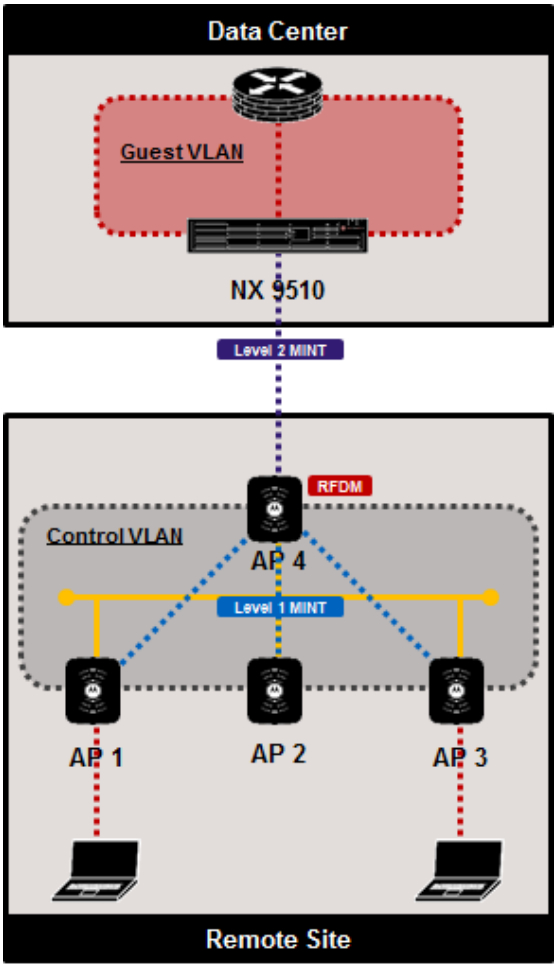
Wireless LANs

Caution

When mapping VLANs to Wireless LANs make sure that same VLAN is not configured for a tunneled and locally bridged WLAN. This is not a valid configuration. A VLAN's bridging mode can either be tunnel or locally bridged but not both.

Tunneling over level 2 MINT links

If there is a requirement to tunnel user traffic with distributed deployments where level 2 MiNT links are used, additional configuration must be in place on the Controller and Access Point Profile.



Wi-Fi user traffic is encapsulated and forwarded to the elected RF Domain Manager (RFDM) within the site using IP or VLAN based Level 1 MINT links.

Wi-Fi user traffic is re-encapsulated and forwarded by the RFDM to the Active Centralized Controller in the datacenter using an IP based Level 2 MINT link

Wi-Fi user traffic is re-encapsulated and forwarded by the RFDM to the Active Centralized Controller in the datacenter using an IP based Level 2 MINT link

Tunneling via MiNT Level 2 Configuration Example:

```
!
wlan TUNNEL
 ssid TUNNEL
 vlan X
 bridging-mode tunnel
 encryption-type ccmp
authentication-type none
 wpa-wpa2 psk 0 wingsecure
!
profile nx9000 NX9510-NOC
 bridge vlan X
  bridging-mode tunnel
  tunnel-over-level-2
  l2-tunnel-broadcast-optimization
...
!
profile ap7532 AP7532-Branch-1
 bridge vlan X
  bridging-mode tunnel
  tunnel-over-level-2
 interface radio1
  wlan TUNNEL bss 1 primary
 interface radio2
  wlan TUNNEL bss 1 primary
...
!
```

Extended VLANs and MINT DIS election

WiNG 5 utilizes MiNT to ensure the best path is selected for forwarding traffic, which also applies for tunneled user traffic. By default, if traffic is tunneled to the cluster of controllers, each cluster member will first exchange MiNT HELLO packets over the User VLAN to perform DIS election and determine who will forward the traffic for each extended VLAN. Effectively the load is shared between both cluster members.

It is important to understand that in this case both controllers should be able to communicate to each other via MiNT over the User VLAN (not just the cluster MINT link) in order to be able to elect the EVIS. Verify that the tunneled VLANs are assigned to the uplink ports on both Controllers in the cluster. Verify that unregistered multicast frames (Destination MAC 01-A0-F8-00-00-00) are forwarded by the Ethernet Switches. Otherwise it will result in both controllers will elect themselves as designated traffic forwarder, which will create a network loop.

Note

In case cluster nodes are located in different data centers, it is recommended to adjust DIS priority on the active controller using "`mint dis-priority-adjustment`" command under device overrides. This deployment still requires both controllers to see each other in each tunneled VLAN at Layer 2.

Output from each cluster member showing healthy system:

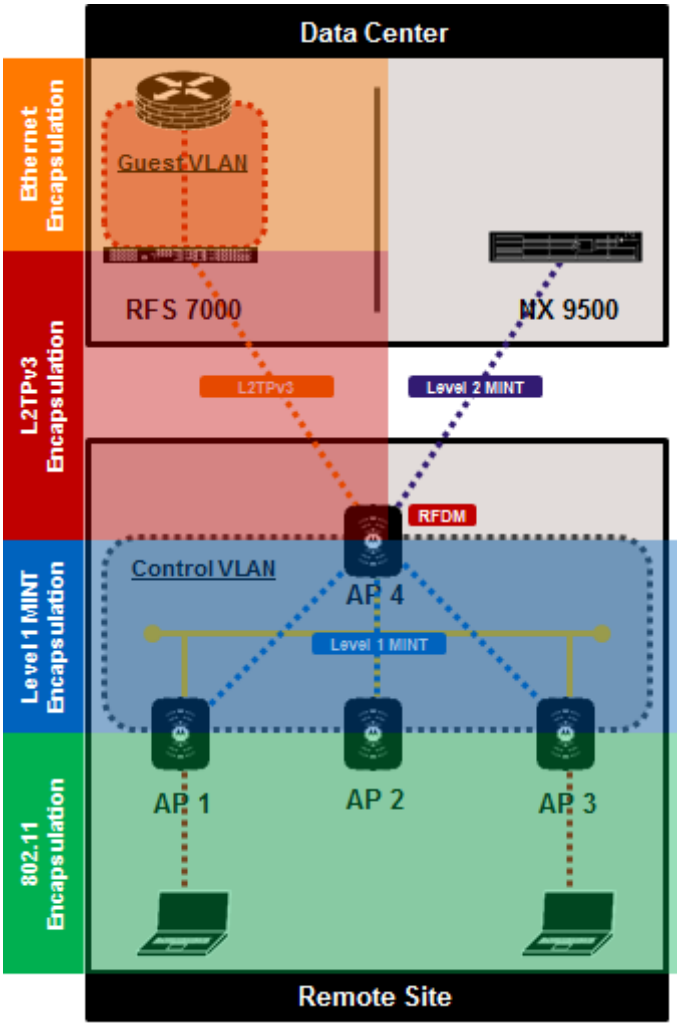
```
CONTROLLER-1# show mint dis
 0 vlan links on 19.6C.87.97:
 3 extended-vlans on 19.6C.87.97:
 extended-vlan 601, EVIS 19.6C.87.98
 extended-vlan 602, EVIS 19.6C.87.97 (self)
 extended-vlan 603, EVIS 19.6C.87.97 (self)
CONTROLLER-2# show mint dis
 0 vlan links on 19.6C.87.98:
 5 extended-vlans on 19.6C.87.98:
 extended-vlan 601, EVIS 19.6C.87.98 (self)
 extended-vlan 602, EVIS 19.6C.87.97
 extended-vlan 603, EVIS 19.6C.87.97
```

Output from each cluster member showing UNHEALTHY system – both controllers think they are the designated forwarded for each tunneled VLAN, this is a loop!

```
CONTROLLER-1# show mint dis
 0 vlan links on 19.6C.87.97:
 3 extended-vlans on 19.6C.87.97:
 extended-vlan 601, EVIS 19.6C.87.97 (self)
 extended-vlan 602, EVIS 19.6C.87.97 (self)
 extended-vlan 603, EVIS 19.6C.87.97 (self)
CONTROLLER-2# show mint dis
 0 vlan links on 19.6C.87.98:
 3 extended-vlans on 19.6C.87.98:
 extended-vlan 601, EVIS 19.6C.87.98 (self)
 extended-vlan 602, EVIS 19.6C.87.98 (self)
 extended-vlan 603, EVIS 19.6C.87.98 (self)
```

L2TPv3 Tunneling

Typical scenario when L2TPv3 tunnels are utilized in a distributed deployment is as follows:



Wi-Fi user traffic is encapsulated and forwarded to the elected RF Domain Manager (RFDM) within the site using IP or VLAN based Level 1 MINT links.

