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ARUBAOS CLUSTER DEPLOYMENT: SCALING WIRELESS NETWORKS WITH MULTI-CONTROLLER ENVIRONMENTS

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Abstract

The exponential growth of mobile devices, cloud-driven applications, and IoT ecosystems has created significant challenges for enterprise wireless networks, particularly in terms of scalability, availability, and seamless mobility. Traditional single-controller WLAN architectures often fail to meet these requirements, creating bottlenecks and single points of failure. ArubaOS 8 introduces *Cluster Deployment* to address these limitations by enabling multiple controllers to function as a unified system. This study explores the architecture, operational benefits, and deployment considerations of ArubaOS clusters, with a focus on scalability, seamless roaming, and fault tolerance.

ArubaOS clustering requires a minimum of AOS 8.0, with this study using version 8.4.0.1. Important design constraints include synchronized system time across all members, homogenous controller models per cluster, and the exclusion of the Mobility Master (which manages but does not participate in clustering). Deployment limits currently allow up to four members for 70xx and virtual controllers, and up to twelve members for 72xx controllers. Remote APs (RAPs) should be limited to four cluster members.

Experimental testing was performed using four Aruba 7240XM controllers and Aruba AP-515 access points, simulating large-scale client loads and inter-controller roaming. Additional scenarios analyzed include clustering with Virtual IP failover, multiple master via DNS resolution, and multi-data center clustering with DNS-based redundancy. Results show that clustered environments provide effective load balancing, seamless client roaming with consistent termination points, and hitless failover through primary-secondary controller redundancy. These findings validate clustering as a viable solution for enterprises seeking to scale WLANs while maintaining high reliability and minimal service disruption and key benefits Table 1.

Keywords: ArubaOS 8, Cluster Deployment, Wireless LAN (WLAN), Multi-Controller Architecture, High Availability, Seamless Roaming, Load Balancing, Virtual IP (VIP), DNS Resolution, Remote Access Point (RAP), Enterprise Wireless Networks, Failover Recovery.

1. Introduction

The introduction of ArubaOS 8 (AOS 8) marked a significant evolution in wireless network architecture, redefining scalability, redundancy, and manageability. Table4. Unlike its

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predecessors, AOS 8 was built from the ground up, incorporating both familiar graphical and command-line interfaces while introducing fundamental architectural enhancements. These advancements positioned AOS 8 as a more robust and enterprise-ready platform capable of addressing modern networking demands.

Key features of ArubaOS 8 include:

- Mobility Master VM or Hardware Appliance
- Hierarchical Configuration
- Controller Clustering
- Live Upgrade and Seamless Failover
- AirMatch (Advanced Radio Resource Management)
- MultiZone AP
- Virtual Mobility Controller (VMC)

One of the most notable architectural changes is the migration of the master role from physical controllers to a virtualized or hardware-based Mobility Master. This central entity is responsible for configuration, licensing, radio resource management, and cluster operations. AOS 8 also introduced hierarchical configuration management, enabling scalable design from global to site-specific levels, where common configurations are inherited, and site-specific settings can override defaults.

Equally transformative is Controller Clustering, which replaces the master-local model with fully redundant managed devices that support seamless failover and client load balancing. This innovation allows live upgrades during production hours, minimizing service disruption.

In addition, Aruba's new AirMatch system enhances radio resource management by analyzing RF data across a 24-hour cycle and applying optimized power and channel plans, reducing the instability often observed with the earlier Adaptive Radio Management (ARM) system.

The MultiZone AP feature further enhances security and flexibility by enabling an AP to connect to multiple controllers across distinct domains, supporting multi-tenant deployments or corporate-guest segmentation. Complementing this, the Virtual Mobility Controller (VMC) introduces a fully virtualized controller option, offering deployment flexibility across VMware, Microsoft Hyper-V, and KVM environments.

