Arista Cognitive Campus Network

Enterprise networks are undergoing massive transitions as administrators must accommodate the needs and challenges of new IoT-ready campuses. Indeed, network architects face a new mandate to better align with morphing business needs and ubiquitous user workloads, using open, software-driven cloud principles for a consistent, uniform, enterprise-wide operational experience.

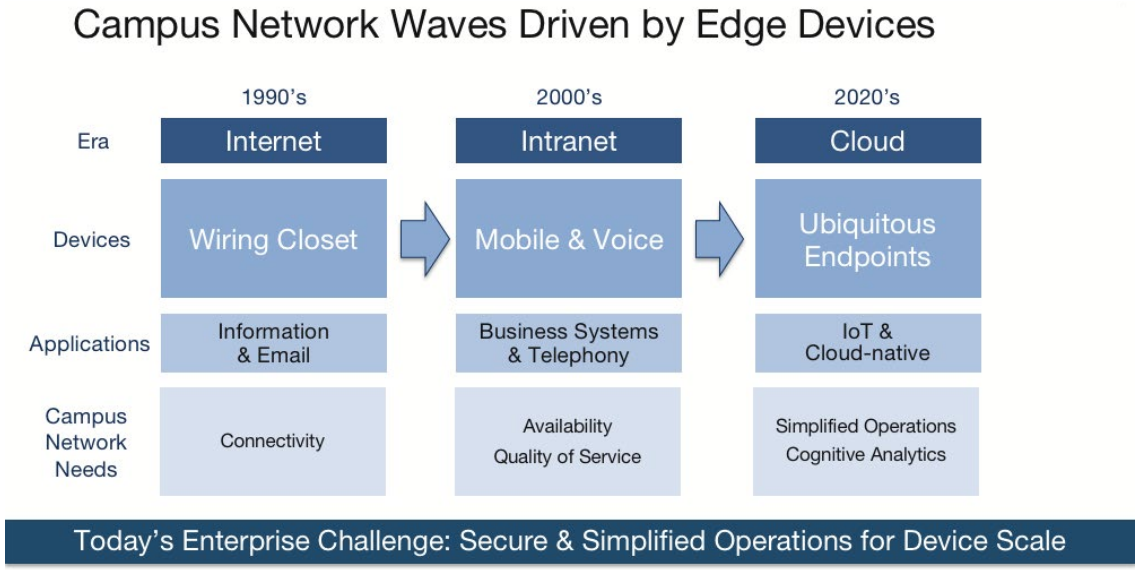


Figure 1:Evolution of the Cognitive Campus Network

The 1990s saw the challenge of information sharing via the internet and email.The 2000s marked the convergence of business systems and PBX networks, improving productivity and lowering operational costs. This unfolding decade marks another fundamental transition where administrators face a confluence of challenges ranging from an interconnected IoT (Internet of Things) environment and older firewalled boundaries to shifting workloads, sprawling user bases, and a complex mix of diverse operating systems and network management tools amidst ever-increasing security concerns. Consequently, network architects face critical questions in this age of an IoT-ready campus : How to scale IT operations without increasing operational expenses? What is the impact on the network as workloads shift to advanced cloud environments?

For organizations that consider IT a competitive advantage, Arista offers cloud class solutions with industry-leading merchant silicon architectures, all running a single image of its Extensible Operating System, EOS®. Indeed, Arista has emerged as a cloud networking pioneer and leader, providing customers visibility, security and programmability across their physical and virtual networks with best-of-breed reliability and automated operations.

Extending Cloud Grade Principles to the Campus

Arista's latest innovations drive campus networks to the cognitive cloud age, replacing the oversubscribed legacy three-tier model of access-aggregation-core. Specifically, the campus network is rapidly evolving from siloed, box-based places in the network (PINs) to places in the cloud (PICs). End users and network designers expect similar benefits from Universal Campus Network architectures that they currently derive from Arista's Universal Cloud Network(UCN) of uniform single-tier cognitive Spine-Leaf based data centers.

