The Arista Advantage Cloud Networking Trends

The world is rapidly moving to the cloud to achieve greater agility and economy, following the lead of the cloud titans. Arista's revolutionary innovations in data-driven cloud networking are propelling this dynamic transformation that integrates private, public and hybrid clouds into a seamless network running a single operating system.

Modern applications including artificial intelligence and machine learning (AI/ML), social media, and big data, coupled with emerging architectures that include dense server virtualization and IP Storage have placed enormous demands on the network infrastructure in the Data Centers, Clouds, WANs and Workspaces.

Key transformations include:

- Architectures are transforming the enterprise, extending to the campus and branch, converting siloed places in the network to a cloud-first strategy resulting in places in the cloud.
- Application standards and methodologies are changing, requiring agility and elastic demand in order to meet business requirements.
- Traffic patterns of the past are supplanted by highly distributed applications that drive east-west traffic for workloads, workflows, workstreams, and disparate devices.
- The pressing mandate facing cloud-scale and enterprise providers to easily move between different workloads without compromising cycle time.
- Data centers are moving to microservices that can be deployed physically, virtually, and in containerized models.

Clearly, the market demands in the networking arena have created a perfect storm for industry transformation.

Arista Purpose

Arista Networks was founded and has continuously evolved our hardware and EOS software to deliver data-driven networking systems and solutions for thousands of customers from the largest cloud providers to healthcare, government, carrier, finance, education, and production web/SaaS companies. Traditional approaches have been shackled in working with proprietary closed or limited network operating systems. This seriously restricts the ability of an organization to be flexible as application requirements change and handicaps the network operations teams into using only historic, error-prone methods rather than modern network-wide management tools.

Arista, a pioneer and market leader in cloud networking, has emerged as one of the fastest-growing companies in the industry. Arista has more recently expanded into the routing arena that offers another multi-billion dollar market opportunity. Arista has disrupted the market with two significant innovations. Arista's principle invention is an advanced network operating system, Arista EOS® (Extensible Operating System), designed based on open standards to deliver high reliability and unique programmability at all system levels, allowing third-party integration for best-of-breed solutions in multi-vendor networks. Arista EOS offers a data-driven network platform that automates IT workflows, provides network-wide visibility, and enables rapid problem resolution.

Arista's other key innovation is the exclusive use of best-in-class merchant silicon that enables open standards-based networking with rapid time-to-market. Notably, Arista's merchant silicon strategy delivers state-of-the-art platforms at a faster time to market enabled by technology advances associated with Moore's Law. In contrast, legacy approaches are built on custom ASICs coupled with monolithic software resulting in proprietary platforms and increased costs. The figure below illustrates Arista's revolutionary approach to data-driven cloud networking.

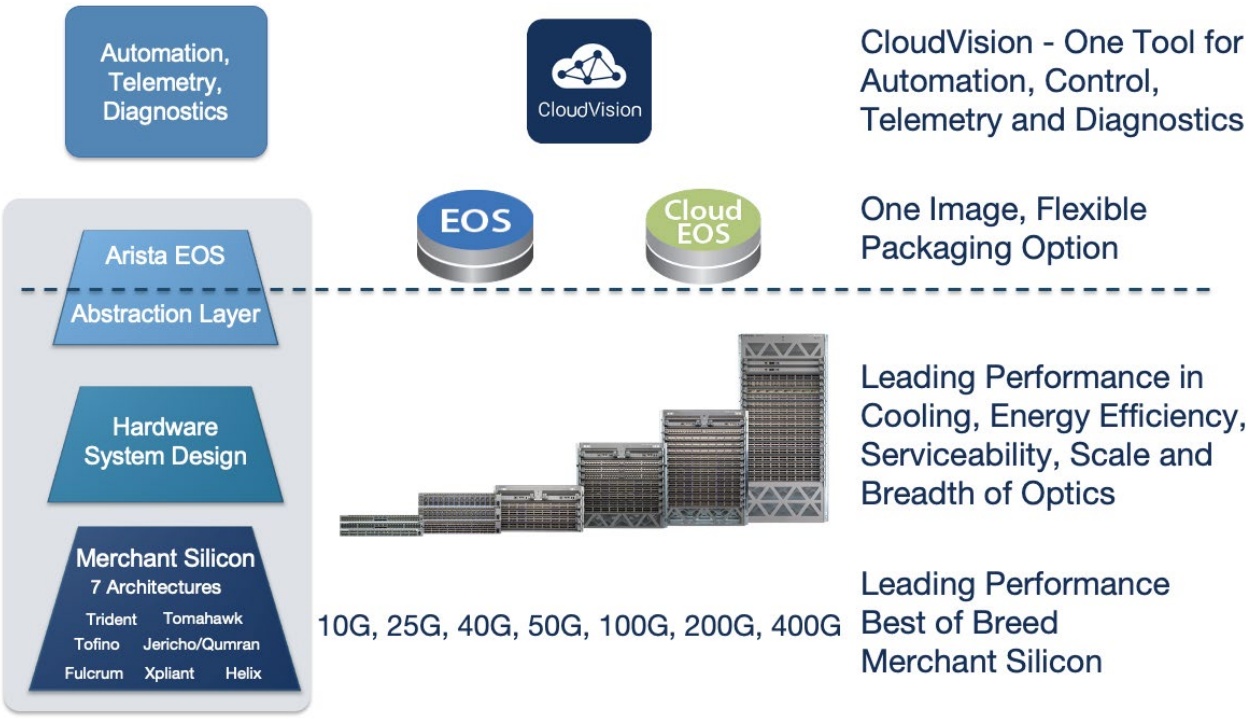

Figure 1: Differentiated Portfolio for Universal Cloud Networking

PINs to PICs Migration:

In another transformative shift, the rapid acceptance of cloud networking principles in data centers across industry verticals has challenged the network silos that have historically separated the data center, core, campus, and branches. Consequently, the lines bordering the traditional box-by-box approach are morphing into a data-driven cloud networking landscape.