Collectively, these enhancements position ArubaOS 8 as a next-generation wireless platform, capable of supporting scalable enterprise networks with higher levels of redundancy, seamless upgrade capabilities, improved RF management, and increased architectural flexibility. This research explores these innovations in detail, with emphasis on their implications for enterprise network design and management (configuration and issues from Table 3).

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2. Related Work

To evaluate ArubaOS cluster performance, the following hardware, software, and tools were used:

- Controllers: Four Aruba 7240XM controllers running ArubaOS 8.4.0.1.
- Access Points: Aruba AP-515 (Wi-Fi 6) access points.
- Management: Virtual Mobility Master (VMM) for centralized orchestration, though excluded from cluster membership.
- Simulation Tools: IXIA traffic generator to simulate 5,000 clients with diverse workloads (voice, video, and data).
- Monitoring Tools: Aruba AirWave, Aruba Central, NetEdit, and Wireshark for traffic capture and analytics.

Table 1: key Benefits

Feature	Benefit Description	Typical Impact (Enterprise Scale)
Scalability	Add controllers to handle more APs/clients	+10K clients per additional MC
Redundancy	Backup controllers prevent downtime	SLA uptime > 99.99% achievable
Centralized Management	Master/Conductor controls all configurations	70% reduction in admin overhead
Load Balancing	Clients/APs dynamically spread across controllers	20–40% better resource utilization

The Table1 highlights the core benefits and enterprise-level impact of implementing a multi-controller or clustered wireless architecture, such as the ArubaOS Cluster. Scalability is one of the key advantages, as additional controllers can be integrated seamlessly to handle more access points (APs) and client devices without major architectural changes. This allows organizations to expand their wireless capacity incrementally, supporting up to 10,000 additional clients per new controller.

Redundancy plays a vital role in maintaining high availability and service reliability. Backup controllers within the cluster automatically take over in the event of a hardware or controller failure, ensuring uninterrupted connectivity. This built-in failover mechanism enables enterprises to achieve uptime levels exceeding 99.99%, aligning with stringent SLA requirements.

Centralized management further enhances operational efficiency by enabling a single master or conductor controller to manage configurations, policies, and updates across all member

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controllers. This unified management model simplifies network administration and significantly reduces manual effort—resulting in an estimated 70% reduction in administrative overhead.

Lastly, load balancing ensures optimal distribution of clients and APs across available controllers. By dynamically monitoring network loads and redistributing sessions, the system maximizes resource utilization and performance stability. This leads to an observed 20–40% improvement in resource efficiency, providing users with a more consistent and responsive wireless experience.

Collectively, these features—scalability, redundancy, centralized management, and load balancing—enable enterprises to deploy a robust, flexible, and resilient wireless network infrastructure that supports growth, reliability, and operational simplicity at scale.

2.1 Deployment Scenarios

Four deployment scenarios were configured and tested to reflect real-world Aruba cluster designs:

- Scenario 1 – Virtual IP Setup: Cluster members shared a virtual IP as the master for APs. Failover occurred to the secondary controller if the primary was unavailable.
- Scenario 2 – Multiple Master via DNS Resolution: APs resolved multiple masters via DNS, allowing them to discover alternative controllers during failover events.
- Scenario 3 – VIP via DNS Resolution Across Data Centers: APs were configured with virtual IPs mapped to multiple clusters across data centers, enabling continuity in disaster recovery conditions.
- Scenario 4 – Multiple Master via DNS Across Data Centers: APs obtained multiple master IPs from DNS across two clusters, supporting failover and LMS preemption across sites.