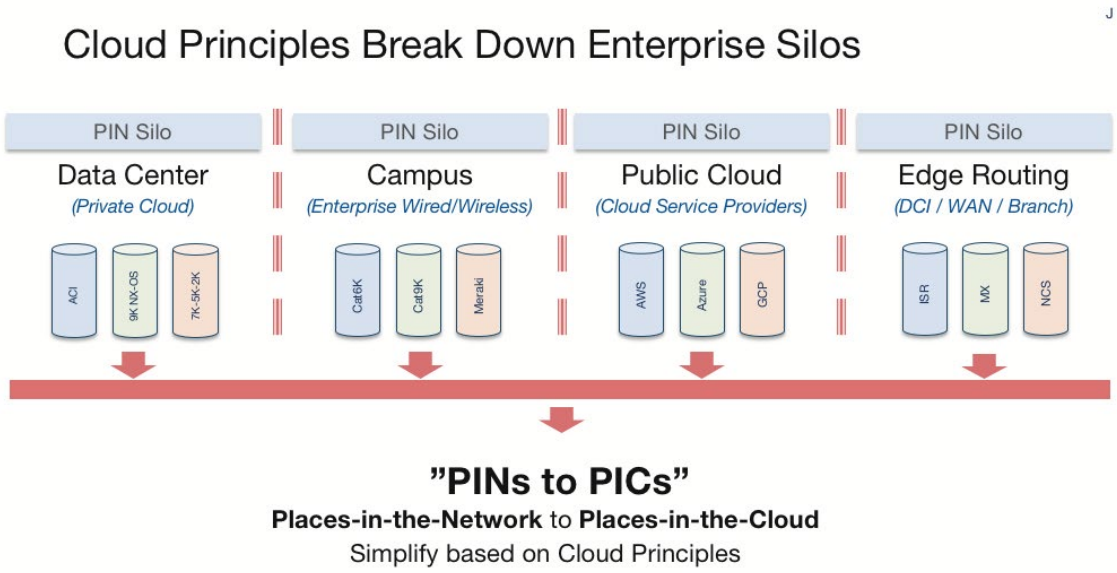


Figure 2: Universal Cloud Network

These advantages, including high scalability, reliability, automated traffic visibility, and security, have to exist in the campus to support a seamless, Client-to-Cloud environment. The challenge lies in successfully transitioning the existing siloed campus into an integral place in the cloud, while addressing security and availability needs with lower operational costs.

While the proliferation and sophistication of campus applications and IoT devices are growing geometrically, IT budgets and network capacities have not kept pace. Yet the demand for improved campus security, reliability and performance has never been higher. These coalescing factors mandate the need for uniform network designs that can adapt and grow, keeping pace with the demands of sprawling users and devices.

Campus designers should look to their datacenter peers for the automation, telemetry, and AI capabilities of the datacenter that simplify provisioning and troubleshooting while also automating compliance and segmentation. Additionally, campus administrators should look to the price/performance benefits of cloud grade platforms that marry cost effective 10/25/40/50/100G Spline uplinks to evolving 10/100M, 1G, 2.5-5MGig and WiFi6 access technologies.

Finally, campus architects shouldn't have to associate critical campus services like, voice/video grade QoS or 802.1X, with legacy hierarchical designs, proprietary protocols or vendor monolithic "blob" operating systems. The goal of a cloud-grade campus is to fulfill SLAs, improve key performance indicators, and overcome the brittleness of hierarchical multi-tier designs, plagued with disparate OS' and images; collapsing legacy access-aggregation-core to a campus leaf-spine or spline as shown in Figure 3.

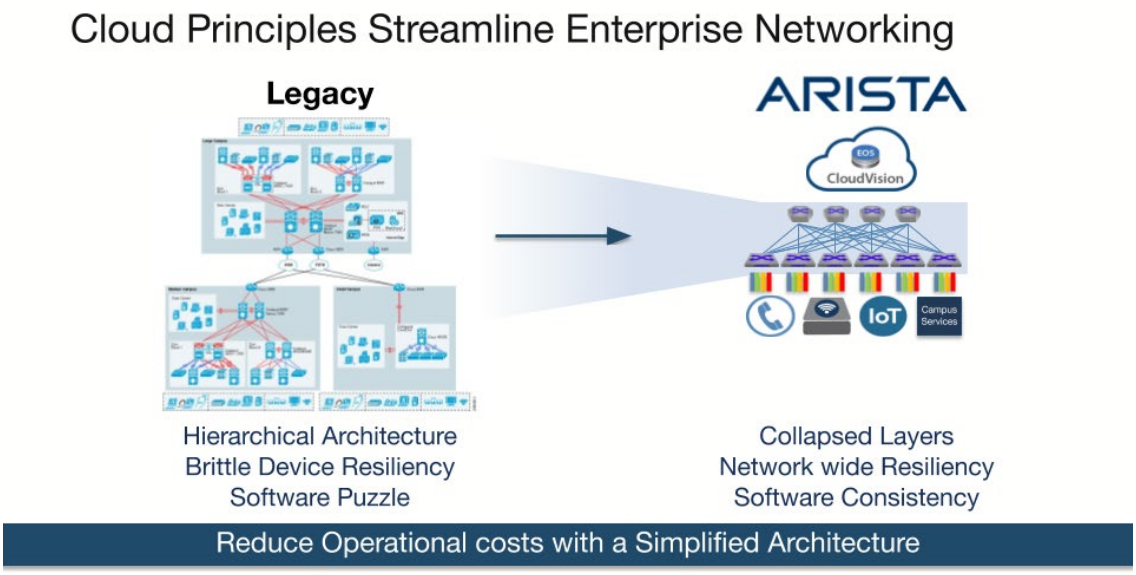
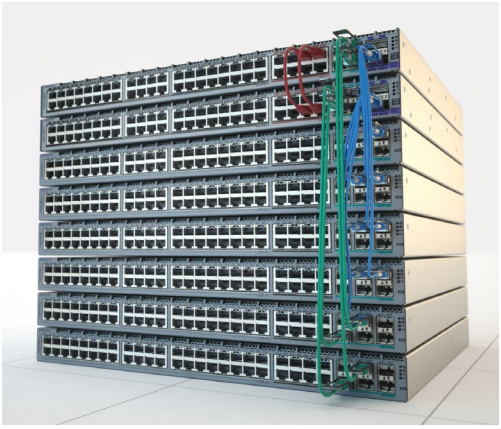