The advent of native cloud applications and SaaS (Software as a Service) models is transforming siloed PINs (places in the network) into PICs (places in the cloud). Arista's leading-edge programmable state-based software foundation is designed to balance workloads between the public and private enterprise. Arista's EOS leads the industry in the transition from static to dynamic provisioning of workloads, workflows, and workstreams through availability, agility, automation, and analytics across any API and AI driven cloud network. Arista's "Five A's", the underpinnings of the data-driven cloud, are changing the way data centers, branches, core, and campus networks are built.

Key Attributes of Arista's "Five A's"

As enterprises increasingly adopt modern cloud networking and computing architectures, they gain the advantages realized by the public cloud providers today, including: automation, scalability, always-on availability, and lower TCO. Importantly, hybrid clouds, that are formed when data centers, private clouds and campus networks extend to public clouds, can deploy a uniform set of management and orchestration tools for data-driven cloud networking.

The Arista Advantage incorporates the following five "A" principles:

1. Available Architecture: Delivers a self-healing architecture of quality and aperture of data-collection across a highly available leaf-spine network with link, path, device, and network-wide redundancy;
2. Agile Work-X: Orchestrates microservices, workloads, work-streams, and workflows based on Arista universal data-driven network foundation;
3. Automation: Supports workload mobility across the cloud network, and the emerging container infrastructures for rapid and agile provisioning in minutes instead of hours or days;
4. Analytics: CloudVision Analytics engines and Telemetry Apps take full advantage of the state streaming infrastructure to give customers an unprecedented level of visibility into their network operations; and,
5. API and AI Driven: Enables the state of the network (via Arista NetDLTM) and open APIs, seamlessly connecting the cloud and premises.

Arista's 'Five A's' architecture is illustrated in the following figure:

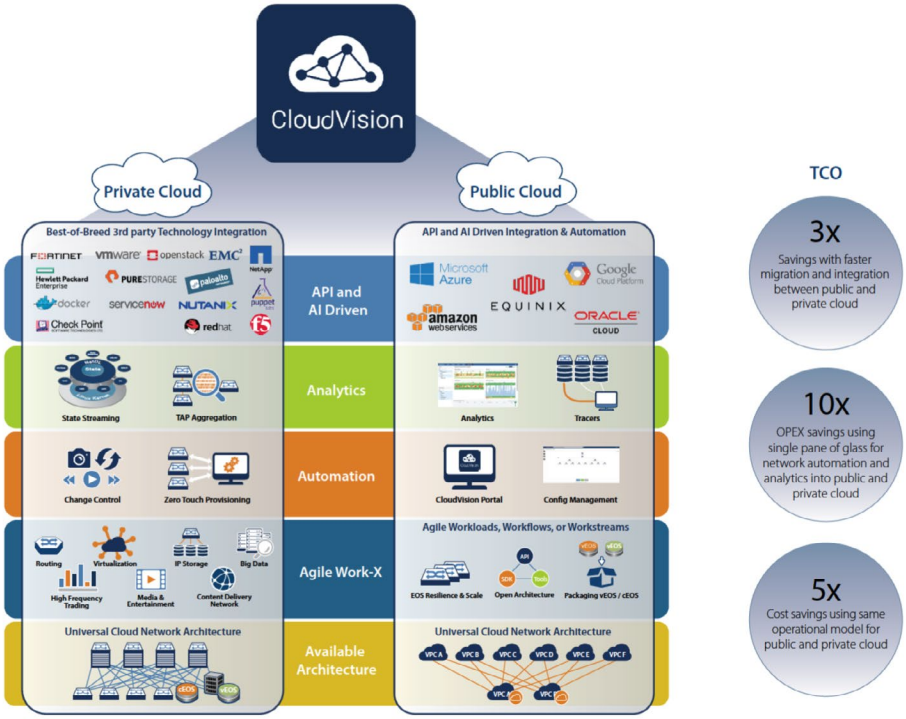

Figure 2: Arista's "Five A's" Architecture

Arista Architectural Innovation

Arista's engineering team started from a blank sheet of paper to architect an entirely new networking operating system. Arista's unique architecture is based on three guiding principles: i) state orientation, ii) open standards-based approach, and iii) single software image for consistency. Arista EOS, through this differentiated software architecture, is a ground-breaking foundation that meets the complex cloud-scale requirements of high availability, high-scale and programmability. Network alternatives have failed to develop towards these crucial concepts, or have recognized it as an afterthought and continue to play catch-up.

State Orientation for publish-subscribe communication

State Orientation uses a unique multi-process state-sharing architecture that separates state information from protocol processing and application logic. Its design resembles an enterprise IT infrastructure wherein a central database is shared by diverse applications. Arista has applied the same architectural principle, wherein the state database is the source that software processes rely upon for synchronization.

System state and data are stored in EOS and maintained in a highly efficient, centralized system database where data is accessed via an automated publish/subscribe model. This distinct design principle provides module independence, self-healing resiliency, and multi-process software stability.

Arista EOS contrasts with the decades-old legacy approach that uses extensive inter-process communications (IPC), a shared memory bus, or a complex message passing framework to communicate across the system components. This outdated approach requires manual integration of subsystems and as a result, dynamic system events can result in an impossible recovery. The distinct difference between the legacy and Arista's cloud-scale software foundation is shown below.

