Why is Arista's Cognitive Wi-Fi Distributed Architecture Unique?

Since the early days of Wi-Fi technology, dating back to more than 2 decades ago, the industry has witnessed multiple Wi-Fi architectural evolutions. From stand alone access points to controller based systems and on-premises management to cloud based, modern Wi-Fi architectures are transforming how network administrators ensure "always on" wireless networks. Removing data rate bottlenecks and single points of failure that can cripple a network and in turn lower productivity are key challenges that can be overcome with Arista's Cognitive Wi-Fi Distributed Architecture.

This tech note provides a brief summary of these various evolutions, and articulates why Arista's Cognitive Wi-Fi Distributed Architecture is unique and advantageous over the others.

Wi-Fi Architecture Evolution

Standalone Architecture

The first generation APs (access points) were designed to be standalone, meaning each AP operated independently and was managed individually (through its own user interface). As Wi-Fi became the de-facto standard of connectivity in various enterprises, and as mobility became very important, this architecture broke down.

Controller Based Architecture

In this architecture, a centralized appliance called the controller, took over the functionality of the management plane, the control plane and the data plane from the Access Points. The controller was typically deployed on-prem, and the APs connected to a group/cluster of controllers for redundancy & load balancing. Many controller architectures run proprietary communication protocols between AP and the controller, and between the controllers deployed in a group/cluster. The controller became a single point of failure for control plane functions like RF management, roaming, firewall, etc. From a data plane perspective, the controller became a single choke point as all wireless user traffic was aggregated at the controller. As newer Wi-Fi standards emerged, the Wi-Fi throughput increased, alleviating the problem of the controller being the chokepoint. However, one of the biggest advantages of the controller architecture was aggregation of all wireless VLANs, making it easier for admins to deploy wireless networks over existing wired networks without having to configure the ports on the access switches.

Main disadvantages of the controller based architecture were:

- Needed more appliances and hardware as the network grew limiting scalability
- Siloed management (each controller clusters needed to be managed individually)
- Additional appliances & licenses meant additional cost
- Single point of failure for control plane functions
- As Wi-Fi traffic grew in bandwidth, the controller became a single choke point for data traffic.
- Proprietary communication protocol between AP and controller made troubleshooting difficult
- Complex software on the controller to manage AP communication, implement redundancy, etc. created additional operational & version compatibility headache
- Any unplanned outage on the controller (e.g. software bug) meant large scope of impact across the wireless network
- Very hard to upgrade the network without downtime and without impacting wireless users

On-premises Centralized Management Platform

To overcome the management scale limitation of the controller based architecture, a centralized management system provided a mechanism to manage multiple controller groups/clusters. Though this unified the management in some aspects and to some scale (limited by on-prem resource and legacy monolithic software architecture), it really did not solve the other challenges of controller based architecture as laid out above.

Controller-less Architecture

As the APs became more powerful in terms of processing and memory footprint, they were able to handle the control plane and data plane by itself, but this was designed to scale only for small & medium branch deployments. Most controller-less architectures were restricted to ~100 APs or 2000 clients that can be deployed in a contiguous RF roaming domain, making it not suitable for large campus type networks. However, this obviated the need for deploying additional controllers in those small branch locations.

This architecture was built on a completely different code base as compared to the controller architecture, with significant differences in functionality. Enterprise customers were really caught at this crossroads of having to choose between the controller and 'controller-less' architecture, and some of them even had different architectures deployed to suit their network needs. The inconsistency across the architecture made it very complex for customers to design, deploy and manage their network.

Cloud Managed Architecture

As cloud computing became more pervasive, most vendors built a cloud based management platform, and some even designed the controller (control plane functions) to be in the cloud. Though this provided immense benefit from a scale and management perspective, the architecture was not resilient to WAN / cloud outage and still suffered from the same network scale limitations as above.

Arista's Cognitive Wi-Fi Distributed Architecture

Enter Arista's Cognitive Wi-Fi Distributed Architecture. Arista's Cognitive Wi-Fi Distributed Architecture separates the management, control and data plane functions into individual software components. The management plane can be deployed on-prem or in the cloud, and takes care of functions like configuration management, monitoring, AI/ML based troubleshooting & root cause analysis, reporting, alerting, etc. The smart control plane handles all control plane functions like RF management, roaming, firewall, QoS, WIPS detection & prevention, etc. The data plane allows flexible traffic path options including local bridging (from the AP) or tunneling to a switch to centralize the wireless VLANs thus retaining one of the main benefits of the controller.