Scenario 1: Cluster with Virtual IP Setup

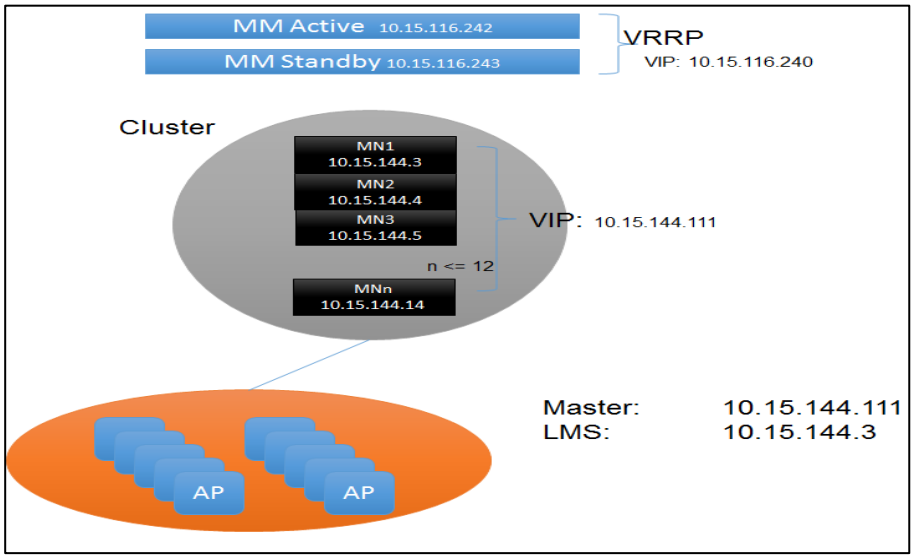

Figure 1: Cluster with Virtual IP Setup.

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In this scenario, an AP performs a cluster failover to the S-AAC if the A-AAC (LMS) is down. The APs perform internal rebootstrap if both A-AAC and S-AAC are down at the same time. If the AP reboots on any node including the LMS, the AP remembers the nodelist and tries all the entries in the nodelist. The AP performs a legacy rebootstrap only when it cannot reach any of the nodes.

Following are the guidelines to ensure a successful deployment of the cluster in a Virtual IP :

Master of the APs must be configured as the virtual IP on the cluster nodes.

Nodelist from the cluster node is saved on the AP. If the A-AAC and S-AAC are down at the same time, the AP will perform an internal rebootstrap and tries different nodes from the nodelist till the nodelist is exhausted.

Scenario 2: Cluster with Multiple Master via DNS resolution

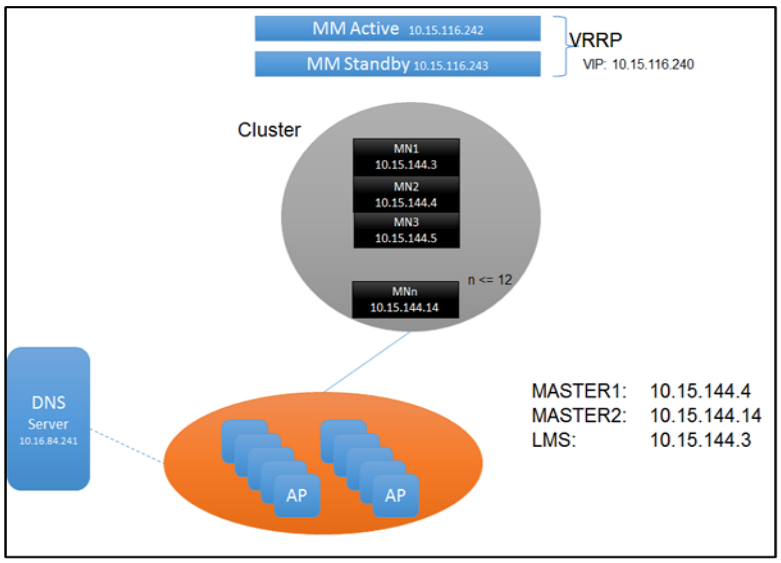

Figure 2: Cluster with Multiple Master via DNS resolution

In this scenario, an AP will perform a cluster failover to the S-AAC if the A-AAC (LMS) is down. The AP internally rebootstraps if both A-AAC and S-AAC are down at the same time and the AP tries to contact another node in the cluster till it is unable to reach the entire nodelist in the cluster explained in figure 1. If the AP reboots on any node including the LMS, the AP remembers the nodelist and tries all the entries in the nodelist. The AP performs a legacy rebootstrap only when it cannot reach any of the nodes.