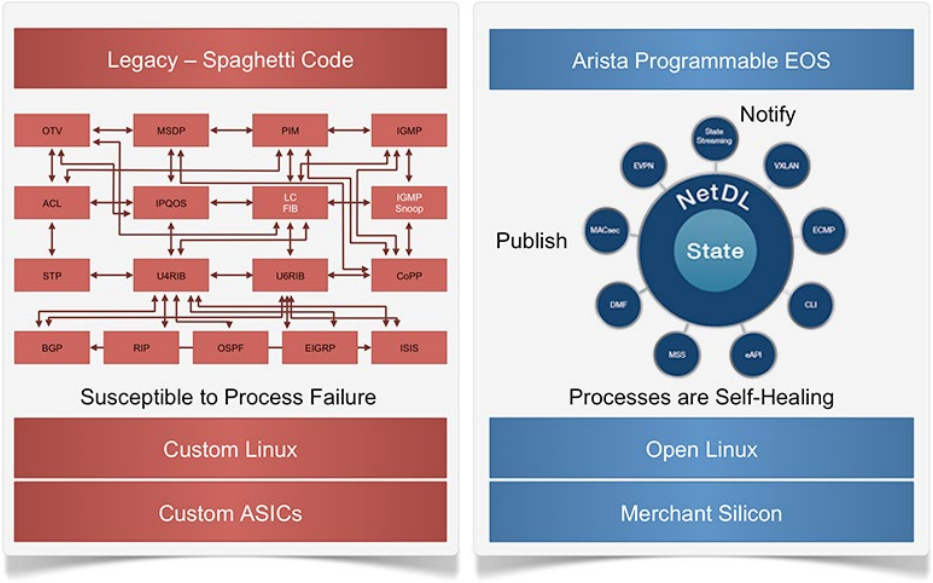

Figure 3: Arista's Cloud Scale Software Foundation

An Open Approach

Arista took to heart the lessons of the open-source world and built EOS on top of an unmodified Linux kernel, maintaining full, secured access to the Linux shell and utilities. It is notable that it is the same Linux OS that Arista's customers run in their data centers and on their servers. This foundational methodology enables EOS to preserve the security, feature development, and tools of the Linux community, unlike legacy approaches where the original OS kernel is either modified or based on older, less maintained versions. By adhering to open source Linux, EOS also natively supports Linux containers and virtual machines, simplifying the deployment of new services and enhancing DevOps practices.

A Single Image

Arista's third and crucial guiding principle is to provide a single software image that runs across all products in various packaging forms - physical platforms, virtual machines, and containers. The EOS single image uses the same source code, and the same version of the software released across the entire portfolio of switches and routers, thus improving network testing and reliability while reducing the complexity and cost of network operations.

This approach is a large differentiator to legacy vendors who use multiple operating systems with numerous images to implement a siloed network. Managing these multiple software images with quality control testing or new features testing multiplies operational costs. In contrast, when Arista releases a new software version, customers merely deploy a single image networkwide.

In addition, having a single image improves automation workflows by allowing DevOps tools, such as Ansible or Terraform, to work across all Arista devices with a single integration. Using these integrations, operators can establish Continuous Integration (CI) pipelines that build, test, and deploy network configurations across the entire data center with increased speed and reliability.

Data Driven Cloud

The acceleration of AI/ML workloads combined with a growing demand for informed decisions based on network models and behavior patterns is fueling the adoption of the data driven cloud network. Fundamentally, data-driven cloud networking resolves the key requirement of cloud titans to provide a smooth pathway between AI workloads without compromising application performance. The data driven cloud networking model for the enterprise has been realized via Arista's Virtual Assist (AVA) through Arista's advanced cognitive management plane, machine learning, and state streaming technologies. This level of programmability and customization of the network is vital for large cloud networks that connect millions of servers. A major cloud titan stated that it deployed 300 major new features and services on its cloud in the preceding 12 months – an average of six per week. This level of innovation requires not only the rapid release of new features from Arista EOS but also the ability to instantaneously customize IT.

EOS Stack Architecture Evolution - Network Data Lake (NetDL)

Arista has continued to evolve the principle of EOS State Orientation from a single-system state database, to NetDB where the network device state is centralized across 100s of systems, to the EOS Network Data Lake (NetDL) where in addition to network device state, additional data sources have been added including packet data, flow data, and external enrichment data such as DNS naming and BGP Internet performance data.

We are extending classic Software-Defined Networking (SDN) principles to software-driven networking control and an AI enabled holistic view with NetDL, while building on Arista's core pillars of reliability, open standards, and programmability. The following illustration explains the EOS foundation and evolution to data-driven networking.

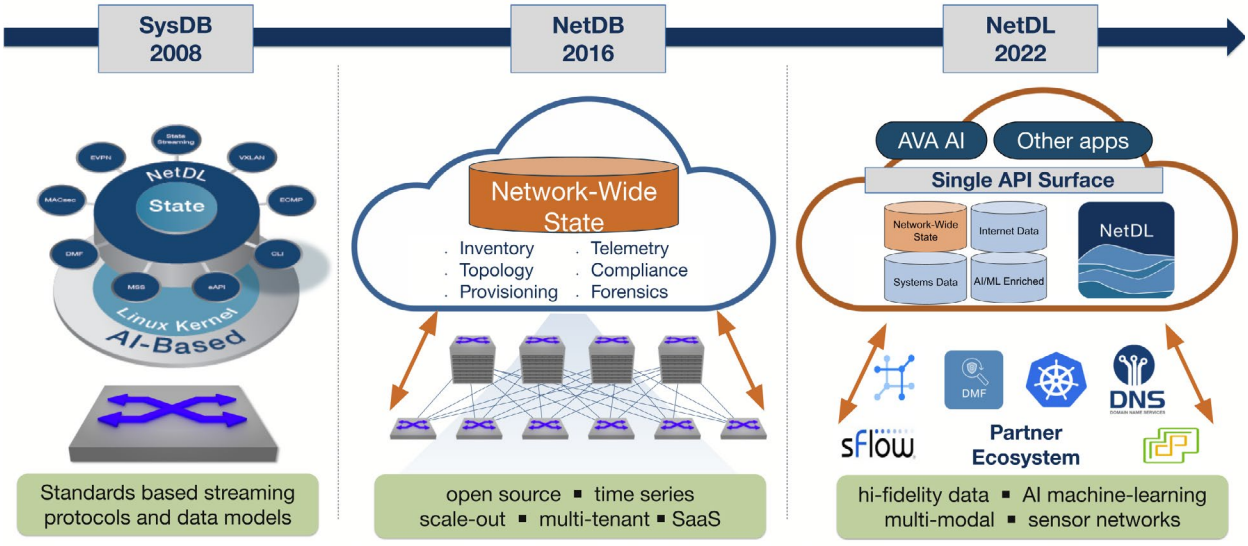

Figure 4: EOS Stack Architecture

The major components that make up the EOS Stack Architecture are:

1. NetDL, at its core, is a multi-tenant and multi-modal data lake that stores all network state from EOS networking devices as well as being capable of supporting additional data models such as: third-party device telemetry, full packet capture, full and partial/sampled flow capture, DNS records, BGP performance data, and third-party data from key partners as well as other external data enrichment sources.
2. EOS devices can encrypt and then stream networking state telemetry back to NetDL which stores all data in time-series: this enables highly accurate data for time-sensitive event root cause analysis as well as forming the data foundation for future AI/ML projects to solve critical network operational issues.
3. An API layer that enables third-party applications to utilize NetDL state, packet/flow, and network data to provide a broad set of capabilities for clients ranging from: TAC Case Management, predictive component failure modeling, Network/Endpoint Detection and Response, capacity planning, and SLA and Digital Experience Monitoring.
4. AVA - Arista's Automated Virtual Assist technology is being enhanced as a first-class analytics and monitoring application that will run on top of the EOS NetDL to provide AI-based assistance to networking and information security professionals by automating many operational tasks.

Programmability at Many Levels

Programmability is imperative to enable automation and customization of networking equipment. In marked contrast to networking companies who promote basic programmability, a capability merely bolted onto their OS, Arista architected EOS with inherent open programmability.

Arista offers five types of extensibility for EOS that provide granular control and management for multiple EOS consumption models as shown in the following figure:

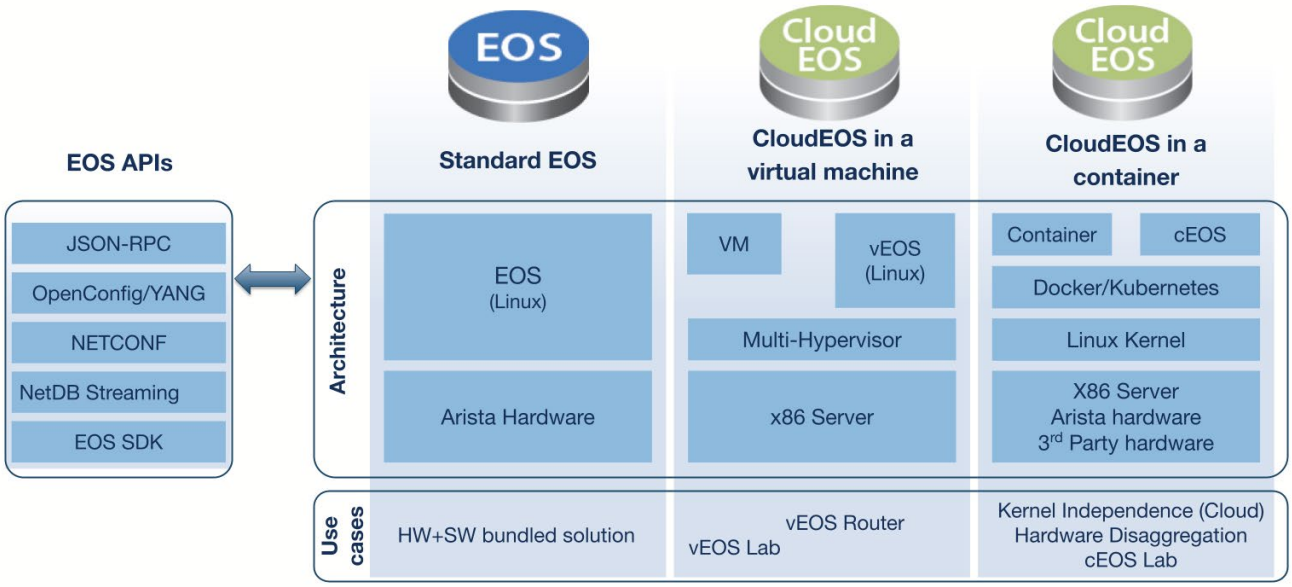

Figure 5: Programmability at all levels brings Extensible Options

1. eAPI - inputs ordinary CLI commands in the form of JSON RPC calls and responds with an output that is easy to parse in a programmatic way, providing direct access to industry management systems.
2. OpenConfig - an operator-led effort to establish a vendor-neutral data model for monitoring and managing network devices.

3. NetDL Streaming - streams the state of every EOS device into a centralized data lake, delivering a granular real-time view of the current and historical state of the network.
4. CloudVision Studios - provides the tools needed for a fully automated network operations lifecycle, including building the network configurations, deployment, and ongoing operations.
5. EOS SDK - a comprehensive software development kit for creating applications that run directly on the switch.

CloudVision for Turnkey Approach

Cloud Titans have taken advantage of Arista's EOS programmable architecture by writing their own management and automation tools. However, many large enterprise customers lack the resources to build their tools in house. Arista's CloudVision offers comparable operational advantages by incorporating powerful control features for proactive configuration and change-management, performance monitoring, and compliance. Unlike niche management products designed for a narrow use-case; CloudVision is a scalable multi-domain platform providing rich functionality that is useful across the entire enterprise, and yet provides leadership domain-specific features.

Designed for use in data center, wired and wireless workspaces, multi-cloud, and WAN routing use-cases, CloudVision provides a consistent operational model across domains, helping enterprises to simplify network operations by breaking down traditional network management silos. It provides a single unified management plane with open APIs for extensibility. These customer segments as shown in the Figure below are traditional enterprises that predominantly deploy turnkey solutions and are rapidly embracing the cloud, Cloud Class - enterprise verticals that prefer best of breed solutions for competitive advantage, and Cloud Scale - cloud providers and service providers that consider scale and control as paramount.