Wi-Fi user traffic is re-encapsulated and forwarded by the RFDM to the L2TPv3 concentrator in the datacenter using an L2TPv3 tunnel. In this case since NOC NX9500 controller does not have a data plane, we have to tunnel to a dedicated NX or RFS cluster via L2TPv3.

Tunneling via L2TPv3 Configuration Example:

```
!
wlan L2TPv3-TUNNEL
 ssid L2TPv3-TUNNEL
 vlan X
 bridging-mode local
 encryption-type ccmp
 authentication-type none
 wpa-wpa2 psk 0 helloworld
!
profile nx9000 NX9500-NOC
 ...
!
profile rfs7000 RFS7K-L2TPv3-CONCENTRATOR
 bridge vlan X
  l2-tunnel-broadcast-optimisation
 ...
l2tpv3 tunnel GUEST
 peer 1 hostname any router-id any
 session GUEST pseudowire-id 999 traffic-source vlan X establishment-criteria cluster-master
!
profile ap7532 AP7532-Branch-1
 bridge vlan X
  bridging-mode tunnel
 interface radio1
  wlan TUNNEL bss 1 primary
 interface radio2
  wlan TUNNEL bss 1 primary
 ...
 l2tpv3 tunnel GUEST
  peer 1 ip-address 89.102.33.201 hostname any router-id any
  peer 2 ip-address 89.102.33.202 hostname any router-id any
  session GUEST pseudowire-id 999 traffic-source vlan X establishment-criteria rf-domain-manager
 l2tpv3 inter-tunnel-bridging
!
```

L2TPv3 vs MiNT Level 2 Tunneling

Currently there are two main methods of tunneling user traffic in large distributed deployments. There are certain use-cases to use L2TPv3 tunneling over MiNT level 2 tunneling and vice versa.

When to implement tunneling via MiNT level 2:

- HM / Distributed deployments that use RFS 7000, NX 7500 or NX 9510 / 9610 as Centralized Controllers (i.e. have a data-plane).
- HM / Distributed deployments that require the tunneled traffic to terminate on the Active Centralized Controller.

When to implement tunneling via L2TPv3:

- HM / Distributed deployments that use NX 9500 / NX9600 as Centralized Controllers (i.e. no data-plane).
- HM / Distributed deployments that require the tunneled traffic to be offloaded to an isolated part of the network such as a DMZ or POP (i.e. separate from the data center).
- HM / Distributed deployments that have Controllers in different data centers without direct Layer 2 connectivity (which will prevent proper MiNT EVIS election).
- HM / Distributed deployments that wish to distribute tunneled traffic between multiple points in the network.
- Large Campus Deployments with Mint Level 2 and Controller Managed RF Domains. This will provide mobility at the controller level by enabling inter-tunnel-bridging and allow passing WNMP roam notifications between multiple tunnels. In these deployments L2TPv3 additionally provides fast tunnel failover between controllers in case of primary failure.

Wireless Mesh

MeshConnex Configuration for Bridge Links

Since Single Hop Mesh feature is considered legacy and will not be supported in our latest AP platforms, MeshConnex can be utilized to create simple bridge links.

Note that in case when MeshConnex is used for creating a bridge link it is recommended to extend the VLANs between the Root and Non-Root APs rather that add them into allowed VLANs list under Mesh Connex policy. This will provide better performance. Each VLAN that you need to pass through the MeshConnex link should be extended at the Root and the Non-Root AP. Extended VLANs must not be in the allowed-vlans list, otherwise it will cause a network loop.

Control VLAN can be any VLAN in case only 1 single Root AP will be present. Control VLAN under MeshConnex policy is only used for communication between Root APs.

Note that by default Layer 2 MiNT traffic will not be passed through the MeshConnex link. In case adoption of Access Points behind MeshConnex link is required it is recommended to use IP based MiNT links.

Example configuration below is a typical scenario with a bridge link between 2 buildings where VLANs 10 and 20 needs to be passed across with MCX ACS configured for ETSI regulatory domain using outdoor 5GHz channels with lowest CAC:

Meshconnex Policy, Access Point Profile and Device Override Example:

```
!
meshpoint BRIDGE
 meshid BRIDGE
 beacon-format mesh-point
 control-vlan 50
 allowed-vlans 50
 security-mode psk
 wpa2 psk 0 helloworld
 no root
!
profile ap7562 bridge-APs
 bridge vlan 10
  bridging-mode tunnel
 bridge vlan 20
  bridging-mode tunnel
 interface radio2
  meshpoint BRIDGE bss 1
  no dynamic-chain-selection
  no dfs-rehome
 interface ge1
  switchport mode trunk
  switchport trunk native vlan 50
  no switchport trunk native tagged
  switchport trunk allowed vlan 10,20,50
 interface ge2
 interface vlan50
  ip address dhcp
  ip dhcp client request options all
 meshpoint-device BRIDGE
  root
!
rf-domain APs
 timezone CET
 country-code cz
 channel-list dynamic
 channel-list 5GHz 100,104,108,112,116,132,136,140
!
ap7562 B4-C7-99-71-FC-F4
 use profile bridge-APs
 use rf-domain APs
 hostname ROOT
!
ap7562 B4-C7-99-71-FC-F4
 use profile bridge-APs
 use rf-domain APs
 hostname NONROOT
 meshpoint-device BRIDGE
  no root
!
```

Roaming Assist

Roaming Assistance is a feature in WiNG5 platform to address the issue of "sticky client":

- Some clients do not roam in spite of moving away from current AP
- This impacts their wireless experience negatively
- And also impacts clients nearby because they are wasting airtime (lower data rates and higher retries)

It is recommended to utilize Roaming Assist feature in Guest Access network environment when hundreds of unknown client types are present with different behavior, which might affect overall performance. Additionally, if using industrial grade mobile terminals that support 802.11k and 802.11v this feature can help to increase roaming effectiveness, as it utilized non-intrusive assisted roam action which is negotiated with the client according to 802.11v specification.

With roaming assist the client initially associates with an access point which it hears first or the access point with best signal strength. As soon as the wireless client moves away from the access point, its signal strength drops. Roaming Assistance keeps a continuous check on wireless clients by sampling the client's signal strength at configured intervals. Once the client's signal strength crosses the configured threshold, Roaming Assistance starts monitoring the client aggressively. If the client's signal strength is consistently below the threshold for a small interval, Roaming Assistance triggers an action to force a client to roam and directs the client to find the best AP. When the client now looks for an access point, only the access point with the minimum load and a minimum signal strength threshold will respond to the client. Roaming Assistance helps clients to initiate a roam as the signal strength degrades and find the best access point with which to associate.