Figure 3: Universal Cloud Network

Collapsing the mid-tier aggregation and core layers reduces equipment count and costs while increasing reliability. Next generation, active-active, dynamically load sharing paths improve spine to leaf bandwidth utilization, delivering performance with reliability. This contrasts the "reliability for performance" compromise of active-passive control plane architectures. The new cloud campus spines and leafs ensure hitless maintenance and advanced features that prevent network degradation and failure. Finally, L2, L3 and virtual overlay feature sets are scalable and dynamically reconfigurable, giving network designers the flexibility to accommodate workload variety. Examples range from reconfigurable route scale to supporting open standards based EVPN-VXLAN in the campus, letting managers transcend the limitations of 802.1q 4K VLANs to the possibility of 16 million VNIs (Virtual Network Interfaces) to accommodate device and workload proliferation.

MLAG Aggregation

Proprietary stacking architectures were developed to simplify administration and expansion of multiple switches in the campus in the 1990's. However these stacking models compromised reliability, complicated life cycle management, and increased OpEx costs through complex software, master/backup arbitration process, and hardware complexity of oversubscribed daisy chained network devices.



Arista's EOS MLAG uses industry standard LACP-LAG with dynamic load balancing to deliver active/active connectivity to stacked switches. Field validated in thousands of datacenters, MLAG is simpler, more reliable, standards based, and interoperable with other LAG capable devices. Maintenance and expansion is hitless, while monitoring and software lifecycle management is simplified through Arista's CloudVision Management platform, or other, industry standard DevOps tools.

Real-Time Telemetry: Network, User and Application Monitoring

Campus administrators must also review their requirements for management and telemetry. Real time monitoring, coupled with performance analytics oriented to the infrastructure, applications and users, helps the operations team maintain SLAs, spot troubles in their infancy and rationalize infrastructure investment. To achieve these goals, campus infrastructure platforms must deliver state streaming telemetry, beyond bytes and drops, to include throughput and latency data at the client and application level. Infrastructure must support monitoring of tens of thousands of user and application flows detailing throughput, duration, latency and drops, to name a few. Lastly, administrators should expect no compromise in reliability, performance or manageability.

Of course, innovations in telemetry must be matched with advances in monitoring systems. Even at five second intervals, polling is too slow and limited in the new world of cloud and campus sprawl. In contrast to legacy schemes, cognitive cloud-based telemetry combines real-time streaming with big data analytics as shown in Table 1. Open schemes such as OpenConfig or gNMI use standard APIs to quickly and efficiently deliver a wealth of streaming information. Publish-subscribe exchange models are inherently more efficient and adaptable because only information updates are shared. The shared data model is also more advanced, providing both data definition or keys, along with data values. Together, this scheme greatly reduces telemetry processing and network load.

Table 1: Legacy vs Modern Telemetry

Traditional / Legacy Approach	Campus Telemetry Requirements
Polling Approach (10-15 min)	Real-time Streaming
State scope limited to MIB definition	Complete state history
Per-Switch Per Device	Network-wide scope
Static, discrete events. Manually correlated	Dynamic event correlation

While many networking companies understand the value of telemetry and analytics, few have architected analytics to create, stream and process networking data effectively.

Arista's Cognitive Campus Network

Arista's vision and framework for the Cognitive Campus Network leverages cloud capabilities and state of the art merchant silicon to deliver critical services that automate deployment, configuration, visibility troubleshooting and security. The Arista Cognitive Campus delivers spline, leaf and wireless infrastructure platforms, telemetry and analytics, and a single Image EOS that supports an ecosystem of solutions from industry leading partners as shown in Figure 4.

