ADARA

SD WAN

Performance Based

Cloud Interconnections

Rev 2019

ADARA Networks
1731 Technology Drive
San Jose, CA 95110
U.S.A.

www.adaranetworks.com

10 9 8 7 6 5 4 3 2 1

ADARA SD WAN on Amazon Web Services (AWS) enables enterprises to rapidly and cost-effectively deploy world-class SD WAN capabilities within their Amazon Web Services Public Cloud deployments. SD WAN on AWS combines the elasticity and flexibility of the AWS Cloud Infrastructure with the performance, optimizations, scaling, and security, that ADARA SD WAN provides for the Private Cloud.

The SD WAN Amazon Machine Image (AMI) is a packaging of the same binary used on ADARA SD WAN VNFs. This enables enterprises to enjoy all of the same SD WAN functionality that they receive in their on premise deployments; including Performance Based WAN Virtualization through MultiPath over Multi Service provider Connections, Network Load Balancing, Content Routing and Switching, WAN Acceleration through TCP Performance Acceleration, WAN Optimization through Performance Based Data Deduplication and Compression, IPsec VPN, Business Policy Routing, Deep Packet Inspection, and more. Multiple use cases are natively supported including Hybrid Cloud, Cloud Bursting, Capacity on Demand, Business Continuity and Multi VPC Development Testing Promotion and Deployment..

The AWS Cloud has some design characteristics which should be known to AWS Architects. These design characteristics are mitigated by the ADARAs Automated Installation and Configuration of the SD WAN AMIs; the SD WAN AMIs deployment is Automated both deployed as Service Functions, or deployed as part of ADARA Direct Connections Cloud Interconnection. ADARA leverages AWS CloudFormations for Automated Public Cloud deployment. This reduces the need for AWS Architcets to manually validate the deployment of ADARA SD WAN AMIs. Additionally there are design characteristics specific to AWS to note. AWS does not expose Layer 2 networking capabilities to customers, administrators will need to enable high availability pairs in a manner that is likely different than is done in Private Cloud on-premise deployments.

SD WAN: Virtualization, Acceleration, Optimization

WAN Virtualization

ADARA SD WAN Virtualization bonds multiple WAN links, even when they are from different service providers and use a different connection medium, together to create a single, secure, logical link in order to expand WAN capacity. This enables the concurrent use of multiple circuits; enterprises can bond MPLS circuits with lower-cost Internet access options including flexible broadband connections and aggregate the bandwidth together. The effect of this is multiplication of the bandwidth available for the reliability of high-priority application traffic. Regardless of all the fluctuations in network conditions, because ADARA WAN Virtualization enables concurrent Real Time Performance Based Multipath Routing, ADARA SD WAN natively includes automatic rerouting of application traffic to ensure continued application performance. ADARA SD WAN also routes application to the best path at request time; this differs from common SD WAN which forwards traffic based on a static policy; application traffic by type is statically assigned to a path based on connection type, not based on performance.

WAN Virtualization multiplies available bandwidth for all services; UDP, TCP, as well as both repetitive (cacheable) and non-repetitive (un-cacheable) data. Additionally, ADARA WAN Virtualization features ADARA DLSP which enables dynamic performance based Multi-Path session based forwarding which eliminates the limitations of single circuit/single path networking in both switching (Spanning Tree) and routing (OSPF, RIP, BGP, PIM and IGMP).

ADARA WAN Virtualization features ADARA DLSP which enables dynamic Topology Discovery; DLSP auto-discovers all the ADARA WAN Routers on the network and establishes all neighboring relationships. ADARA DLSP computes multiple paths

between each ADARA WAN Router using multiple real-time performance, not just statistics or hashes. ADARA WAN Virtualization features ADARA DLSP which requires zero configuration and only requires the name of the management interface. ADARA DLSP uses a standard method for auto-configuration of the network interfaces and a link-local address from the special block 169.254.0.0/16, as described in RFC 3927. ADARA WAM Virtualization supports any tunneling including VXLAN and MPLS; in addition to clear text tunnels encrypted SSL and IPSec VPN tunnels are supported.

WAN Acceleration

ADARA SD WAN Acceleration speeds the rate of transmitting all TCP based data which accounts for 95% of all traffic in Networking, and the Internet. ADARA WAN Acceleration increases the performance of both repetitive (cacheable) and non-repetitive (un-cacheable) data. ADARA SD WAN Acceleration utilizes 100% of the Bandwidth; Vanilla TCP and other TCP flavors use variants of the slow start/exponential back off probing function of TCP which produces a “saw tooth” utilization pattern of transmission throughput peaks and valleys which when averaged results in only 20% to 30% of available bandwidth being utilized.

ADARA WAN TCP acceleration eliminates the delay of TCP operation by eliminating slow start (additive increase) and exponential back off (multiplicative decrease) due to TCP’s inability to know real-time network conditions and continuously and precisely reset network condition congestion control mechanisms. Conventional TCP acceleration methods are unable to determine real-time network conditions; and some TCP variants precariously function by removing congestion controls from TCP; (removing congestion controls will consume all bandwidth unfairly and prevent other services from operating).