Roam Assist feature has two different actions available to trigger once handoff-threshold is reached:

1. Legacy Roaming Assistance (action "**deauth**", pre-5.8.0)

   AP will send a de-authentication frame to the client, forcing it to find a better AP. While the client will move to the new AP eventually, this is not a roam (re-association), but a new association. Once client will receive the deauth frame all firewall sessions for this client will be purged by an AP. This type of handoff is intrusive and will break current sessions. It is not recommended to use in enterprise environment for corporate devices.

2. Assisted Roam (action "assisted-roam", post-5.8.0)

   Instead of sending a **de-authentication** message to the sticky client, the client is requested to perform a graceful roam using the 802.11v ***BSS Transition Management Request Action Frame*** to the client. The message provides a list of roam candidates to the client (candidate AP list is built from the 802.11k neighbor report).

   The Client has 3 choices:

   - Client can Accept the request and select an AP from the list provided in the transition request.
   - Accept the Transition request, but start its own roam scan to select an AP.
   - The client can Reject the request.

   If Client accepts the request it will then perform a graceful roam with no impact to the running sessions.

   Clients must support 802.11k and 802.11v to be able to fully leverage this feature. Client support can be checked by enabling `debug wireless client rasst level debug` on the Access Point. This mode is also backwards compatible to clients that do not support 802.11v and 802.11k:

```
DOT11: client:wireless client 40-83-DE-7C-43-1B changing state from [Data-Ready] to [Roaming]
(mgmt.c:591)
DOT11: rasst:MU doesnt support 802.11V Bss Transition :default action:Deauth (aroam.c:124)
DOT11: rasst:Handoff exceeded 40-83-DE-7C-43-1B on wlan 2 count 2 (aroam.c:92)
```

Roaming Assistance policy includes many configurable parameters but the most important ones are listed below. Default Roaming Assist policy contains recommended values, however handoff threshold must be based on the site survey data to ensure there is enough overlap to support -72 cell size (default handoff threshold), otherwise threshold value must be increased. It is also recommended to be a bit conservative and add another 3 dB to the handoff threshold of the actual cell overall, i.e. if the cell overlap is -67dBm, then handoff threshold should be set to -70 - 72dBm.:

```
!
roaming-assist-policy RASST
 aggressiveness medium-high
 sampling-interval 15
 monitoring-interval 5
 handoff-count 3
 detection-threshold -67
 handoff-threshold -72
 action assisted-roam
 disassoc-time 5
!
wlan LABS-GUEST
ssid GUEST
vlan $GUEST
bridging-mode local
encryption-type none
authentication-type none
radio-resource-measurement
802.11v bss-transition
assoc-response rssi-threshold -82
assoc-response deny-threshold 3
use roaming-assist-policy RASST
!
```

- **Detection threshold RSSI:** The detection threshold is the value at which the Roaming Assistance kicks in. If the wireless client's signal strength value crosses this detection threshold value, the Roaming Assistance starts monitoring the client aggressively.
- **Hand-off threshold RSSI:** This is the value which triggers an action (deauth or assisted-roam). When an access point monitors the client aggressively and senses that the client's signal strength is beyond this threshold value, it initiates a roam.
- **Hand-off threshold count:** If a client's signal strength consistently remains below hand-off threshold (-65 dBm) for more than 3 counts, as configured, roaming is initiated.
- **Aggressiveness:** How client Signal Quality is calculated. By default, it is based on average received signal as well as last received signal level, weighted towards last received value

On the WLAN, configure the minimum association signal threshold and deny threshold

- **Association response RSSI threshold:** (3 dB less than handoff threshold). The associate response RSSI means the access point will respond to wireless clients only if their signal strength is greater than -62 dBm. This ensures when the client roams from the current access point due to Roaming Assistance, the same access point does not respond back to the client's association request.

Migrating legacy installations to new 802.11ac Access Points

The following are industry best practices when migrating from any legacy installation to a new generation 802.11n/802.11ac Access Points:

- Use the 5GHz radio for sensitive voice over WLAN applications.

  The 2.4GHz ISM band is heavily used for non 802.11 RF that can prevent the 2.4GHz network from achieving the network latency and jitter requirements for voice applications. The result often is represented as poor voice quality or poor roaming performance. The underlying cause is radio transmission backoff as a result of RF noise on the same or adjacent channel. In any country or regulatory domain, the 5GHz band will provide significantly more non-overlapping channels than the 2.4GHz band. This ensures that non-adjacent and non-overlapping channels can be used to meet the latency and jitter requirements. If the desired voice application only runs on 2.4GHz band, use an AP with a three stream antenna system such as the AP 8132, or AP 7532.

- Architect the solution for a high AP density.

  Customers that are upgrading a network using the AP 300 or AP 5131 may assume that a newer AP will be a one-to-one replacement for the older technology. However, this is not the case. Over the years, regulatory bodies have adjusted the allowed limits for RF transmitters and the technology has undergone dramatic changes. A site survey will determine the actual AP density, but in general a newer 802.11n or 802.11ac. The target RSSI is -65dBm.

  Usually in low density deployments we will be looking at 5000sqft / 460sqm coverage areas, while a bit denser deployment for 5GHz and higher data-rates will have roughly 3500-4000sqft / 325-371sqm. For high density deployments with locationing services approximate numbers would be ranging from 2500-3000sqft / 232-278sqm. Please note that these values are only approximate and a site survey is always recommended.

- Conduct a thorough site survey of the RF environment.
- Make sure that wired infrastructure (access switches) provides 1Gbps uplinks to the Access Points, especially when migrating legacy 802.11a/b/g Access Points to newer 802.11ac. If a new Access Point deployment will push a lot of traffic, legacy FastEthernet switches will not be able to handle this amount of traffic. As a temporary workaround it is possible to assign rate-limiting per WLAN to make sure overall traffic will not exceed the capacity of a single 100Mbps switch port. Note that WLAN rate limit is per WLAN, not cumulative for all WLANs.:

  WLAN Rate Limit Example:

```
!
wlan-qos-policy rate-limit
 rate-limit wlan to-air
 rate-limit wlan to-air rate 51200
 rate-limit wlan from-air
 rate-limit wlan from-air rate 51200
 qos trust dscp
 qos trust wmm
!
wlan SecuredAccess
 ssid SecuredAccess
 vlan 3004
 bridging-mode local
 encryption-type ccmp
 authentication-type eap
 no answer-broadcast-probes
 radio-resource-measurement
 fast-bss-transition
 802.11v bss-transition
 use wlan-qos-policy rate-limit
 use aaa-policy TME-DC-1
 use ip-access-list out BC-MC-CONTROL_PLUS_VOIP
 use mac-access-list out PERMIT-ARP-AND-IPv4
!
```

A site survey will encompass three distinct phases:

- **Site scan**: The site scan will determine the noise level and utilization across all channels in the band. Pick five locations around the environment and capture packets for at least five minutes on all channels and all bands for that location. Characterize the resulting noise in terms of average and peak utilization on each channel, received noise floor, number of stations and number of clients on each channel. Filter the site scan data so that the current network can be distinguished from the background RF signals. The new APs will need to support the current network and avoid contention from background RF signals.
- **Site Survey**: Set the site survey software to only scan the channels that you are using during the site survey. Since the site survey software must dwell on each channel for approximately 200ms, scanning all possible channels will result in a significant reduction in the quality of the data. The output of the site survey is a heat map showing the AP signal levels (RSSI), and SNR.

Survey both 2.4GHz and 5GHz bands. Make sure to use more capture points to get reliable results from the Site Survey software.

- **Performance test**: Once the site survey is done, locate the areas at the edges of the coverage and conduct performance tests using a device that will be typical in the use case. iPerf running on a wired client and running on a common tablet device may be an effective tool. The tested value will not match the maximum throughput of the AP, but will be accurate for the test environment and devices.