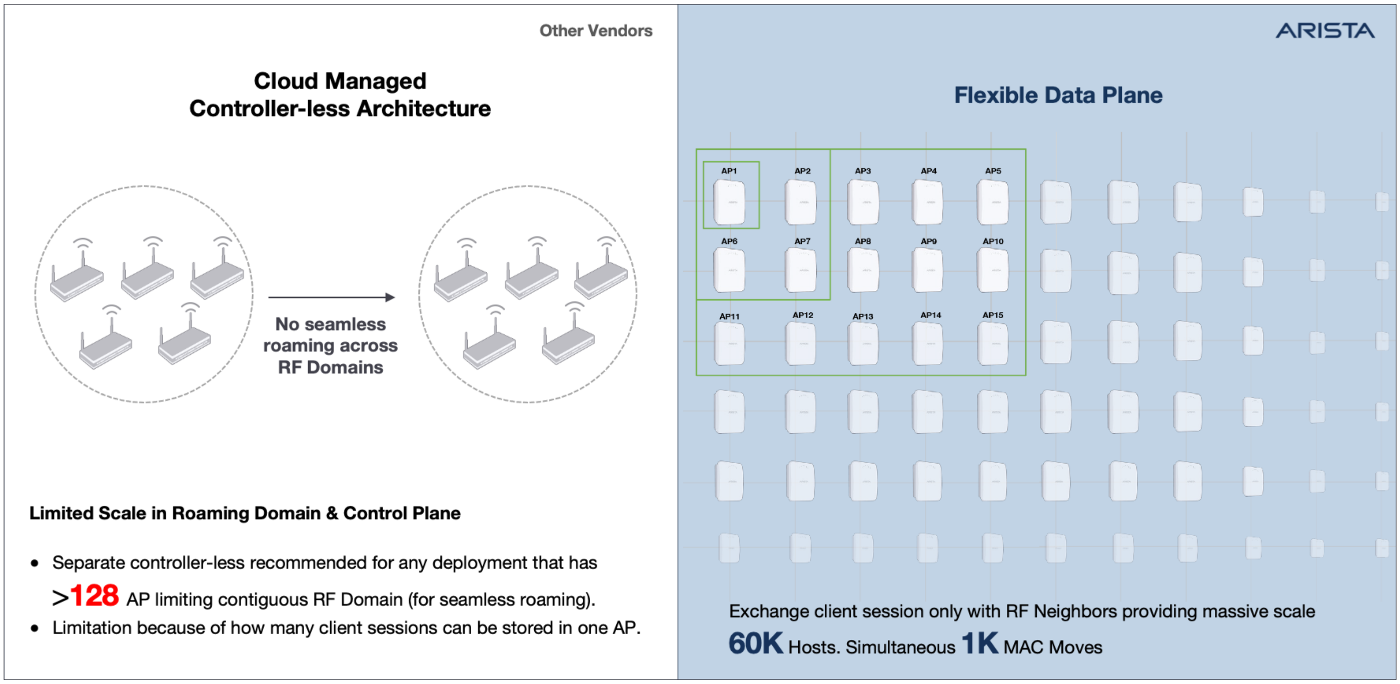
Management Plane

The first unique aspect of Arista's architecture is that the management plane can be deployed **on cloud or on-prem**. Some customers are very open to the public cloud, but some have legal & privacy constraints that prevent them from moving to the cloud. Depending on what customers prefer, they can choose to go either path and they would get the exact same set of features, barring a very few subset that is available only on the cloud. The same cannot be said of other vendor solutions - some of them offer only cloud management options. Others provide completely different management platforms for on-prem and cloud, making it very hard for customers to choose one over the other.

Control Plane

Arista's control plane architecture is continually scalable, without a controller, on prem or cloud. Designed to scale to networks of any size, we have proof points of large enterprises that have deployed 1000s of APs in a contiguous RF domain to customers that have deployed tens of thousands of small branches, all based on a single architecture and code base.

So how are we able to scale where other vendors had limitations scaling their controller-less architecture? To appreciate the uniqueness of our architecture, let's understand why other 'controller-less' solutions are not able to scale. In other solutions, every AP that is deployed in a cluster or in a contiguous RF domain, exchanges the state of all the clients that connect to the network with every other AP, so that fast roaming can be supported. This restricts the scale of the network to the number of clients states that one AP can store, which is usually restricted to 2000 clients.