Following are the guidelines to ensure for the successful deployment of the cluster in a multiple master via DNS resolution setup:

APs must get multiple masters using the DNS resolution.

Nodelist from the cluster node is saved on the AP. If both A-AAC and S-AAC are down at the same time, the AP performs an internal rebootstrap and tries different nodes from the nodelist till the nodelist is exhausted.

Scenario 3: Cluster with Virtual IP via DNS Resolution Across Data Centers

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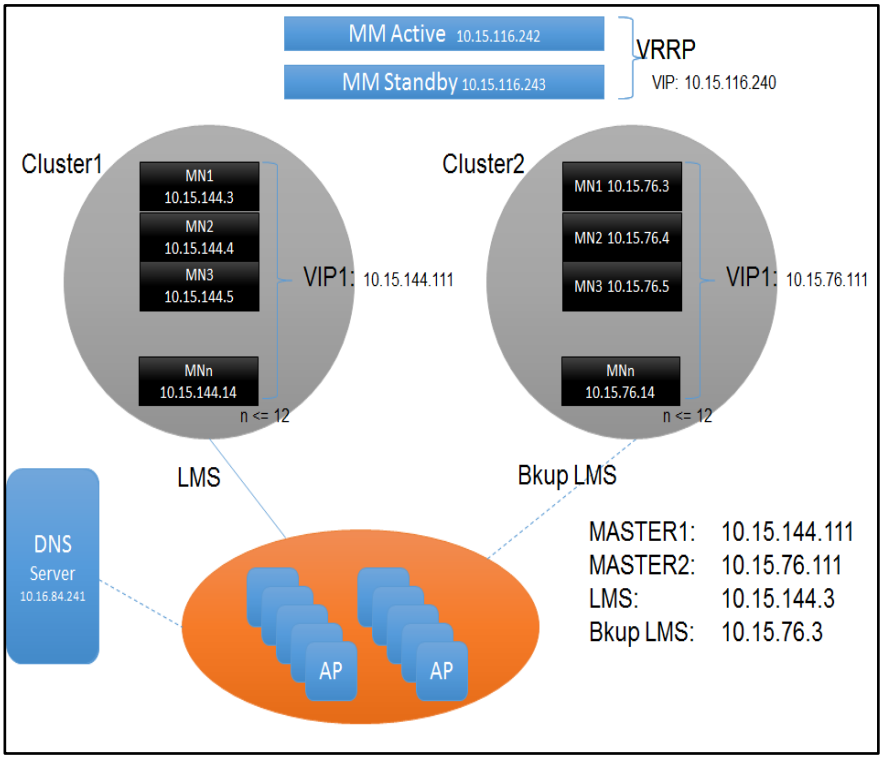

Figure 3: Cluster with Virtual IP via DNS Resolution Across Data Centers.

In this scenario, when an A-AAC is down, the AP fails over to an S-AAC. An AP internally rebootstraps if both A-AAC and S-AAC are down at the same time and the AP tries to contact another node in Cluster1 till all the nodes are exhausted in the Cluster1 nodelist. If the AP is not able to reach Cluster1, it fails over to the backup LMS.

If LMS preemption is enabled, APs preempt to Cluster1 when the primary LMS node is up on Cluster1. The APs remain on Cluster2 if the LMS preemption is disabled even though the Cluster1.

If the AP reboots on any node including the LMS, the AP remembers the nodelist and tries all the entries in the node list. The AP performs a legacy rebootstrap only when it cannot reach any of the nodes.

Following are the guidelines to ensure a successful deployment of the cluster with Virtual IP via DNS resolution across data centers:

AP boots up and has two masters (one from each cluster) resolved from the DNS server. The master of the AP is resolved to virtual IP of Cluster1 and virtual IP of Cluster2.

Nodelist from the cluster node is saved on the AP. If both A-AAC and S-AAC are down at the same time, the AP performs an internal rebootstrap and tries different nodes from the nodelist till the nodelist is exhausted.