Note
Always account for external antenna gain when doing a migration or a new installation. APs with Internal Antennas have antenna gain hardcoded in the software, so it will be automatically deducted during the EIRP calculation. Also when migrating from legacy 802.11a/b/g infrastructure note that new generation 802.11n/802.11ac Access Points also subtract MIMO gain (based on the number of transmit chains) when setting up power values.

Smart RF

Calibration

Running Smart-RF calibration manually is not recommended in WiNG 5. During normal operation it is recommended that you allow Smart-RF to converge on its own. If you need to re-run Smart-RF in an an environment where Smart-RF is already running, use the **`service smart-rf clear-config`** command. It will take 5 to 10 minutes for Smart-RF to re-converge and assign the new channel and transmit power values.

Clearing Smart-RF Configuration Example:

```
VX9000#service smart-rf clear-config on <RF-Domain Name>
```

Channels and TX Power Assignments

WiNG 5 allows Access Point channel and transmit power values to be assigned to Access Point radios using static configuration or Smart-RF. It is recommended to use Smart-RF whenever possible.

The following is a list of recommendations for optimum Channel and Transmit Power assignments:

3. The use of Smart-RF requires that a Smart-RF Policy be assigned to each RF Domain. By default, Access Points will use ACS (Automatic Channel Selection) and maximum transmit power which should be avoided.
4. The minimum transmit power range needs to be defined based on a physical site survey. By default, the minimum transmit power is 4 and for a lot of sites this will not be an ideal value. For high density deployments minimum/maximum values will usually be configured as 8/11 dBm or 11/14 dBm respectively. For low density environments it may be beneficial to set the power statically to 17dBm and keep channel selection to smart.
5. The Access Point radios should also not be assigned the maximum transmit power. If the Access Point radios are operating at maximum power, Smart-RF will have no room to perform recovery operations.
6. By default, Smart-RF will use all the available regulatory channels based on the assigned country code. For 5GHz operation it is recommended that you select a channel-list that does not include DFS channels whenever possible.
7. If Access Points are assigned to different Floors and / or Areas, it is recommended to use Smart- RF grouping based on areas or floors. Usually only grouping by floor will be required indoors, while grouping by area will be used outdoors.

Note

For retail distribution center type deployments, the ideal minimum value for Smart-RF power is typically 8dBm with high AP density environments. For retail store deployments (especially with high Access Point density), the default minimum power value (4dBm) is not ideal.

Coverage Hole Recovery

The coverage hole recovery feature is required only for deployments where Access Point density/overlap is not optimal and there could be potential coverage holes in the network. In most cases these situations arise when customers perform a one for one Access Point replacement from a legacy low density 802.11b or 802.11bg deployments.

If the client density is high, it is recommended that you increase the coverage hole recovery client threshold. Using the default values will initiate coverage hole recovery if one client is below the SNR threshold.

For greenfield or new replacements performed using a site survey with -65dBm or -70dBm coverage requirement with 15 to 20% overlap, the coverage hole recovery feature is not required. If enabled, it should be configured with a client threshold of 3 to 5 clients.

Smart Off Channel Scanning (OCS)

For retail deployments with handheld devices using terminal emulation applications such as wave-link, it is recommended to use the **`smart-ocs-monitoring <band> power-save-aware strict`** mode.

Please be aware that setting Power-Save-Aware checks to strict will prevent radio to perform off channel scan when any client with Power Save enabled is associated (which means almost any client today, since most of them have some sort of PS enabled by default). It is possible to configure awareness-override to ignore those checks at either specified time slot/day of the week:

Smart-RF Smart Off Channel Scanning Example:

```
VX9000(config-smart-rf-policy-default)#smart-ocs-monitoring power-save-aware 2.4GHz strict
```

Smart-RF Smart Off Channel Scanning Awareness Override example:

```
VX9000(config-smart-rf-policy-default)#smart-ocs-monitoring awareness-override schedule 1 00:00
06:00 sat,sun
```

Example Smart-RF Policy

Smart-RF Policy Example for Retail Store with US country code:

```
!
smart-rf-policy STORES
 sensitivity custom
 assignable-power 5GHz min 14
 assignable-power 2.4GHz min 8
 channel-list 5GHz 36,40,44,48,149,153,157,161,165
 channel-width 5GHz 20MHz
 smart-ocs-monitoring sample-count 5GHz 10
 smart-ocs-monitoring sample-count 2.4GHz 15
 coverage-hole-recovery snr-threshold 5GHz 18
 coverage-hole-recovery snr-threshold 2.4GHz 18
 neighbor-recovery dynamic-sampling
!
```

Smart-RF Policy Example for Low Density Deployments:

```
!
smart-rf-policy CAMPUS
 sensitivity custom
 assignable-power 5GHz max 20
 assignable-power 5GHz min 17
 assignable-power 2.4GHz min 14
 assignable-power 2.4GHz max 17
 channel-list 5GHz 36,40,44,48,149,153,157,161,165
 smart-ocs-monitoring sample-count 5GHz 10
 smart-ocs-monitoring sample-count 2.4GHz 15
 smart-ocs-monitoring awareness-override schedule 1 23:00 04:00 all
 coverage-hole-recovery snr-threshold 5GHz 20
 coverage-hole-recovery snr-threshold 2.4GHz 20
 coverage-hole-recovery client-threshold 2.4GHz 3
 neighbor-recovery dynamic-sampling
!
```

For additional tweaking of the Smart RF policy it is advised to export the smart rf report for a particular RF-domain, which will provide details about the RF environment. CLI syntax to generate the report is:

Generate Smart RF Report example command syntax:

```
nx9500-1#remote-debug copy-smart-rf-report rf-domain <RFD Name> write
ftp://user:password@ftp.site.com/reports-folder/
```

Mobility

Seamless Roaming Checklist

For seamless wireless client roaming and handoff following items must be ensured:

- Sufficient coverage cell overlap, i.e. the worst client should hear an AP at least at -67dBm.
- Key Caching must be enabled on the WLAN for secure fast roaming. OKC and PMK caching is enabled by default. It is recommended to enable 802.11r (fast-bss-transition) when clients support it.
- WNMP roaming notifications are responsible for updating wired infrastructure MAC address tables, as well as key cache exchange between the Access Points. It is important to ensure that:

For locally bridged WLANs:

- DST MAC `01:A0:F8:F0:F0:04` (WNMP roam notification) is allowed on the wired switches for all user VLANs, at least on the switchports going out to the APs.

For tunneled VLANs:

- DST MAC `01:A0:F8:F0:F0:04` (WNMP roam notification) is allowed on the wired switches for all user VLANs, on the switchports going out to the controllers.
- In case with MiNT level 2 tunneling and controller-managed RF Domains in a campus deployment "mint inter-tunnel-bridging" should be enabled only on the controller side to allow passing WNMP roam notifications between multiple MiNT tunnels. It must not be enabled in NOC deployments.
- In case with L2TPv3 tunnels from every AP back to the controllers, "`l2tpv3 inter-tunnel-bridging`" must be enabled on the controller side to allow passing of WNMP messages. It is not required when each remote site is tunneling via an RF Domain Manager.
- Wireless Firewall is enabled for client session migration to work. Additionally, for this feature to work Access Points must be able to discover each other over MiNT either at level 1 or level 2.