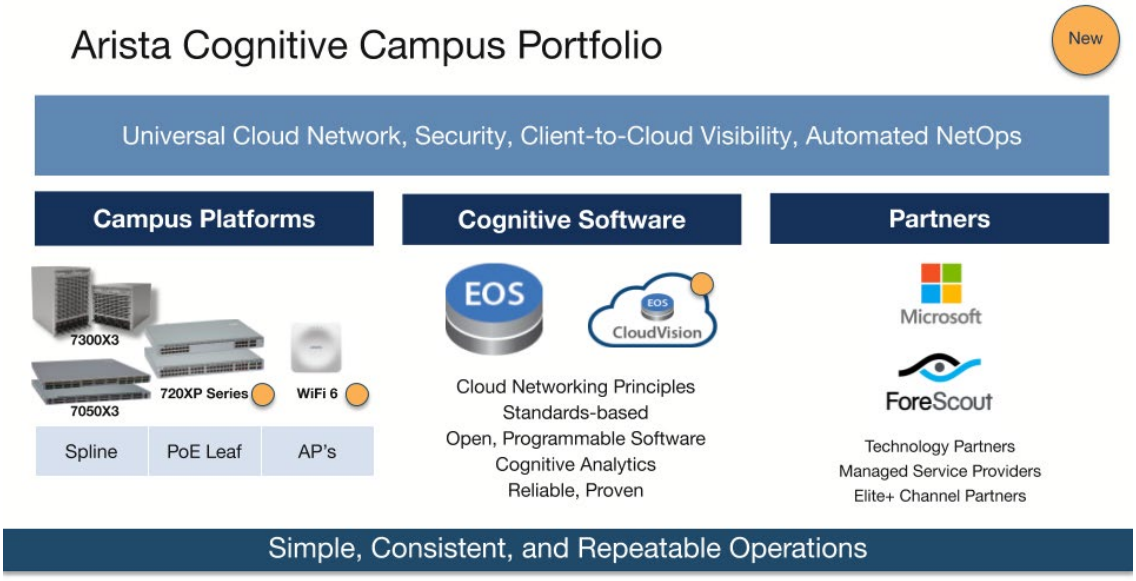


Figure 4: Arista Cognitive Campus - Cognitive Wifi, PoE Leaf, & Spline Platforms, EOS and Cognitive Management Plane based on CloudVision

1. **Splines for Collapsed Campus Fabric**

   Arista has uniquely extended cloud grade capabilities to the campus with the modular 7300X3 and fixed 7050X3 platforms. These spline platforms are designed to provide a suite of cognitive actions and features for high availability and simplicity. Self healing, hitless upgrades and live patching are cognitive actions that avoid impact on the infrastructure. Arista's Smart System Upgrade (SSU) feature enables switch operating software to be completely upgraded while the platform continues to process campus traffic.

   The X3 series switches provide a variety of connectivity options: 1-10G and 25G SFP+, 40G, 50G and 100G QSFP. These platforms support dynamic buffer allocation available to all networked ports to help avoid data loss due to congestion or micro-bursts. The Splines work with all devices that support static or dynamic port aggregation so that installed base investment is preserved.

2. **Cognitive Leaf POE Switches**

   With the release of the 720XP series switches, Arista extends Cognitive Campus management and monitoring services to the wiring closet, delivering connectivity, security, and power for all campus user workloads. The suite of platforms offer a variety of connection options for user desktops, POE appliances and IoT devices. Managed 802.3af-t/bt power services deliver up to 60W, with speed options ranging from 10Mbps to 5Gbps (MGig) over UTP, to support a variety of campus workloads. Modular SFP and QSFP uplinks support speeds of 1Gbps to 100Gbps which offer flexibility in network architecture and scalability. The 720XP runs Arista's common binary EOS, providing a comprehensive feature set of layer 2 and layer 3 open standard features including MLAG stacking, EVPN virtualization, and QoS services. Arista EOS supports standards based 802.1X access control and LLDP device identification services to automate admission and segmentation of appliances, users, and applications in the campus.

   The X3 Spline and 720XP series share the same architecture, designed to provide dynamic traffic load balancing, and real time flow monitoring of all campus workloads.

   The dynamic load balancing feature makes forwarding decisions based on the rates of existing flows in addition to the usual load hashing tuples. Therefore, new flows are balanced to the least utilized link and are resorted as stale flows age out. this performance optimizing feature interoperates with all devices that support link aggregation to ensure trouble free interoperability and migration.