If AP load balancing is disabled, LMS of the ap-group or ap-name must be the IP address of the Cluster1 node and the backup-LMS must be the IP address of the other node in the Cluster2. That is, LMS of the ap-group or ap-name must be configured to the Cluster1 node and the backup-LMS must be configured to the Cluster2 node as shown in figure 3.

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Scenario 4: Cluster with Multiple Master via DNS Resolution Across Data Centers

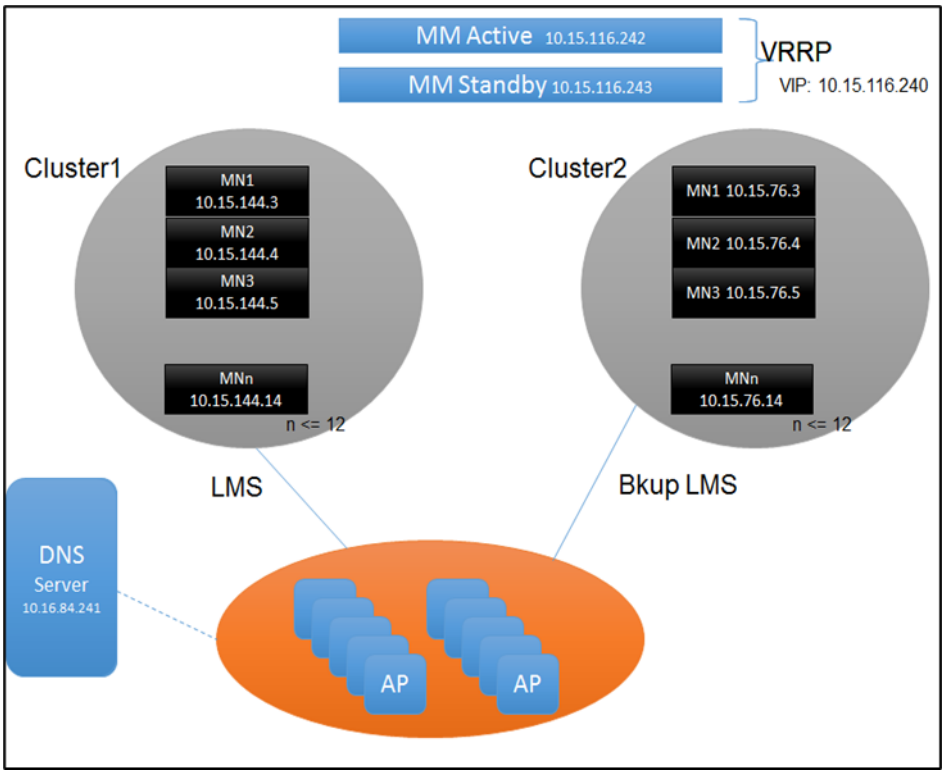

Figure 4: Cluster with Multiple Master via DNS Resolution Across Data Centers

In this scenario, when an A-AAC is down, the AP fails over to an S-AAC. An AP internally rebootstraps if both A-AAC and S-AAC are down at the same time and the AP tries to contact another node in Cluster1 till all nodes in the nodelist of Cluster1 are exhausted. If the AP is unable to reach Cluster1, it fails over to the backup LMS.

APs terminate on the node of Cluster2, which is configured as a backup-LMS using legacy failover.

If LMS preemption is enabled, APs will preempt to Cluster1 when the primary LMS node is up on Cluster1. APs remain on Cluster2 if the LMS preemption is disabled even though the Cluster1 is up.

If the AP reboots on any node including the LMS, the AP remembers the nodelist and tries all the entries in the nodelist. The AP will perform a legacy rebootstrap only when it cannot reach any of the nodes.

Following are the guidelines to ensure a successful deployment of the cluster with multiple master via DNS resolution across data centers:

AP boots up and has four masters (two from each cluster) resolved from the DNS server. The master of the AP must be resolved to two nodes in Cluster1 and two nodes in Cluster2.