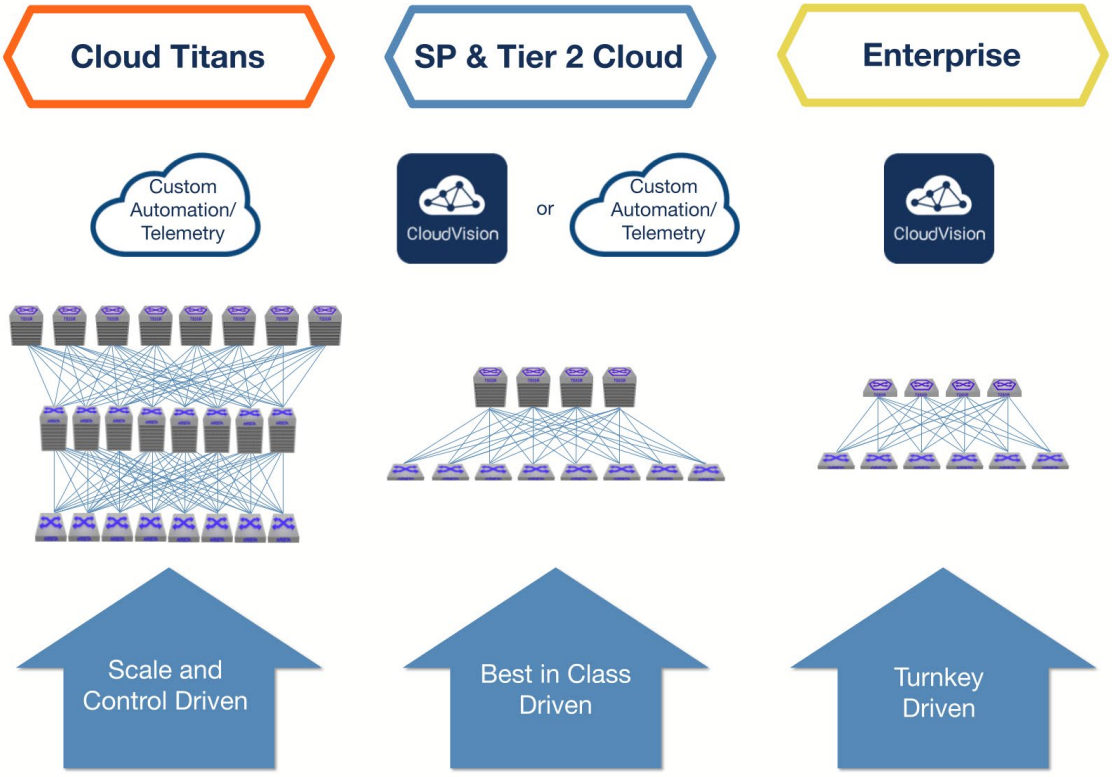

Figure 6: CloudVision offers Operational Advantages for a range of customer types

Native EOS Turnkey Automation

Organizations are rapidly automating IT to deliver repeatable results, improve enterprise agility, and keep the network responsive while adopting cloud operating principles. Programmability helps automate network provisioning, reduces time to market, automates network maintenance and can intelligently eliminate crucial downtimes. Arista's Smart System Upgrade (SSU) capability in conjunction with Arista's Zero Touch Provisioning (ZTP) features utilizes automation to create smooth and non-disruptive boot up and software upgrade processes through the intelligent insertion and removal of network elements from the network topology. When combined with Arista's network rollback feature, which can restore a previous configuration or software version across a network, these automation tools offer a modern approach to management compared to the legacy manual box-by-box approach. These simple automation tools, native to Arista's EOS, are helping customers consume and utilize automation across their cloud networks.

Real-Time Streaming Analytics

An important element of a software-driven cloud network is the ability to proactively identify, troubleshoot, and fix problems before they become impactful.

Legacy tracking approaches have been ineffective and fall short by using SNMP polling as the primary solution. The downside of this process occurs when an issue happens between the polls, making it invisible and unretrievable regardless of historical analysis. Incomplete and inflexible Management Information Bases (MIBs) are historically incomplete, leaving network operators in legacy networks blind to problematic network events.

Arista's original approach using a state-oriented, data-driven architecture with streaming telemetry has addressed this limitation by identifying issues in real-time, eliminating the SNMP shortcomings of a sampling window with limited MIBs. Arista EOS detects detailed state changes for every interface and micro-burst across the entire network using network state-oriented NetDL. This process delivers the ability to capture and view network-wide statistics with sub-second visibility allowing for rapid root cause analysis on first failure. Arista's Data Driven Analytics for network telemetry is expounded in the figure below.