Other Vendors

Cloud Managed
Controller-less Architecture

Limited Scale in Roaming Domain & Control Plane

- Separate controller-less recommended for any deployment that has >128 AP limiting contiguous RF Domain (for seamless roaming).
- Limitation because of how many client sessions can be stored in one AP.

ARISTA

Flexible Data Plane

Exchange client session only with RF Neighbors providing massive scale

60K Hosts. Simultaneous **1K** MAC Moves

Figure 1

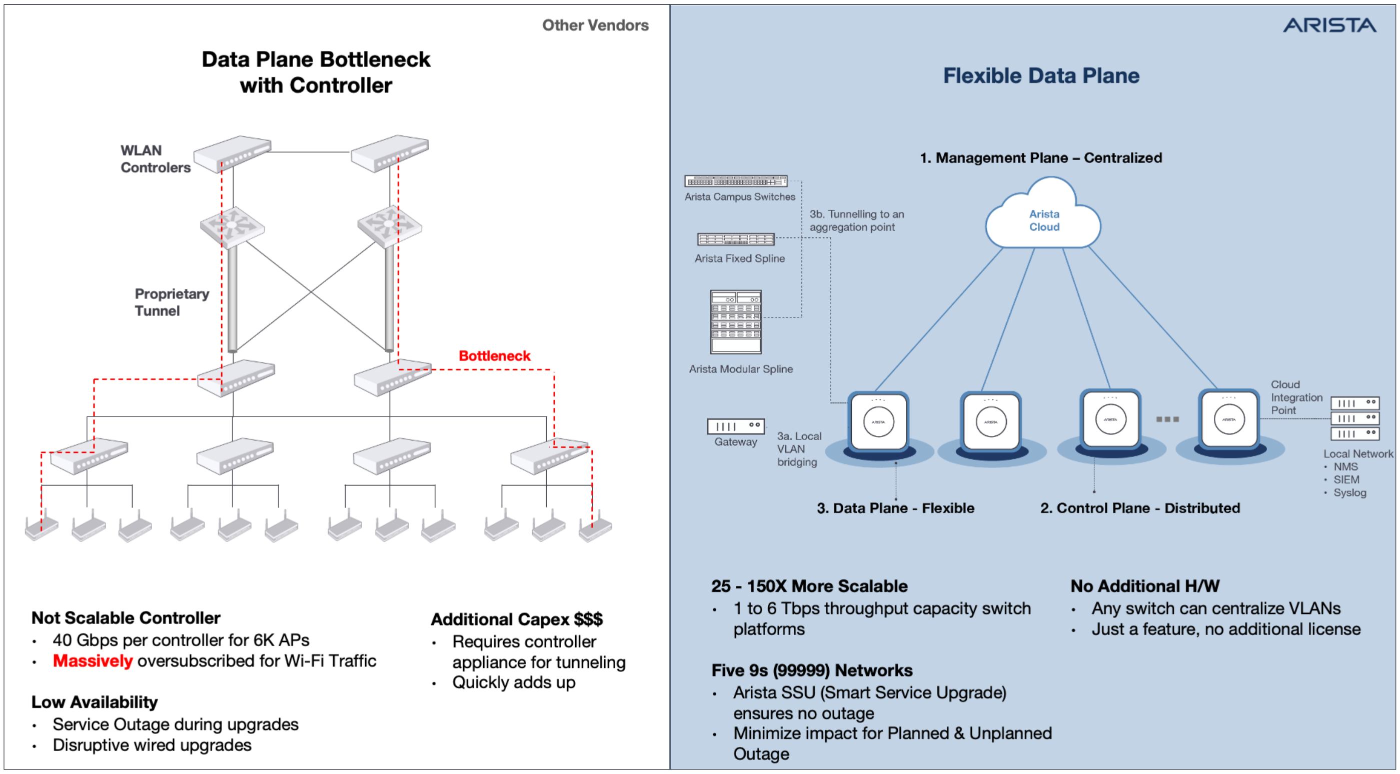
In Arista’s architecture, instead of exchanging client state and radio frequency (RF) information with every other AP in the network, each AP identifies its RF neighbors (through the always-on multi-band scanning capability of the Multi-Function Radio) and shares information only with its RF neighbors. The network predicts where the client can roam to, and selectively shares the client session only with those APs. As the client roams to a new AP, the client session exchange domain is reconstituted based on the RF neighbors of the new AP, thus allowing the architecture to scale continuously.

Because the control plane is built locally at the Access Points, the architecture is resilient to cloud / WAN outage, ensuring functions like RF management, roaming, WIPS, QoE, etc continue to work. This becomes really critical to ensure there is continuous WIPS compliance and endure the RF network always runs optimally.