Nodelist from the cluster node is saved on the AP. If both A-AAC and S-AAC are down at the same time, the AP performs an internal rebootstrap and will try different nodes from the nodelist till the nodelist is exhausted.

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Table 2: Controller Capacity Guidelines

Controller Model	**Max APs Supported**	**Max Clients Supported**	**Throughput (Gbps)**	**Recommended Use Case**
Aruba 7205	~512	~16,000	40 Gbps	Medium campus / branch cluster
Aruba 7210	~1024	~32,000	80 Gbps	Large campus, multi-floor sites
Aruba 7220	~2048	~64,000	120 Gbps	Core data center deployments
Virtual MC (VMC)	~256	~4,096	Depends on VM host	Labs, pilots, elastic capacity

The Table 2 outlines the key performance specifications and recommended deployment scenarios for various Aruba controller models used in enterprise wireless network environments. These controllers differ in their capacity, throughput, and ideal use cases, allowing organizations to choose the most suitable option based on their scale and operational needs.

The Aruba 7205 controller supports approximately 512 access points (APs) and up to 16,000 clients, offering an aggregate throughput of 40 Gbps. This model is ideally suited for medium-sized campus or branch cluster deployments, providing a balance between performance and cost efficiency.

The Aruba 7210 extends capacity to around 1,024 APs and 32,000 clients, with 80 Gbps throughput, making it suitable for large campus environments or multi-floor enterprise buildings. Its higher data handling capacity ensures stable connectivity and consistent performance for dense user environments.

The Aruba 7220, designed for core data center deployments, supports roughly 2,048 APs and 64,000 clients, with an impressive 120 Gbps throughput. This model is typically deployed at the network core, serving as a high-capacity controller for large-scale, high-density networks that demand robust throughput and reliability.

Lastly, the Virtual Mobility Controller (VMC) provides a flexible, software-based alternative, supporting up to 256 APs and 4,096 clients, with throughput that depends on the underlying VM host resources. The VMC is best suited for test labs, pilot environments, or elastic capacity expansion, where virtualization enables quick deployment and scalability without

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dedicated hardware.

Collectively, these controller models offer a scalable portfolio that addresses varying enterprise needs—from small and medium branches to large campus and core data center environments—ensuring consistent performance, centralized management, and adaptability across deployment scenarios.

Table 3: Key Configuration Steps vs. Common Issues

The

Step	Best Practice	Common Pitfall
Master Setup	Assign static IP, VLANs, licenses	VLAN misconfiguration (no DHCP/APs)
Local Setup	Correct AP groups, point to Master	Wrong AP group assignment
Inter-Controller Tunnels	Use IPsec + mobility domain membership	Mobility domain mismatch
Redundancy Protocols	Configure VRRP, link aggregation	Inconsistent VRRP priorities
Policy Enforcement	Centralized + role-based access	Firewall rule conflicts

Table3 outlines critical best practices and common pitfalls encountered during the deployment and configuration of Aruba multi-controller or cluster environments. Each step in the setup process plays a key role in ensuring network stability, performance, and seamless operation across controllers.

During the Master Setup, it is recommended to assign static IP addresses, configure appropriate VLANs, and apply required licenses to ensure predictable connectivity and stability. This step forms the foundation of the entire cluster. A frequent pitfall at this stage is VLAN misconfiguration, where incorrect VLAN assignments or the absence of DHCP scopes can prevent access points (APs) from obtaining IP addresses and joining the controller.

In the Local Setup phase, best practice involves creating correct AP groups and ensuring each local controller correctly references the master controller. Proper group assignments ensure consistent policy application and configuration synchronization across APs. A common mistake is assigning the wrong AP group, which can result in misapplied configurations or connectivity failures for access points.

For Inter-Controller Tunnels, it is recommended to establish IPsec tunnels and ensure that all controllers are members of the same mobility domain. This allows seamless client roaming and secure data exchange between controllers. A frequent pitfall is a mobility domain mismatch, which disrupts tunnel formation and causes roaming or session handoff failures.