ADARA WAN Acceleration features ADARA's implementation of the Quick Start Protocol (RFC 4782) enhanced with ADARA's DLSP, creating ADARA's Quick Start Plus TCP Protocol (QS +). Each and every TCP connection probes for the sending rate; the probing attempts to discover: "What is the correct sending rate for the current network path?" TCP by design is without visibility into networks and is unable to determine the rate at connection setup; each TCP connection merely probes the network and based on the success or failure of probes over time, TCP alters the congestion window (cwnd) based on perceived congestion.

ADARA WAN Acceleration with ADARA QS + and ADARA DLSP is a form of Explicit Congestion Notification (ECN) with communication from routers to transport protocols so that the correct transmission rate for every connection on every path is continuously calculated in real-time by ADARA WAN Routers. Traditional TCP is limited based on the ability of all the routers along any path to determine if their respective output links are significantly underutilized through those routers detecting congestion through buffer overflow (RFC3168).

ADARA QS + Proxies with ADARA DLSP enable transport protocols to know the utilization and performance of all the paths and to send at higher rates, speeding application traffic of all types and fully utilizing bandwidth. ADARA QS + WAN Acceleration virtually eliminates packet drops from arbitrary discards and congestion that cause retransmissions. Because TCP is severely impacted by both Latency and Packet Loss, it is critical to select a route for the important application connections which does not have a significant degree of Latency or a high Packet Drop rate. This allows TCP to function at optimal levels with no back off. This is why ADARA SD WAN Virtualization Performance Routing is a critical compliment to ADARA SD WAN Acceleration and reinforces their cooperative function as a system.

WAN Optimization

ADARA SD WAN Optimization uses Data de-duplication to reduce request frequency through digital caching and intelligent compression to decrease the size of requests. ADARAs WAN Optimization algorithm is so advanced that compression level has increased from 91.4% to and industry leading 99.6% level using novel ADARA technologies.

Since Voice and Video traffic are highly latency sensitive; ADARA SD WAN Optimization does not inject latency by manipulating packets for UDP services; this would only increase delay at both of the- WAN links. However, ADARA WAN Optimization improves performance for select UDP applications such as Instagram uploads, file transfers, streaming Audio/Video media and movie downloads may all use HTTP/TCP, and. For Real-time UDP traffic, the correct method is to utilize Admission Control mechanisms to prioritize and guarantee bandwidth where appropriate and optimize Control instead of Data channels. ADARA WAN Optimization by design does not delay data when it is UDP audio or video media type.

Quality of Service (QoS)

ADARA Quality of Service (QoS) delivers Traffic Shaping for TCP sessions. Additionally, QoS enables Priority in Queue Processing, and Class based Bandwidth Resource Reservation in percentage of the static circuit or an explicit data rate in bits per second with full support for borrowing between classes.

ADARA Quality of Service extends from Active Queue Management; Prioritizing in Queue, and Reserving and Borrowing Bandwidth. ADARA Quality of Service also includes ADARA QoS Routing.

ADARA Passive QoS Routing

ADARA Passive QoS Routing, or ADARA Constraint Based Routing is an ADARA industry leading feature. QoS is performed by forwarding application traffic over circuits or paths where QoS performance is measured in real-time to match the application's needs.The ADARA Passive QoS Routing provides another measure of QoS over the intermediate interfaces that compose the WAN and Internet, exactly the portions of the end-to-end path that traditional QoS Prioritization and Resource Reservation cannot be controlled.

ADARA Active QoS Routing and Traffic Engineering

ADARA Active QoS Routing, is ADARA Real Time Traffic Engineering; is an ADARA industry leading feature; QoS by forwarding application traffic over circuits / paths where QoS (performance) is measured and enforced in real time; shaping path quality to match the application's needs. ADARA Active QoS Routing distributes and re-distributes application traffic, enabling Traffic Engineering with / without MPLS using traffic oriented performance metrics together including packet transmission delay (latency), packet delay variation (jitter) packet loss (drop rate), throughput, utilization, real time link bandwidth, real-time tunnel bandwidth, congestion, and more.

The forwarding decision provides another measure of QoS over the intermediate interfaces that compose the WAN and Internet, exactly the portions of the end-to-end path that traditional QoS Prioritization and Resource Reservation cannot be controlled. ADARA Active QoS Routing measures performance in real time and supports dynamic Traffic Engineering in response to real-time conditions; the ADARA Active QoS Routing provides a measure of QoS.

ADARA Quality of Service (QoS) and Active Queue Management (AQM)

ADARA QoS features ADARA Active Queue Management (AQM). Industry-wide, queue management is limited to an administrative determination of resources into which there is little to no visibility. ADARA QoS with Active Queue Management has full visibility into application flows and real-time network performance.