   Arista's campus switches also provide real time flow tracker telemetry. Supporting CloudVision and IPFIX APIs, flow tracker allows administrators to capture key performance indicators for infrastructure, device, application and user data for SLA monitoring and troubleshooting use cases. The combined telemetry of the campus leaf and spline helps administrators better understand the proliferation of mobile, diverse and bursty traffic generated by campus users and devices. Salient EOS features and their benefits enhancing the cognitive campus are listed below in Figure 5.

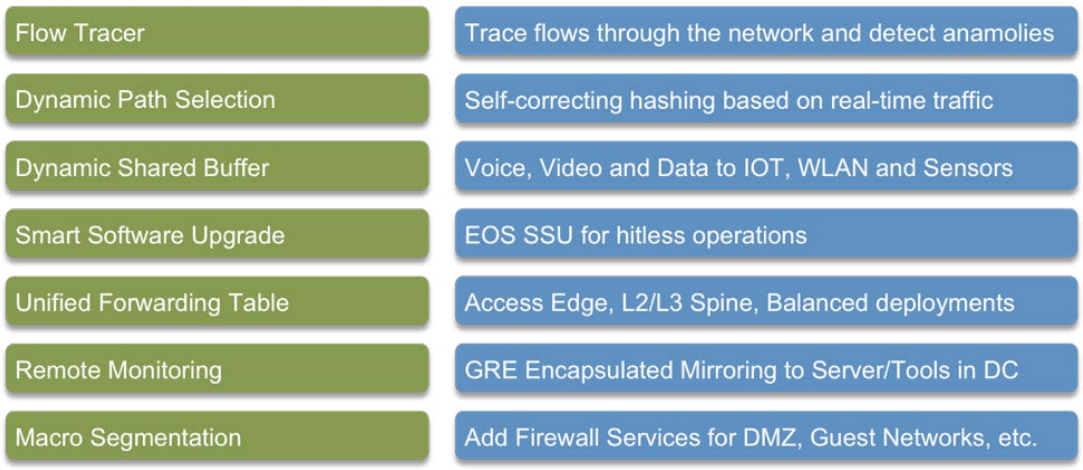


Figure 5 : Key Attributes of Cognitive Campus Splines and EOS

Finally, Arista's campus platforms accommodate a variety of layer 2 and 3 scaling demands with the help of its dynamically configurable Unified Forwarding Table (UFT). Unlike other static architectures with fixed L2 MAC and L3 routing tables, the X3 platforms let administrators select from multiple profiles optimized for either L2 MAC addressing, L3 host addressing or IPV4-6 route table scale. This simplifies design considerations because a common platform can be optimized for various campus use cases. Consistent with other Arista platforms, the X3 series supports wire speed L2 VLAN, L3 routing and L2 over L3 VXLAN that transcends 4K vlans to more than 16.7 million industry standard VXLAN virtual networks. Campus-wide dynamic segmentation of workgroups is accomplished through EVPN services facilitated with Cloudvision automation. CloudVision can extend segmentation orchestration to datacenter and cloud based workloads.

3. Cognitive WiFi Edge

Arista's distributed data plane architecture for WiFi embeds manageability and segmentation within the access points. This controller-less architecture continues to evolve with the WiFi6 enabled, AP-C250 cognitive access point. Updated Gen2 802.11ax radio technology supports upstream/downstream MU-MIMO and OFDMA transmission which greatly improves performance and user density compared to earlier Gen1 .11ax systems. Packaged with a third scanning radio, and integrated BLE, the C250 delivers the highest performance, utility and security to the wireless campus edge. The C250's performance is balanced with its efficiency, requiring only an 802.3bt/MGig (with PoE failover on uplink ports) connection for full feature capability. Finally, the C250, like all Arista WiFi platforms, is managed by Arista's CloudVision WiFi management suite.

CloudVisionWiFi helps optimize user experience, facilitate network and application performance monitoring, and provide tools for segmenting, securing and monitoring campus airwaves. These features include:

- Client Journey:
  - Connection dashboard to streamline troubleshooting of campus users connectivity problems. The dashboard simplifies troubleshooting including WiFi association, authentication and DHCP address allocation to name a few.
  - Network and application performance monitoring so administrators can baseline key applications and take corrective measures if they falter
- WiFi Tracers:
  - Wireless Intrusion Prevention System to protect against rogue devices
  - Application and Internet reachability tools to diagnose connectivity problems
  - WiFi airwave health scanning tools that don't compromise WiFi resources

Utilizing the comprehensive data set derived from the Cognitive Management Plane, Arista's CloudVision WiFi tools streamlines and automates provisioning, Key Performance Indicator Monitoring (KPI), troubleshooting and the securing of the Cognitive Campus.