Wireless Client Credential Cache

For public Wi-Fi deployments with thousands of new clients seen every day it is recommended to reduce the default age-out of the credential cache for the wireless clients from 24 hours to 30 minutes:

```
!
wlan Guest-WiFi
 ssid Guest-WiFi
 vlan $GUEST
 bridging-mode local
 encryption-type none
 authentication-type mac
 wireless-client cred-cache-ageout 1800
 radio-resource-measurement
 client-load-balancing
 client-load-balancing max-probe-req 2.4ghz 10
 client-load-balancing band-discovery-intvl 5
 use aaa-policy ONBOARD-VX
 use captive-portal Z-GUEST
 captive-portal-enforcement fall-back
 registration device-OTP group-name GUESTS expiry-time 4320 agreement-refresh 30
 use ip-access-list out BROADCAST-MULTICAST-CONTROL
 use mac-access-list out PERMIT-ARP-AND-IPv4
 proxy-arp-mode strict
 broadcast-dhcp validate-offer
 service monitor dhcp crm DHCP-SERVER vlan 1000
 no nsight client-history
!
```

Current Credential Cache entries may be seen using the following command. This information can be useful to identify which fast roaming mechanisms are currently used by a client and which keys / VLAN info are stored on the Access Point:

```
VX-1#service show wireless credential-cache on <AP Hostname>
  #    Client          PMK PTK  FT  MAC-AUTH LA  WLAN          VLAN   Expires in
  0    40-83-DE-73-1E-54 N   N   Y     N      N  SecuredAccess   10   0 days 08:38.18
  1    C8-69-CD-06-8B-50 N   N   N     N      N  ccast            1   0 days 08:14.07
  2    CC-C7-60-1C-AB-C8 N   N   N     N      N  ccast            1   0 days 08:16.51
  3    FC-F8-AE-35-30-FE Y   Y   N     N      N  tls             10   0 days 08:53.44
  4    30-A8-DB-64-25-59 N   N   Y     N      N  SecuredAccess   10   0 days 09:28.12
  5    64-BC-0C-6A-D9-5B Y   Y   N     N      N  SecuredAccess   10   0 days 19:31.55
```

Captive Portal

Captive Portal Service

One common mistake with Captive Portal deployments is to not assign the Captive Portal service to the device(s) that are providing the capture and redirection or assigning the Captive Portal service to the wrong device:

- When the Captive Portal is operating on one or more Access Points at a site (“self” mode), the Captive Portal service must be assigned to the Access Points Profile or to individual Access Points as Overrides.
- When the Captive Portal service is operating on one or more centralized Wireless Controllers (“centralized” or “centralized-controller” mode), the Captive Portal service must be assigned to the Wireless Controllers Profile or to individual Wireless Controllers as Overrides.

When *centralized-controller* mode is enabled, ensure that both the Wireless Controllers have the Captive Portal service enabled.

Wireless Controller Profile Example:

```
!
profile rfs6000 tmelabs-rfs7000
 ip name-server 192.168.10.6
 ip domain-name tmelabs.local
 ...
 use management-policy tmelabs
 use firewall-policy default
 use auto-provisioning-policy tmelabs
 use captive-portal server <captive-portal-policy-name>
 ntp server 192.168.10.6
 no auto-learn-staging-config
 service pm sys-restart
!
```

When Internal (Self) mode is enabled, ensure that Access Point profile has the Captive Portal service enabled.

Access Point Profile Example:

```
!
profile anyap remote-APs
 ...
 use management-policy aps
 use firewall-policy default
 use captive-portal server <captive-portal-policy-name>
 service pm sys-restart
!
```

Captive Portal Firewall Policy

The layer 3 firewall must be enabled on the Access Points for the capture and redirection to function. If the layer 3 firewall is disabled, the captive portal will not work. The layer 2 stateful packet inspection firewall may however be disabled if required.

Firewall Policy Example:

```
!
firewall-policy default
 no stateful-packet-inspection-l2
!
```

Captive Portal Firewall Rules

When firewall rules are assigned to the Captive Portal enabled Wireless LAN, the firewall policies need to permit TCP port 880 or 443 for the Captive Portal to function. By default, a Captive Portal operating in HTTP mode will use TCP port 880 while a Captive Portal operating in HTTPS mode will use TCP 443. In addition, ensure that DHCP, DNS and other required ports are permitted.

IP Access Control List Example:

```
!
ip access-list guests
 permit tcp any host 192.168.20.22 eq 880 rule-precedence 20
 permit tcp any host 192.168.20.23 eq 880 rule-precedence 21
 permit tcp any host 1.1.1.1 eq 880 rule-precedence 22
 permit udp any any eq dns rule-precedence 30
 permit udp any eq 68 any eq dhcps rule-precedence 31
 permit tcp any any eq www rule-precedence 32
 permit tcp any any eq https rule-precedence 33
 deny ip any any log rule-precedence 100
!
```

Note that in case Captive Portal service is running directly on the Access Point (self mode) redirection happens to a virtual IP address of 1.1.1.1 if an Access Point does not have an SVI in the User VLAN. In case an SVI exists in the User VLAN with an IP address, then the real IPv4 address will be used for capture & redirection.

If no firewall rules are applied, by default for non-authenticated users the Wireless Controller or Access Points will only permit DHCP, DNS and traffic destined to the Captive Portal service. Once authenticated the Captive Portal users will be provided full access to the network.

Captive Portal Server Cluster Failover

It is recommended to use the captive portal centralized-controller mode when using with cluster of Wireless Controllers to host Captive Portal server. This provides failover in the event of a primary Wireless Controller failure. When using the centralized-controller mode you must enter a complete FQDN. The hostname must be a unique value that is unresolvable from DNS.

Captive Portal Policy Example:

```
!
captive-portal tmelabs-guests
 server host portal.tmelabs.local
 server mode centralized-controller
 use aaa-policy internal-aaa
!
```

Externally Hosted Pages & 3rd Party Captive Portals

When configuring external web-pages the complete URL for each externally hosted page must be defined. In addition, a DNS whitelist policy will also need to be created and assigned to the Captive Portal policy which includes webserver's IP address or fully qualified domain name (FQDN). Failure to create and assign a DNS whitelist policy will result in the wireless users not being able to reach the external webserver.

Note
For DNS whitelist to function DNS ALG must be enabled in the firewall configuration.

DNS Whitelist & Captive Portal Policy Examples:

```
!
 dns-whitelist tmelabs-guests
  permit company.com suffix
!
captive-portal tmelabs-guests
 server host portal.tmelabs.local
 server mode centralized-controller
 webpage-location external
 webpage external login http://login.company.com /<login-page-name>
 webpage external welcome http://welcome.company.com/<welcome-page-name>
 webpage external fail http://fail.company.com/fail-page-name>
 use aaa-policy internal-aaa
 use dns-whitelist tmelabs-guests
!
```

Customizing Pages

When customizing the agreement, failed, login, welcome or registration pages it is important to include the necessary java scripting from the default pages. When creating customized pages, it is recommended that you use the default pages as a reference:

1. First create a Captive Portal policy using the default parameters. Make sure the operating mode (i.e. HTTP or HTTPS) is set to match how you plan on implementing the Captive Portal.
2. Assign the Captive Portal policy to the Wireless Controller. This will create a copy of the default pages on the Wireless Controller which are located in the flash:/hostspot/<captive-portal-name> directory.
3. Copy the default pages to an external TFTP or FTP server.
4. For each customized page ensure the appropriate java scripts are included. Java scripts will be located at the top and bottom of some pages.

When hosting the customized login pages on a Wireless Controller or Access Point, ensure the web-page location is set to Advanced. Otherwise the customized login pages will be overwritten by the default pages when any changes are made to the Captive Portal policy. For detailed information refer to "*WiNG5 Integrating with 3rdParty CaptivePortal*" HowTo Guide.

“No service” page for captive portal

By default, the failure page is only displayed if the Access Point (or Wireless Client) can reach a DNS server. Starting WING 5.5.5 addresses the issue with DNS reachability and provides option to configure DNS Server monitoring.