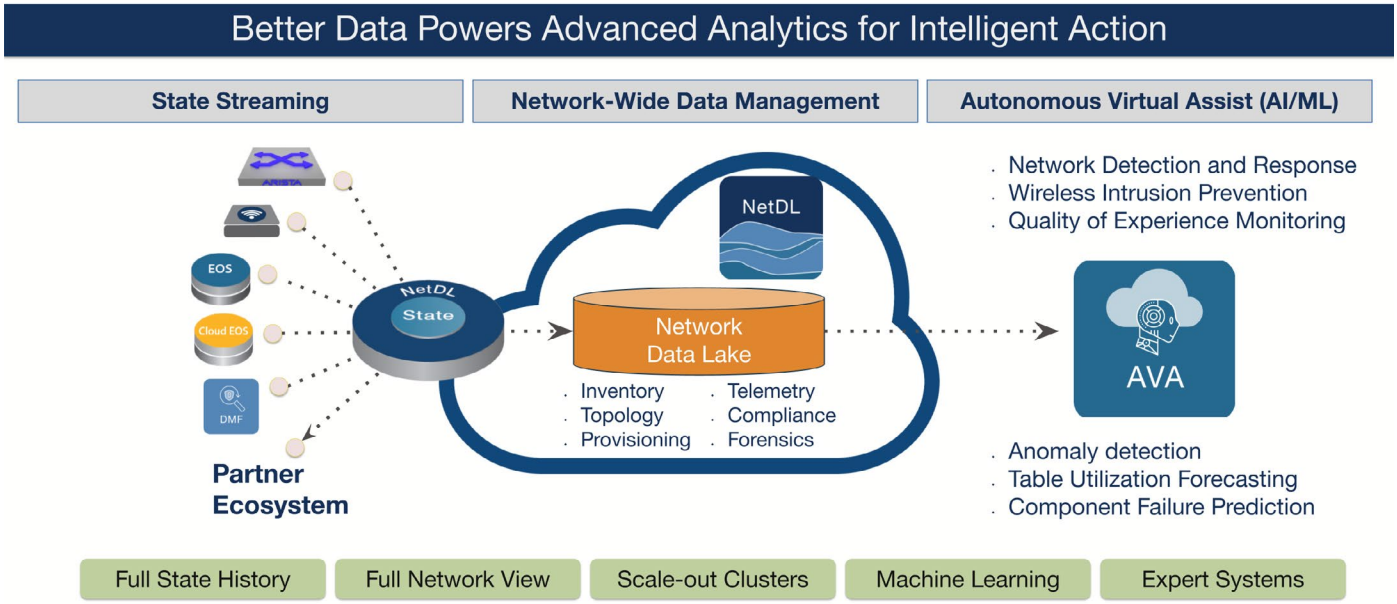

Figure 7: State Streaming Analytics State Streaming Analytics with AVA

Arista's Workflow analyzers, LANZ (Latency Analyzer) and DANZ (Data Analyzer), provide deeper insight into the network operations. DANZ Monitoring Fabric (DMF) cost-effectively monitors, without loss, all data center network traffic while capturing and analyzing

only the most appropriate traffic. LANZ is a breakthrough technology from Arista that tracks sources of congestion and latency with real-time reporting in microseconds.

Network Tracers provide links between the network infrastructure, cloud orchestration, and virtualization environments. By integrating with a variety of cloud, big-data and virtual management tools, these powerful tracers bring visibility to the application level Arista supports many network tracking tracers for specific use-cases including: VM Tracer, Container Tracer, MapReduce Tracer, and Cloud Tracer.

Platform Innovation

Arista's EOS platform is uniquely engineered to support multiple families of merchant silicon to optimize price/performance and feature innovation of the entire switch portfolio for data center, cloud, and campus. This sharply contrasts with the legacy approach that tightly couples software to their preferred proprietary ASICs resulting in multiple families of switches, each with numerous software images.

Figure 8: Cognitive Cloud Platform Portfolio

Arista, as a founding member of the 25 Gigabit Ethernet consortium, is presently leading the industry in 400 Gbps deployments and defining higher data rates for network spines and DCI. Arista's matrix of products offers both value and price-sensitive options. The award-winning modular platforms provide customers considerable investment protection as they represent three interoperable generations of highest performance and density in the Arista 7500 modular platform. Product environmentals also play a critical role in keeping green sustainability and lowering operating costs. Arista has led in the areas of power efficiency, space utilization, port density, and reversible airflow, with true front-rear cooling, underscoring a deep commitment to efficient data center operations and support for environmental sustainability initiatives.

Cloud Grade Routing

The proliferation of cloud architectures and principles are significantly transforming the traditional routing landscape, creating new business models around Service Provider Edge, Cloud WAN, Content Edge, and Data Center Interconnect (DCI).

Arista's next-generation routing solution applies the same cloud networking principles to scale and simplifies software-driven networking beyond the data center into the routing use-cases. Based on Arista's 7280R Universal Leaf and 7500R/7800R Universal Spine platforms, these platforms can be used for both switching and high-performance routing that, unlike legacy box-based routers, provide high port density and deep buffers, integrated DWDM with wire-speed MACSec encryption, and cloud automation.

Hybrid Cloud and Multi-Cloud Networking

Arista's hybrid cloud solution extends networking solutions from private cloud networks to multiple public cloud networks, all managed by Arista's CloudVision. This solution consists of CloudEOS Routers - a virtualized packaging of EOS software - that can be deployed within various public cloud services. Notably, Arista CloudEOS Router supports native cloud API integration and full support for automation and visibility with CloudVision.

The Arista CloudEOS platform provides unmatched operational consistency across public, private, and hybrid clouds including:

- Arista CloudEOS Router, the hypervisor agnostic/cloud-native packaging of the EOS binary with a purpose-built software data plane, for use as standalone software on any cloud environment including Amazon AWS, Microsoft Azure, and Google Cloud Platform.
- Cloud-grade routing solutions for interconnection of private, public, and hybrid clouds using Arista Platforms in cloud exchanges and public cloud edges,
- The Arista CloudVision platform provides the same automated provisioning, change management, analytics, and telemetry for any EOS instance, including CloudEOS running in private, public, or hybrid cloud environments.

The ensuing illustration highlights Arista's CloudEOS platform that provides seamless access across hybrid clouds.