4. Cognitive Arista EOS

Arista EOS provides a common software foundation for the cognitive campus network. The transformational Extensible Operating System (EOS) brings its baseline advantages to the campus with cloud grade control, monitoring, virtualization, scale and reliability. Arista's unique self-healing architecture isolates software defects, supports live patching and redefines hitless upgrade and rollback.The same binary EOS image is used across Arista's entire product line. Doing so ensures EOS quality and reliability is consistently validated across the thousands of Arista customer datacenter, cloud and campus networks.

Open standard APIs in EOS support industry leading DevOps, monitoring solutions. Core to Arista's EOS architecture is NetDB: the network-wide, state-driven, publish-subscribe-notify database. Unlike legacy polling or inter-processor communication (IPC) schemes, NetDB is purpose-built to share all state in real time. Streaming of real-time data is complete and efficient, communicating thousands of state changes at sub-second intervals to monitoring platforms using open JSON over HTTP. Implementing dynamic JSON dictionaries means NetDB can dynamically evolve, sharing new, additional key/value information to monitoring tools.

5. Cognitive Management Plane

There is a striking contrast between the maturity and robustness that has evolved in the data and control planes, and the lack thereof in the management plane. Arista's CloudVision incorporates our cornerstone Cognitive Management Plane (CMP) to automate deployments, simplify infrastructure, user and application monitoring, anticipate errors, and avoid outages across all Arista platforms in real time. CloudVision harnesses the capabilities of cloud computing, big data, and machine learning, collecting and archiving all network state over time.

CloudVision's Cognitive Management Plane ingests all streaming state from EOS platforms while its open APIs allow data sharing with other applications, either custom developed or from third parties. This allows administrators the flexibility to use best-of- breed tools for data-driven actions and analysis. The Cognitive Management Plane's API conveys commands as well as telemetry to allow configuration management tools to control the campus infrastructure. Together with NetDB's schema and native OpenConfig APIs, Arista's CMP fulfills customer's requirements for standards, openness and flexibility with flexible management and actions as depicted in Figure 6.

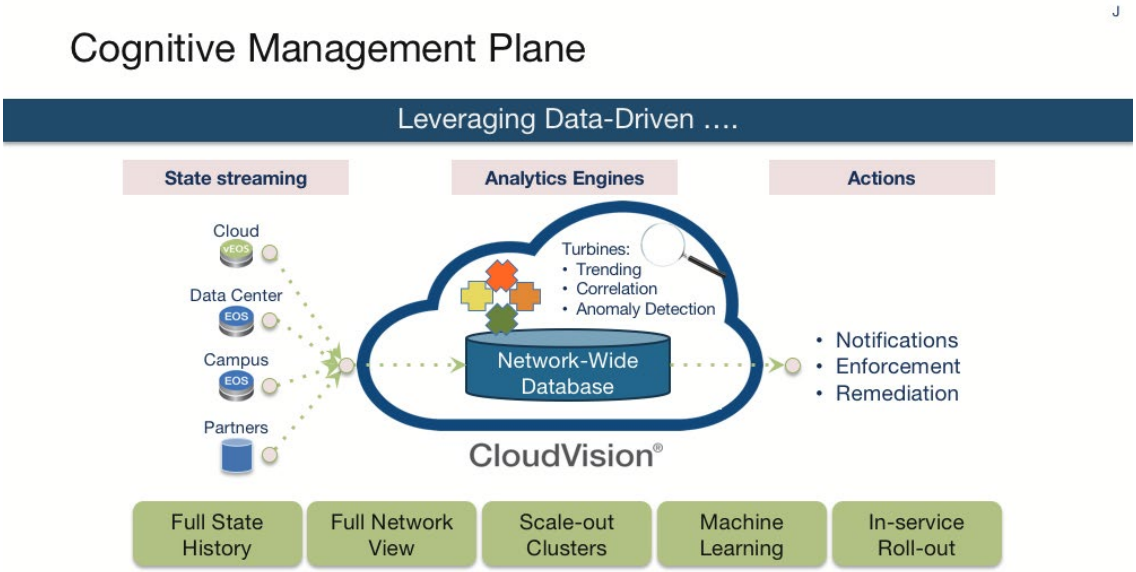


Figure 6 : Cognitive Management Plane, a repository to drive network analysis and actions

The Cognitive Management Plane supports a growing list of analytics options. Based on real-time state streaming (NetDB) and open source tools including Hbase and Kafka, these streaming processors, called turbines, simplify, timestamp and correlate streaming state. Turbines help visualization and other machine processes better identify and make network-state actionable. Turbines for monitoring FRU health, tracking parameters for signs of degradation, and anticipating expected failure points, increase behavioral network actions.