Data Plane

As mentioned earlier, Arista’s architecture can support both local bridge and tunnel mode for wireless traffic. For centralizing VLANs using tunnel mode, Arista does not rely on dedicated controllers. Instead one of the Arista switches deployed in the network can terminate wireless traffic from APs using standard VxLAN tunnels. This is just another feature on the switch that customers can take advantage of, and avoids deploying additional dedicated hardware boxes.

Arista’s VxLAN tunnel architecture can scale up to 10x in terms of capacity to the nearest competitor controller solution. For comparison, let’s take the industry’s largest capacity controller or edge appliance: it can support 80 Gbps of throughput and 6K APs. The per AP capacity would be 13.6 Mbps. With the Arista 720XP switch, 4K AP tunnels can be supported with a throughput capacity of 600 Gbps with a per AP capacity of ~153 Mbps, 10 times more than the largest competitive controller. And ofcourse, with our 7050x series switches, this can scale to 1 Tbps+ of Wi-Fi traffic.



Not Scalable Controller
- 40 Gbps per controller for 6K APs
- **Massively** oversubscribed for Wi-Fi Traffic

Low Availability
- Service Outage during upgrades
- Disruptive wired upgrades

Additional Capex $$$
- Requires controller appliance for tunneling
- Quickly adds up

25 - 150X More Scalable
- 1 to 6 Tbps throughput capacity switch platforms

Five 9s (99999) Networks
- Arista SSU (Smart Service Upgrade) ensures no outage
- Minimize impact for Planned & Unplanned Outage

No Additional H/W
- Any switch can centralize VLANs
- Just a feature, no additional license

Figure 2

Earlier we talked about how the controller architecture can become a single point of failure, and how especially during a controller planned and unplanned outages, it can bring down all the APs connected to the controller and cause widespread impact to the wireless clients. Arista's SSU (Smart System Upgrade) feature allows Arista switches to be upgraded with zero downtime, allowing the wireless network to continue operating with zero impact to wireless clients. Additionally, because Arista's bugs are much lower compared to the industry, our unplanned downtime is orders of magnitude lower as well.

Our tunnel architecture supports multiple redundancy techniques, including configuring a pair of switches in MLAG mode, ensuring they can load balance and ensure ~2 second failover time when one in the pair fails. We don't rely on any proprietary redundancy protocol, and this allows customers to deploy an open network.

As architectures evolved, many vendors built custom solutions to suit the needs of different networks based on size & design (controller for large campus networks, controller-less for small medium branches). However these solutions had disparate management platforms, code versions, features, etc and this forced customers to pick one over the other or had to deploy multiple solutions making it difficult for customers to manage.

Arista's Cognitive Wi-Fi Distributed Architecture can support the needs of any network (large campus needing 1000s of APs or small branch with 1-10s of APs) through a single management platform and single code version making it simple for customers to deploy and manage.

Key Benefits of Arista's Cognitive Wi-Fi Distributed Architecture

To summarize, the key benefits of Arista's Cognitive Wi-Fi Distributed Architecture include:

- A **single architecture** that can support large campus networks with 1000s of APs and tens of thousands of clients in a single roaming domain to distributed networks with 1 to 10s of APs across 1000s of branch locations.
- **Management platform deployment flexibility:** either on-prem or consumed as a service in the cloud
- **Control Plane** that can scale to 1000s of APs and 10K+ clients in a contiguous roaming domains (through intelligent distribution of client states and RF information) as compared to 2K clients with competitor solution
- **Resilient Control Plane:** Critical control plane functions continue to work even when the cloud / management platform is temporarily unavailable
- **Standard protocol** for data plane tunneling including **VxLAN** for overlay, **MLAG** for redundancy making troubleshooting and deployment into an existing network easy
- Existing wired infrastructure can be **leveraged as a tunnel endpoint** from the AP, without requiring any additional hardware in terms dedicated controller or edge appliance thus providing huge cost savings and lowering operational overheads
- When tunneling traffic, our switches provide **10x more bandwidth capacity** per AP as compared to largest controller from other vendors
- Arista SSU allows our switches to be upgraded with **zero downtime**, allowing the wireless network to continue operating with **no impact to wireless clients** as compared to widespread client impact and downtime that will be introduced during planned outage of controllers.
- **Fast failover (2-4 sec)** with MLAG when one of the tunnel endpoint fails, ensuring minimal to no disruption to Wi-Fi traffic

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