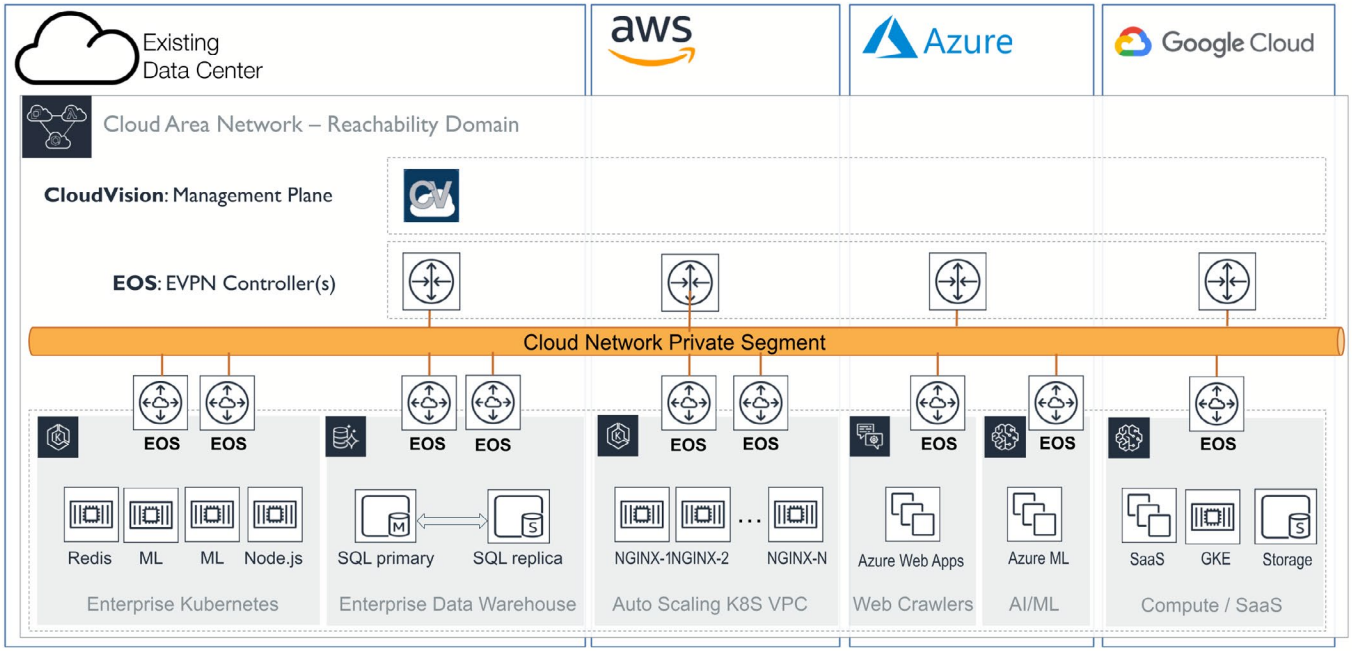

Figure 9: CloudEOS Multi-Cloud Solution

Multi Domain Segmentation

Enterprises hosting workloads in the cloud have to address security challenges. As workloads migrate across multiple clouds, virtual routers enable a new set of inter-cloud routing and segmentation capabilities. Arista's pioneering inter-cloud router CloudEOS offers a crucial built-in security feature called Zone-Segmentation Security or ZSS that eases workload migration. The combination

of Arista's Macro-Segmentation and ZSS form the underlying foundation of a secure cloud framework for on-premises (campus and data center) and public clouds. ZSS can assign several network segments and associated router interfaces as security domains called Zones. ZSS access-control monitors and secures traffic across zones. The end result is enterprises are empowered to efficiently define and control all traffic across the inter-cloud.

Cognitive Campus Networks

Arista's recent breakthroughs drive campus networks to the cognitive cloud era, disrupting the wasteful, oversubscribed legacy three-tier architecture of access-aggregation-core. As the devices move to more disparate IoT for voice, video, and data traffic, Arista is redefining the campus network using cognitive controls and analytics, driven by a single-image operating system that extends across the campus and the data center.

Using a cloud-based approach reduces operational costs by incorporating a network that is a seamless end-to-end solution rather than silos of different places in the network. Arista's cognitive campus workspace is a data driven model coupled with our unified dashboard for wired/wireless edge for next gen zero touch campus deployments. Together, with zero trust security, the cognitive campus drives multifaceted visibility for IoT and OT applications.

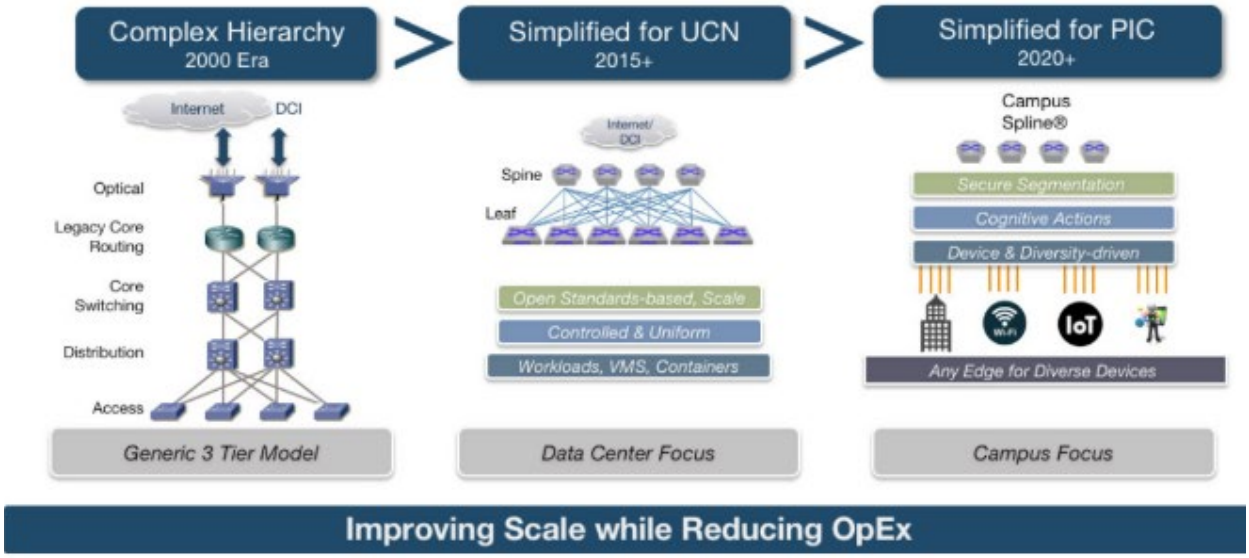

Figure 10: Cloud Networking Evolution

With a suite of features to identify users, devices, and applications and to control the access and privileges they get on the network, Arista provides a comprehensive solution to enforce context-based policies and protect the network from abuse. CloudVision WiFi also enables integration with 3rd party NAC solutions. Together with Arista's spine and PoE leaf switches, EOS software, and cognitive management plane, a new generation of simplified, secure, and automated operations can now be extended beyond the data center into the campus network.