Arista's CMP also collects rich telemetry of IoT appliance, user, and application state through standard IPFIX and accelerated SFlow streaming. This real time data opens new use cases for administrators including:

- Identifying and inventorying campus devices, users and applications
- Monitoring key application and IoT SLAs, such as VoIP or security camera applications
- Identifying critical workflows and segmenting the network to protect them
- Automatically capture device or user rogue behavior and quarantine them

In addition to CloudVision's native capabilities, the platform's open architecture allows administrators to integrate expanded functions like threat detection and network access control services from a partner ecosystem of industry leaders and tech innovators.

Together with CloudVision's suite of configuration management, automation, monitoring and analytics tools, network administrators now have the means to simplify design, automate deployment, streamline monitoring of infrastructure and workloads, anticipate problems and avoid outages.

Key features of the powerful cognitive management plane include:

- State history: Operators can see all state of any device from any point in time. Historical visibility is a big help in debugging transient or intermittent issues.
- Network view: Arista CloudVision fully supports all Arista products and uses standard SNMP MIBs to facilitate data collection from legacy management planes.
- High availability: CMP clusters co-ingest state from the same set of devices, such that if a node in the cluster fails, the cluster continues to manage devices.
- Machine learning: CMP supports machine learning algorithms to automatically identify alerts that are important for likely root causes of anomalous behavior.
- In-service roll-out: Because the management plane is independent from the managed devices control plane, CloudVision can be maintained independent of the physical infrastructure. The management plane doesn't affect applications; hence, management plane upgrades are low risk, and new features can be deployed frequently.
- Multi-vendor scalability. Third parties can provide their own CMP and offer their unique benefits to customers. Multiple CMP clusters can be replicated and distributed to better serve organizational or geographic domains.
- Cross-cluster awareness: Through state export, an application can run in one cluster based on state in other clusters.

Cognitive Client to Campus Use Cases

As campus networks transform to support the latest frontier, many examples and use cases are emerging:

- Flow tracking to pinpoint hotspots
- Dynamic load balancing to alleviate congestion
- Improved security from audit to segmentation
- Enhanced client to cloud automation

Here are a few examples.

1. **Cognitive Use Case - Intelligent Monitoring**

   Campus Spline and leaf platforms deliver real-time flow tracking and dynamic load balancing with a wealth of real-time telemetry so administrators can monitor key performance indicators and maintain service levels in the cognitive campus network. Device ID and port connections can be correlated to network, application and IoT/user flow data to identify and rectify performance or security issues. Administrators can use timestamped data to pinpoint and correct network hotspots before applications are adversely impacted or users even notice.

2. **Cognitive Use Case - Secure Segmentation to WIPS**

   Leveraging flow data to better secure campus networks is a critical element of the cognitive campus network. With behavior-driven workflow data, administrators can employ various standards-based network segmentation technologies to isolate suspicious workflows. Unlike complex, proprietary segmentation schemes, open, standards-based 802.1q and VXLAN-based EVPN segmentation services can be combined to secure critical workloads or isolate suspect workflows across a campus-wide,

multi-vendor environment. For outlier workflows, CloudVision provides traffic steering and segmentation capabilities in its Macro Segmentation Services (MSS) feature set. The campus is dynamically configured to enforce security policy with no impact to other workloads. This simplifies campus network administration, and helps automate security enforcement using standard traffic segmentation technologies.

The ease of WiFi accessibility poses a continuous security challenge to campus administrators. To ensure the security of the campus airwaves, cognitive WiFi systems must automate security scans, provide constant coverage and produce actionable threat assessments. Arista's Cognitive Wireless Intrusion Protection Services (WIPS) provides a comprehensive architecture. Starting with dedicated scanning resources at the edge, telemetry is fed to Arista's Cognitive WIPs turbines which constantly log, process and synthesize performance and threat assessments to ensure the security and availability of the campus WiFi.

3. **Cognitive Use Case : Compliance and Audit Control**

DevOps solutions have proven their worth in countless datacenters for both server and network administration. When used to manage uniform software platforms, DevOps systems have a proven record of reducing errors while improving deployment time.

Yet even in DevOps, there are opportunities for data analytics to further reduce TCO. Databases of system configurations can be checked against bug databases to identify and warn administrators of possible vulnerabilities before they become outages. Cognitive compliance checking is better when configurations and operating systems are uniform and consistent, particularly in a sprawling campus. CloudVision's Compliance dashboard helps perform cognitive audits. Systems configurations and running OS images are compared against Arista's bug tracker database to identify possible compliance issues as depicted in Table 2. This forewarns administrators of potential vulnerabilities and offers remediation options before a catastrophic incident. CloudVision's proactive visibility of pre- and post-differentials for VLANs, MAC or route metric adds additional and valuable audit control.