Note
“No Service” page must always be internal on the WiNG 5 device hosting Captive Portal server.

DNS Critical Resource Monitoring for No Service Page:

```
!
profile ap7532 Branch-1
 ...
 interface radio1
  wlan GUEST bss 1 primary
 interface radio2
  wlan GUEST bss 1 primary
 critical-resource DNS monitor direct any sync-adoptees 192.168.10.5
!
wlan GUEST
 ssid GUEST
 vlan 10
 bridging-mode local
 encryption-type none
 authentication-type none
 use captive-portal PORTAL
 captive-portal-enforcement fall-back
 service monitor dns crm DNS vlan 1000
!
```

This service command will monitor DNS server reachability. When DNS server is not reachable, the clients are moved to failover-vlan.

In the failover-vlan every time DNS request comes from captive portal clients, they are redirected to no-service page since DNS server is not reachable. No-service page must always be an internal page either on the Access Point or Wireless Controller.

In case of an extended VLAN, CRM for service monitor should be configured on the controller with sync-adoptees option under critical resource configuration. Any CRM state changes would be forwarded to the adopted devices which would redirect the wireless clients on the WLAN to no-service page in case the monitored CRM is down.

Wireless Firewall & Security

Stateful Packet Inspection Firewall

For a distribution center type environment with a lot of handheld devices and roaming, for application performance we would recommend disabling the layer 2 stateful packet inspection firewall:

Firewall Policy Example:

```
!
firewall-policy default
 no stateful-packet-inspection-l2
!
```

The stateful packet inspection firewall has different knobs for different types of attacks. Each one can be enabled / disabled depending on customer needs and configuration.

Note that it is not recommended to disable **`proxy-arp`** as it helps reducing overall amount of Broadcast traffic on the network. It is enabled by default.

If the **`ip-mac conflict`** error is frequently seen and customer has verified that the DHCP servers are configured correctly on the network and same IP address isn't provided to multiple host devices, it's possible that ICMP redirects, routers running VRRP / HSRP or proxy devices on the network are causing the error. This can be remedied by applying following to firewall policy in use:

Firewall Policy Example:

```
!
firewall-policy default
 no ip-mac conflict
 no ip-mac routing conflict
!
```

If the **`service pktcap on drop`** command is showing packets are being dropped by a Wireless Controller or Access Point due to an IPSPOOF attack, the **`no ip dos`** command in the firewall policy servicing the affected devices will disable all DoS detection events:

Firewall Policy Example:

```
!
firewall-policy default
 no ip dos smurf
 no ip dos twinge
 no ip dos invalid-protocol
 !
 ! Configuration Removed for Brevity
 !
!
```

Note

Disabling Firewall completely in WiNG 5 is not recommended and not supported, as most of the features require firewall to be on.

Recommended Firewall Policy Configuration:

```
!
firewall-policy default
 no ip dos
 no ip-mac conflict
 no ip-mac routing conflict
 dhcp-offer-convert
 no ipv6 strict-ext-hdr-check
 no ipv6 unknown-options
 no ipv6 duplicate-options
 no ipv6 option strict-hao-opt-check
 no ipv6 option strict-padding
 no stateful-packet-inspection-l2
 no ipv6-mac conflict
 no ipv6-mac routing conflict
!
```

IP and MAC Access Lists

It is always recommended to limit amount of Broadcast / Multicast traffic in the air. For this purpose, default Access Lists can be utilized for each WLAN outbound direction. These ACLs will limit amount of unneeded broadcast/multicast traffic hitting the air. In case some multicast addresses must be allowed in the air (e.g. Video streaming or PTT), these ACLs may be adjusted according to the particular use-case:

Recommended WLAN ACL assignments:

```
!
ip access-list BROADCAST-MULTICAST-CONTROL
 permit tcp any any rule-precedence 10 rule-description "permit all TCP traffic"
 permit udp any eq 67 any eq dhcpc rule-precedence 11 rule-description "permit DHCP replies"
 permit ip any 239.0.0.0/24 rule-precedence 19
 deny udp any range 137 138 any range 137 138 rule-precedence 20 rule-description "deny windows  netbios"
 deny ip any 224.0.0.0/4 rule-precedence 21 rule-description "deny IP multicast"
 deny ip any host 255.255.255.255 rule-precedence 22 rule-description "deny IP local broadcast"
 permit ip any any rule-precedence 100 rule-description "permit all IP traffic"
!
mac access-list PERMIT-ARP-AND-IPv4
 permit any any type ip rule-precedence 10 rule-description "permit all IPv4 traffic"
 permit any any type arp rule-precedence 20 rule-description "permit all ARP traffic"
!
 wlan DOT1X-CORP
 ssid DOT1X-CORP
 vlan 10
 bridging-mode local
 encryption-type ccmp
 authentication-type eap
 no answer-broadcast-probes
 use aaa-policy extEAP
 use ip-access-list out BROADCAST-MULTICAST-CONTROL
 use mac-access-list out PERMIT-ARP-AND-IPv4
!
```

In some cases, it is required to filter out unneeded traffic at the GE1 port of the Access Point before it will be processed by the AP. This may be needed in the environment with a lot of Windows-based clients with IPv6 enabled where IPv6 is not used in production, which is causing a lot of unneeded Multicast traffic to be generated on the network. In that case default MAC Access List should be enhanced to allow Layer 2 MINT and WNMP Ether Types:

MAC ACL to be assigned to the Access Point GE1 port:

```
!
mac access-list PERMIT-ARP-AND-IPv4
 permit any any type ip rule-precedence 10 rule-description "permit all IPv4 traffic"
 permit any any type arp rule-precedence 20 rule-description "permit all ARP traffic"
 permit any any type mint rule-precedence 30 rule-description “permit all MINT traffic”
 permit any any type 34689 rule-precedence 40 rule-description “permit WNMP roam notifications”
!
profile ap8533 Branch-8533
 ...
 interface ge1
  switchport mode trunk
  switchport trunk native vlan 1
  no switchport trunk native tagged
  switchport trunk allowed vlan 1-30
  use mac-access-list in PERMIT-ARP-AND-IPv4
 interface ge2
 interface pppoe1
 use firewall-policy default
 service pm sys-restart
  router ospf
!
```

In scenarios when user traffic is tunneled via MINT to the Controller it might be desirable to block all unwanted Broadcast and Multicast traffic at the AP side, before the traffic will go into the tunnel. In that case only WNMP will need to be added to default MAC Access List, which will be then assigned to the Bridge VLAN context under the AP Profile:

MAC ACL to be assigned to the Access Point Bridge VLAN (for each Extended VLAN):

```
!
mac access-list PERMIT-ARP-AND-IPv4
 permit any any type ip rule-precedence 10 rule-description "permit all IPv4 traffic"
 permit any any type arp rule-precedence 20 rule-description "permit all ARP traffic"
 permit any any type 34689 rule-precedence 40 rule-description “permit WNMP roam notifications”
!
profile ap8533 Branch-8533
 ...
 bridge vlan 999
  bridging-mode tunnel
  tunnel-over-level-2
  use mac-access-list tunnel out PERMIT-ARP-AND-IPv4
 interface ge2
 interface pppoe1
 use firewall-policy default
 service pm sys-restart
  router ospf
!
```

If **Aliases** are used to configure IP or MAC Firewall rules one needs to take rule limits into account carefully:

The maximum number of rules configurable in the Access List is 500. Using Aliases does not increase this limit by summarizing multiple hosts, ports or networks into one rule and as such can lead to low memory issues and system crashes on the Access Points.