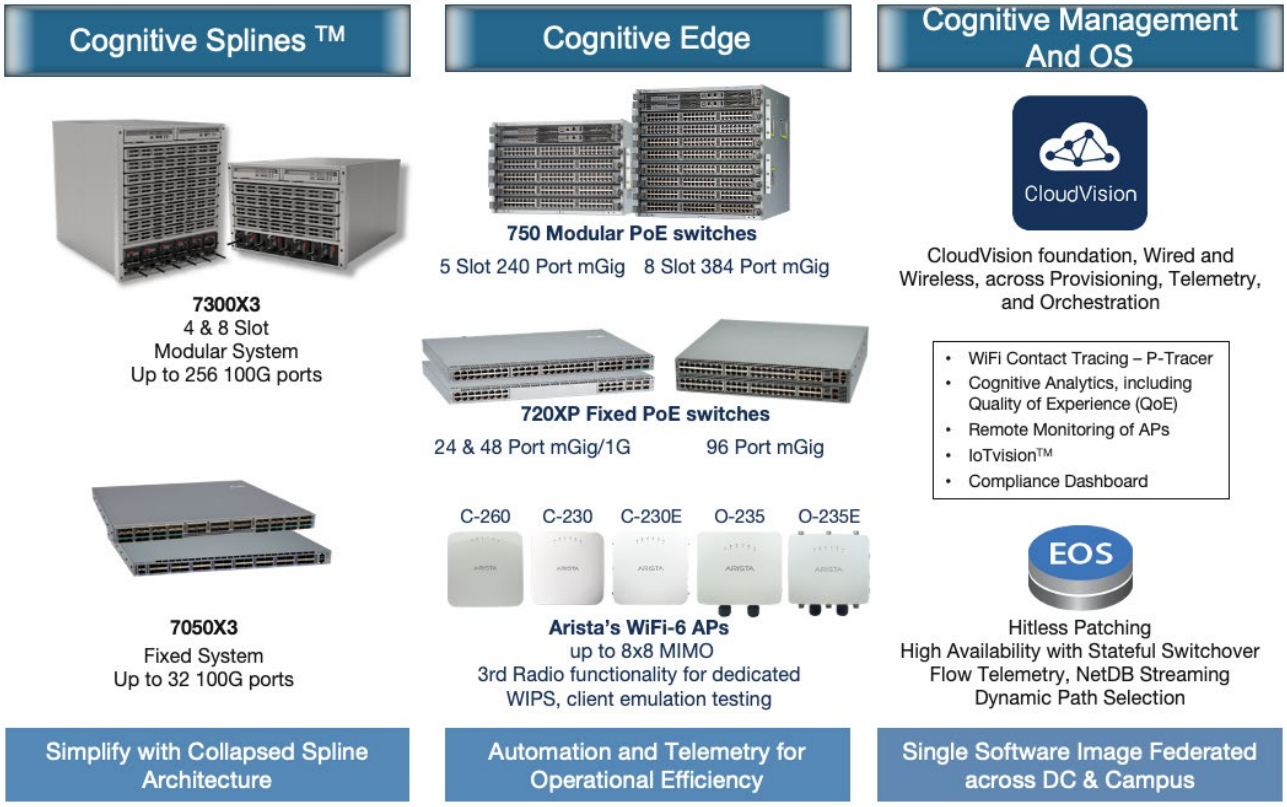

Figure 11: Arista's Cognitive Campus portfolio for cloud-based campus networks.

Data Driven Networking Advantages for this Era

Arista, outpacing legacy providers, has met the cloud providers tremendous demand with its innovative software-driven cloud networking principles and portfolio. Adopted broadly by hyper-scale cloud companies, SaaS providers, production media and gaming, critical healthcare, and global financial customersArista's industry-leading platforms, developed using the latest silicon advances and superior designs, have fueled a new generation of cloud networking solutions. Core to Arista's architecture is EOS (Extensible Operating System) software, with a single image and support for diverse merchant silicon and cloud environments. Together Arista platforms and software are driving the five A's (Availability, Agility, Automation, Analytics, and APIs and AI Driven) across data centers, clouds, and campus workspaces in private, public, and hybrid environments.

Arista continues to aggressively invest in R&D to outpace competitors, thereby bringing differentiated and long-term advantages to our customers. Arista's architecture, with cognitive cloud networking, is transformational, changing complex and siloed Places in the Network to open and efficient Places in the Cloud for profound impact on networking in the 2020 era.

For further reading

Cloud Networking:

- Facebook Blog - Introducing datacenter fabric, the next-generation Facebook datacenter network
- Arista Cloud Networking www.arista.com/en/solutions/cloud-networking

Arista's EOS

- EOS www.arista.com/en/products/eos
- EOS Programmability www.arista.com/en/products/eos/open-and-programmable
- Automation www.arista.com/en/products/eos/automation
- Telemetry and Analytics www.arista.com/en/products/eos/telemetry-analytics

CloudVision:

- At a Glance www.arista.com/assets/data/pdf/TechBulletins/CloudVision_AAG.pdf
- White Paper www.arista.com/en/products/arista-eos-cloud-vision

Platform Overview:

- Switch/Routing Platforms - www.arista.com/en/products/platforms
- Products Quick Reference Guide - www.arista.com/assets/data/pdf/AristaProductQuickReferenceGuide.pdf

Cloud Grade Routing and Hybrid Clouds:

- Cloud Grading Routing - www.arista.com/en/solutions/cloud-scale-routing
- Arista's AnyCloud - www.arista.com/en/solutions/hybrid-cloud

Cognitive Campus:

- Cognitive Campus White Paper - www.arista.com/assets/data/pdf/Whitepapers/Cognitive-Campus-WP.pdf
- Security White Paper - https://www.arista.com/assets/data/pdf/Whitepapers/ARISTA_SecuritySolutionWP.pdf

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