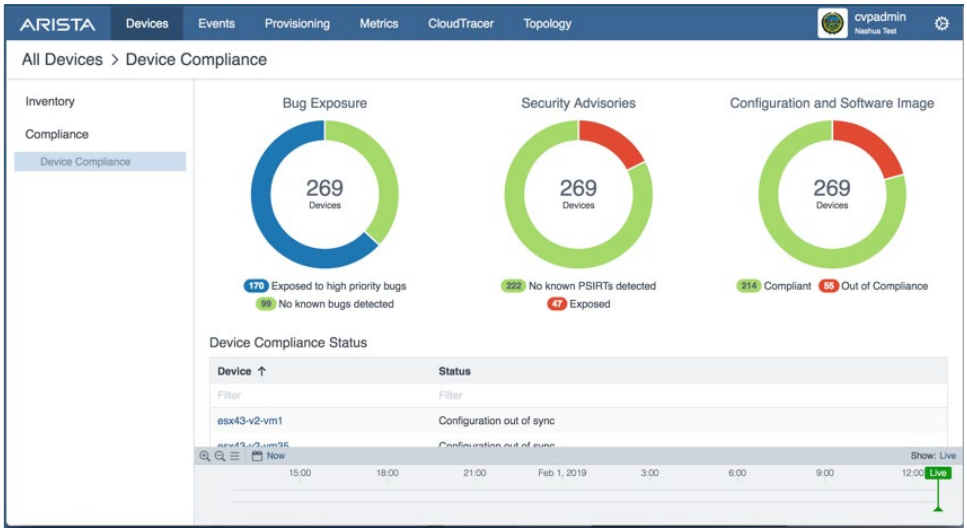


Figure 7 : Cognitive Management Plane, a repository to drive network analysis and actions

4. **Cognitive Use Case: Zero Touch Automation**

There is an ever-increasing frustration with the inconsistent quality of legacy datacenter networks. Campus administrators struggle to manage user's traffic from computers and smartphones, and are now additionally faced with critical campus IoT traffic from badge readers, security cameras and environmental controllers, just to name a few. The challenge of securing and protecting information is paramount, but extreme measures may degrade or outright break legitimate applications. Lastly, the complexities of maintaining installed legacy infrastructure can be its own full-time job as managers must certify discrete platform images for different parts of their multi-tiered network.

Extending Cloud Networking principles, Arista Cognitive Campus Architecture is designed to address users' and administrators' needs with automated end-to-end configuration builder and orchestration services shown in Figure 8 below.

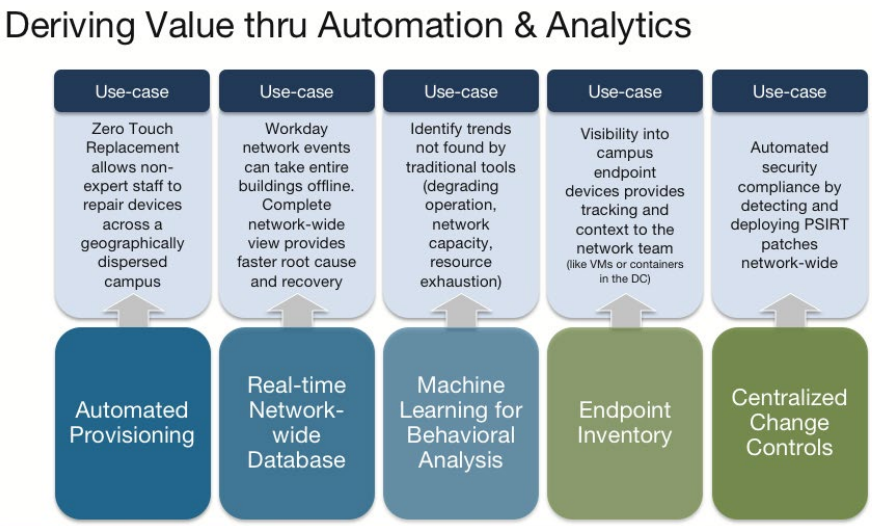


Figure 8 : Prudent automation steps from client to cloud.

The Next Frontier in Campus

The explosion of users, IOT devices and demanding applications in the campus requires thoughtful migration. Designs must evolve from brittle complexity to uniform networking and lower TCO. Arista's expanded campus platform portfolio, running its universal EOS and managed with CloudVision, leverages telemetry innovations of the Cognitive Management Plane to deliver the next level of performance, reliability, security and automation for campus users and administrators.

The contrast between other's intent-based networking, implying hope or hype, versus Arista's pragmatic cognitive-driven actions, is clear. With Arista's cloud grade and cognitive campus platforms, network leaders and IT managers can realize their multi-year journey and start their planning now.

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