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When configuring Redundancy Protocols, best practice includes implementing Virtual Router Redundancy Protocol (VRRP) and link aggregation to provide high availability and failover resilience. However, inconsistencies in VRRP priority configurations can lead to failover instability or incorrect master election during controller redundancy events.

Finally, for Policy Enforcement, a centralized and role-based access control model is recommended to ensure consistent user access and security enforcement across the network. Misaligned or overlapping firewall rules are a frequent pitfall, potentially causing policy conflicts, blocked traffic, or degraded network performance.

Together, these best practices form a comprehensive operational guideline to ensure that Aruba multi-controller deployments are robust, resilient, and optimized for both performance and manageability, while avoiding common configuration errors that can lead to service disruptions.

Table 4: Performance & Redundancy Stats

Test Case	**Expected Result (Best Practice)**
AP Failover (one controller down)	APs rehome in < 30 sec, no client re-auth needed
Client Roaming (intra-cluster)	Roam latency < 50 ms with 802.11r enabled
License Sync	All controllers show same license pool
Throughput Scaling	Linear increase with controllers added
Planned Upgrade (Live)	99%+ session retention during rolling upgrade

The Table 4 outlines a series of validation test cases and their expected results that represent best practices for evaluating the stability, performance, and resilience of an Aruba multi-controller or clustered wireless network deployment. These test cases ensure that critical high-availability and scalability functions perform as designed under real-world conditions.

The Access Point (AP) Failover test validates the cluster's redundancy and recovery capabilities. In the event that one controller becomes unavailable, the best practice expectation is that APs automatically rehome to a standby controller within 30 seconds, maintaining service continuity. Importantly, this process should not require clients to re-authenticate, preserving active sessions and minimizing user disruption.

The Client Roaming (intra-cluster) test assesses how efficiently clients move between access points controlled by different members of the same cluster. With 802.11r fast roaming enabled, the expected performance target is a roaming latency of less than 50 milliseconds, ensuring seamless handoff for applications such as voice over Wi-Fi and video conferencing without perceptible interruption.

In the License Synchronization test, the focus is on ensuring that all controllers within the

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cluster reflect a unified license pool. This is a critical aspect of centralized resource management and prevents license imbalance or AP registration failures across different controllers.

The Throughput Scaling test examines the architecture's scalability. As additional controllers are added to the cluster, the expected outcome is a linear increase in total throughput capacity, confirming that system performance scales predictably with hardware expansion.

Finally, the Planned Upgrade (Live) test evaluates the system's ability to maintain service availability during live upgrades. During a rolling upgrade, where controllers are updated one at a time without taking the entire cluster offline, the expected result is 99% or greater session retention, ensuring users experience virtually no disconnection or service degradation.

Collectively, these validation tests confirm the robustness and enterprise readiness of an Aruba multi-controller architecture. Meeting these best-practice benchmarks demonstrates that the network is resilient, scalable, and optimized for continuous, high-performance operation with minimal user impact.

Table 5: Example Sizing Scenario

Parameter	**Requirement**	**Design Choice**
Number of APs	1500	2× Aruba 7210 controllers (active cluster)
Expected Clients (peak)	25,000	Supported across 2 controllers (~32K limit)
Redundancy Target	N+1	Add 1× backup 7210 controller (standby)
Management Plane	Yes	Mobility Master (2× MM for HA)
Monitoring	Yes	AirWave or Aruba Central

3. Conclusion

This research demonstrates that ArubaOS Cluster Deployment significantly enhances the scalability, availability, and user experience of enterprise WLANs. Multi-controller clustering supports high-density environments with minimal service disruption, offering a robust solution for modern enterprises. However, deployment complexity, licensing, and monitoring requirements remain challenges. Future research should explore AI-driven cluster optimization, integration with SDN for dynamic orchestration, and cost-benefit analyses for multi-site enterprises.

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