For example, two network-group aliases are defined - one to include 5 network subnets and one to define 2 subnets that belong to corporate resources and one network-service alias which defines a specific set of destination ports allowed:

```
!
 alias network-group $CORPORATE-USERS network 10.1.1.0/24 10.2.1.0/24 10.5.1.0/24 192.168.10.0/24
10.10.0.0/16
 alias network-group $CORPORATE-SERVERS network 172.16.10.0/23 172.16.20.0/23
 alias network-service $CORPORATE-PORTS proto tcp 3005 3006 proto tcp 8443 8000 proto tcp 5353 443 proto
tcp 80 8088
!
ip access-list CORP-ACCESS
 permit $CORPORATE-PORTS $CORPORATE-USERS $CORPORATE-SERVERS log rule-precedence 10 rule-description “CORP-
USERS-ALLOWED”
!

$CORPORATE-USERS = 5 subnets
$CORPORATE-PORTS = 8 ports
$CORPORTATE-SERVERS = 2 networks
```

One single IP ACL rules above would actually result in 8 x 5 x 2 = 80 rules in the IP Access List.

To make sure the total number of rules does not exceed the 500 rule limit it is possible to check device proc table directly or using a remote debug feature:

```
more system:/proc/dataplane/fw/map_acl_name
more system:/proc/dataplane/fw/acl/<acl#>

remote-debug more hosts <hostname> path system:/proc/dataplane/fw/map_acl_name
remote-debug more hosts <hostname> path system:/proc/dataplane/fw/acl/<acl#>
```

Enforce DHCP and Strict Proxy ARP

For a Guest WiFi networks it is recommended to block all wireless clients with static IP addresses, as well as enable strict proxy ARP to reduce overall amount of unneeded broadcast traffic coming from the wired side.

Enforce DHCP is utilizing DHCP snooping functionality of the wireless firewall to detect whether a wireless client has completed a DHCP handshake to confirm that it is using dynamically assigned IP address.

Strict Proxy ARP will block forwarding of ARP requests from the wired side to the wireless if the IP/MAC combination is not known by the Access Point. This is typically not desired when wireless clients with static IP addresses are present, but should be enabled as a security measure on Guest WiFi networks:

```
!
wlan Guest-WiFi
 ssid Guest-WiFi
 vlan $GUEST
 bridging-mode local
 encryption-type none
 authentication-type mac
 wireless-client cred-cache-ageout 1800
 radio-resource-measurement
 client-load-balancing
 client-load-balancing max-probe-req 2.4ghz 10
 client-load-balancing band-discovery-intvl 5
 use aaa-policy ONBOARD-VX
 use captive-portal Z-GUEST
 captive-portal-enforcement fall-back
 registration device-OTP group-name GUESTS expiry-time 4320 agreement-refresh 30
 use ip-access-list out BROADCAST-MULTICAST-CONTROL
 use mac-access-list out PERMIT-ARP-AND-IPv4
 enforce-dhcp
 proxy-arp-mode strict
 service monitor dhcp crm DHCP-SERVER vlan 1000
 no nsight client-history
!
```

Secure MINT Key

Whenever any sensitive information is being exchanged between WiNG devices, such as secrets, username and passwords, secure mint key is used to encrypt this content. It is recommended to change the default mint encryption key *on both AP and Controller profile* to prevent any attacks using default key values:

```
!
profile vx9000 default-vx9000
 service wireless inter-ap-key 2 aTYNPlYxqY0Ruy6wer2qYwAAAAydMHQ65uGhOJqxaZzec4gy
 no autoinstall configuration
 no autoinstall firmware
 no device-upgrade auto
 use radius-server-policy NOC
 file-sync auto
 crypto ikev1 policy ikev1-default
  isakmp-proposal default encryption aes-256 group 2 hash sha
 crypto ikev2 policy ikev2-default
  isakmp-proposal default encryption aes-256 group 2 hash sha
 crypto ipsec transform-set default esp-aes-256 esp-sha-hmac
 crypto ikev1 remote-vpn
 crypto ikev2 remote-vpn
 crypto auto-ipsec-secure
 crypto load-management
 crypto remote-vpn-client
 interface xge1
 interface xge2
 interface xge3
 interface xge4
 interface ge1
 interface ge2
 use guest-management GM
 use firewall-policy default
 use auto-provisioning-policy NOC
```

```
 logging on
 service pm sys-restart
 router bgp
 controller adopted-devices aps controllers
 adoption-mode controller
!
```

Firmware Upgrades

Centrally Managed Environments

When upgrading Access Points in large centrally managed distributed environments, it is recommended that the **device-upgrade** command be utilized to perform the upgrade. By default, after a Controller is upgraded to a new release, the remote Access Points will individually download their new firmware upon re-adoption. The maximum number of simultaneous upgrades a Controller can support is 20.

To optimize WAN bandwidth and streamline the upgrade process for large centrally managed deployments it is recommended that:

1. Automatic AP upgrades be disabled on the Controller profile prior to reloading the Controllers with the new firmware release with command “no device-upgrade auto”
2. The **device-upgrade** command can be utilized to initiate the upgrade via the elected RF Domain Managers at each remote site.
3. Optionally **device-upgrade** command may be used in combination with either option **no-reboot** to prevent automatic reboot after upgrade or **staggered-reboot** to reboot APs one by one at the site to minimize the impact. However please note that **staggered-reboot** may take considerable amount of time as it reboots only one AP at a time and waits till this AP boots up and readopts.
4. Use **reload on <RF DOMAIN> exclude-controllers** command to reboot all APs at specific RF-domain, in case **no-reboot** option has been used during the device upgrade.
5. In MeshConnex deployments it is always recommended to upgrade Non-Root APs first, hence using **device-upgrade rf-domain <RF DOMAIN> containing <name substring>** will ensure that only APs containing specified string in the hostname will be upgraded.
6. Assuming proper naming is in place to distinguish between Root and Non-Root APs example below shows the syntax for this use-case:

```
nx9500-1#device-upgrade rf-domain remote-1 containing non-root
```

Using this methodology allows up to 20 x remote sites to be simultaneously upgraded vs. 20x individual Access Points.

Clearing manually loaded device images from the Controller

In case network administrator had manually loaded any AP or controller image to the NOC controller via device-upgrade load-image command, those images will not be automatically cleared upon controller upgrade. They will be stored inside the flash:/upgrade/ directory and can be deleted if needed to free up flash storage via command syntax delete flash:/upgrade/<image name>.img, for example:

Deleting Previously Loaded Images on the Controller:

```
rfs4000-1#delete flash:/upgrade/khepri.img
```

Slow WAN Links

When performing manual firmware upgrades over slow WAN links, it is recommended that you increase the **idle-sessions-timeout** parameter in the management policy to a higher value. By default, the idle timeout value is set to 30 minutes and the telnet, SSH or HTTP(s) session may timeout if the manual firmware upgrade exceeds 30 minutes. Increasing this value allows the management session to be maintained for longer periods allowing a manual firmware upgrade to be completed.

Increasing the Idle Session Timeout Interval:

```
(config-management-policy-<name># idle-session-timeout <value>
```

Please note that this parameter will only be applied to new telnet, SSH or HTTP(s) management sessions. Once this value is changed you will need to close your existing management session and restart a new management session.

NSight

Standalone NSight Deployment

Standalone NSight server does not manage any configuration from any remote site or controller, as well as it does not adopt any Access Points. Instead standalone NSight server receives configuration information as part of the nsight statistics update.

On the WiNG controller that is reporting stats to the NSight (either standalone site controller or NOC controller managing multiple remote sites), make sure that controller adoption is disabled to allow posting of site tree information. By default, it is enabled on RFS controllers and NX55/45/65:

```
!
profile rfs6000 rfs6k
 no autoinstall configuration
 no autoinstall firmware
 crypto ikev1 policy ikev1-default
  isakmp-proposal default encryption aes-256 group 2 hash sha
 crypto ikev2 policy ikev2-default
  isakmp-proposal default encryption aes-256 group 2 hash sha
 crypto ipsec transform-set default esp-aes-256 esp-sha-hmac
 crypto ikev1 remote-vpn
 crypto ikev2 remote-vpn
 crypto auto-ipsec-secure
 crypto remote-vpn-client
 interface me1
 interface up1
 interface ge1
 interface ge2
 interface ge3
 interface ge4
 interface ge5
 interface ge6
 interface ge7
 interface ge8
 interface wwan1
 interface pppoe1
 use firewall-policy default
 service pm sys-restart
 no controller adoption
!
```

NSight Client History

For public Guest WiFi deployments with thousands of new clients seen every day/hour it is recommended to keep guest clients information on NSight for much shorter period of time. By default, all client information will be stored for a period of 180 days, which is controlled by “history-ttl clients <>” parameter under nsight-policy on the sever.

It is possible to have a special “guest-clients” data retention time period, which is set to 8 hours by default by simply adding the following line to the Wireless LAN configuration:

```
!
wlan Guest-WiFi
 ssid Guest-WiFi
 vlan $GUEST
 bridging-mode local
 encryption-type none
 authentication-type mac
 radio-resource-measurement
 client-load-balancing
 client-load-balancing max-probe-req 2.4ghz 10
 client-load-balancing band-discovery-intvl 5
 use aaa-policy ONBOARD-VX
 use captive-portal Z-GUEST
 captive-portal-enforcement fall-back
 registration device-OTP group-name GUESTS expiry-time 4320 agreement-refresh 30
 use ip-access-list out BROADCAST-MULTICAST-CONTROL
 use mac-access-list out PERMIT-ARP-AND-IPv4
 proxy-arp-mode strict
 broadcast-dhcp validate-offer
 service monitor dhcp crm DHCP-SERVER vlan 1000
 no nsight client-history
!
```

On the NSight server it is possible to further tweak data retention time for guest vs corporate clients:

```
!
nsight-policy STD
 nsight-server standalone
 no nsight-server smtp-report-delivery
 history-ttl devices 180
 history-ttl clients 180   << age-out for corporate clients in days
 history-ttl guest-clients 8  << age-out for guest clients in hours
 event-history-size low
!
```

Upgrading NSight Server

Upgrade process for the NSight server is different to a standard WiNG controller:

For the Replica-Set Deployments:

- Backup the database:

```
NSIGHT-PRIMARY#database-backup database nsight
<ftp|sftp>://<user>:<passwd>@<hostname|IP>[:port]/path/file.tar.gz
```

- Wait until backup is finished monitoring the logs or event history:

```
NSIGHT-PRIMARY : %DATABASE-6-OPERATION_COMPLETE: backup for database nsight successful
```

- Upgrade NSight server on all replica-set members, do NOT reboot the devices.
- Stop NSight server on both primary and secondary replica-set members:

```
NSIGHT-PRIMARY#conf
NSIGHT-PRIMARY(config)#nsight-policy STD
NSIGHT-PRIMARY(config-nsight-policy-STD)#no enable
NSIGHT-PRIMARY(config-nsight-policy-STD)#commit write

NSIGHT-SECONDARY#conf
NSIGHT-SECONDARY(config)#nsight-policy STD
NSIGHT-SECONDARY(config-nsight-policy-STD)#no enable
NSIGHT-SECONDARY(config-nsight-policy-STD)#commit write
```

- Reboot the primary replica-set member and wait for the device to come up and join the replica-set. Watch using show database status:

```
NSIGHT-PRIMARY#show database status
--------------------------------------------------------------------------------
        MEMBER              STATE                    ONLINE TIME
--------------------------------------------------------------------------------
  172.31.0.49*          PRIMARY           0 hours 5 min 12 sec
  172.31.2.248          SECONDARY         2 days 20 hours 4 min 52 sec
  172.31.5.121          ARBITER           2 days 19 hours 59 min 14 sec
--------------------------------------------------------------------------------
[*] indicates this device.
```

- Reboot the secondary replica-set member and wait for the device to come up and join the replica-set. Watch using show database status
- Reboot the arbiter replica-set member and wait for the device to come up and join the replica-set. Watch using show database status
- Enable NSight server on both primary and secondary. Verify using “show nsight status”

```
NSIGHT-PRIMARY#conf
NSIGHT-PRIMARY(config)#nsight-policy STD
NSIGHT-PRIMARY(config-nsight-policy-STD)#enable
NSIGHT-PRIMARY(config-nsight-policy-STD)#commit write

NSIGHT-SECONDARY#conf
NSIGHT-SECONDARY(config)#nsight-policy STD
NSIGHT-SECONDARY(config-nsight-policy-STD)#enable
NSIGHT-SECONDARY(config-nsight-policy-STD)#commit write

NSIGHT-PRIMARY#show nsight status
 Nsight is enabled
 Nsight report and aggregation daemon is running
 Nsight alarm daemon is running
 Nsight server daemon is running
 Database server is local
 Database server is reachable
```

For the Standalone Server Deployments:

- Backup NSight database:

```
NSIGHT#database-backup database nsight
<ftp|sftp>://<user>:<passwd>@<hostname|IP>[:port]/path/file.tar.gz
```

- Wait until backup is finished monitoring the logs or event history:

```
NSIGHT: %DATABASE-6-OPERATION_COMPLETE: backup for database nsight successful
```

- Upgrade the NSight server, do NOT reboot the device.
- Stop the NSight server:

```
NSIGHT#conf
NSIGHT(config)#nsight-policy STD
NSIGHT(config-nsight-policy-STD)#no enable
NSIGHT(config-nsight-policy-STD)#commit write
```

- Reboot the NSight server and wait for the device to come up and start the database. Watch using show database status

```
NSIGHT#show database status
--------------------------------------------------------------------------------
        MEMBER             STATE                      ONLINE TIME
--------------------------------------------------------------------------------
  localhost           PRIMARY           0 days 0 hours 5 min 32 sec
--------------------------------------------------------------------------------
[*] indicates this device.
```

- Start the NSight server and verify using show nsight status:

```
NSIGHT#conf
NSIGHT-PRIMARY(config)#nsight-policy STD
NSIGHT-PRIMARY(config-nsight-policy-STD)#enable
NSIGHT-PRIMARY(config-nsight-policy-STD)#commit write
NSIGHT#show nsight status
 Nsight is enabled
 Nsight report and aggregation daemon is running
 Nsight alarm daemon is running
 Nsight server daemon is running
 Database server is local
 Database server is reachable
```

Contacting GTAC

Should you require technical support assistance, below is the basic list of information you should provide ahead to help GTAC engineers address your issue as soon as possible. This list is not finite; it may be required to provide additional data depending on the particular case.

- Serial Number or Service Contract number that will prove Entitlement to receive Technical Support
- Tech support file from the affected WiNG devices, usually it is the main controller and/or APs where the issue is observed. Techsupport dump contains current snapshot of the system at the moment it is taken, for example running and startup configuration, output from most of the "show" command, even history, log messages and crash info.

```
remote-debug copy-techsupport hosts <Controller hostname> <AP hostname> write <URL>
```

Example command to collect Techsupport dump from any WiNG device

```
vx9000-1#remote-debug copy-techsupport hosts vx9000-1 remote-AP-1 write
ftp://ftpuser:ftppassword@ftp.server.local/folderForDumps/
```

For additional information on collecting relevant troubleshooting information please refer to *WING 5.X HowTo Remote Debugging Guide*.