Industry queue management consists of "Policing"; the discarding or intentional dropping of packets to "trick" TCP's blind probing mechanism into perceiving link quality is poor, causing TCP to slow down flows; this type of "shaping" and policing is not beneficial to services. Industry-wide, vendors using any of a number of Queue Management techniques; Tail Drop, RED, WRED, ARED, RRED, consist of routers that have no knowledge of the traffic that they are dropping.

ADARA AQM and Access Control features "a flow in a flow set" with Access Control ("AC") assigned and monitored in real time. Bandwidth used by the flow is determined and if a flow begins to exceed its threshold level, instead of randomly dropping packets, a selectable integer of one or more of nth packets associated with the flow are selectively passed through a "Penalty Box" based upon ADARA's advanced algorithms. Multiple Passes through the Penalty Box are possible and one or more packets associated with the flow can be either selectively delayed or dropped based upon bandwidth and ADARA AC Policy.

ADARA's advanced algorithms support selectively determining the number of packets in the penalty box, the time the packets are in the penalty box, the arrival rate of the packets in the penalty box; all determined by the ADARA AC Policy algorithm. ADARA AQM has full visibility, is dynamic, requiring zero configuration; users are not required to make any adjustments. ADARA AQM is so dynamic it can treat good queue and bad queue differently; keeping delays low while permitting bursts of traffic. ADARA AQM is real time, so it adapts to dynamically changing link rates with no negative impact on utilization while it manages delay, round-trip times, link rates, and traffic loads. It is simple and efficient, and easily scales and spans the spectrum from low to high

throughput. ADARA QoS with Active Queue Management delivers the Best Available Rate, or the Best Enforceable Rate.

ADARA QS + and ADARA DLSP operates as a form of Explicit Congestion Notification (ECN); the correct transmission rate for every connection on every path is continuously calculated in real time by ADARA Active Queue Management in ADARA WAN Routers.

ADARA Advanced Admission Control

ADARA Advanced Admission Control features the industry's most advanced technologies for real-time applications'. ADARA's novel algorithms enable fully protected lossless real time flows. Real-time Applications are perhaps most difficult to network; they are based upon UDP, with no concept of sessions, guaranteed delivery, and acknowledgment; only flows.

Since UDP-based applications are real-time streams, without re-transmissions for lost or dropped packets, typical congestion control mechanisms' are a poor choice for QoS; typical QoS mechanisms' for TCP; static bit rate and percentage of bandwidth reservation mechanisms cut across all sessions and do not protect "whole flows" of real-time streaming applications.

Industry-wide admission control for non-congestion-controlled flows, such as streaming video, is severely limited; as the number of users increases, all flows are degraded equally, all flows start dropping packets because the existing techniques cannot maintain a quality data traffic throughput. Since these packets are dropped from flows equally, instead dropping packets based on statistical probabilities, the user experiences, poor video, choppy frames and video freezing. All users are degraded equally, and this leads to situations where none of the users receive good streaming service.

ADARA Advanced Admission Control uses the novel ADARA AC Policy Algorithm. The access control policy is assigned to the flow, bandwidth for the flow is monitored, and the flow is marked for transmission based on monitoring of the bandwidth. ADARA AC policy assigned to the flow is associated with at least one or more of (a) a bandwidth and (b) a priority rank and the protected flows are guaranteed lossless streaming service. The flows are defined based on; Source/Destination Address, Source/Destination Port, Source/Destination MAC, Type of Service (ToS), DiffServCodePoint (DSCP) and ADARA Sky Controller and Flow Rules.

ADARA WAN platform delivers the industry best video and audio services. Streaming multimedia services consumption is the fastest growing area of networking. ADARA WAN works with ADARA's Content Delivery Platform, with Distributed Load Balanced Content Caching, Dynamic, Video Caching for video on demand and Streaming Media Bridging for live streams, video, and audio. This content can be from any internal and external sites can be identified, optimized and actively managed.

ADARA Service Level Agreement Manager and Deep Packet Inspection Dashboard

To guarantee the best in end-user Quality of Experience (QoE), ADARA delivers real-time and historical trends in dashboard views showing performance and usage levels, and allowing quick and easy identification of performance issues in application delivery.

ADARA's Deep Packet Inspection Engine supports 600 + pre-defined application types; the best-known applications already engineered, ready for out-of-the-box enhanced WAN service.

Private Cloud, Enterprise and Branch Service

ADARA's SD WAN Platform offers the option of implementing in any size environment. With remote install and configuration, Branch deployment is seamless. ADARA also works with services such as MSFT Active Directory, DNS, DHCP and others to enable easy management in your environment. ADARA's SD WAN Platform runs as VNFs with or without OpenStack Cloud Software. Additionally ADARA offers a complete OpenStack Implementation, or ADARA SD WAN VNFs can be deployed on existing customer OpenStack implementations. ADARA SD WAN VNFs are fully integrated with the ADARA Sky Controller; and additionally can be managed by any standards based OpenFlow Controller.

ADARA SD WAN Platform – Key Benefits:

WAN Acceleration

- Accelerating application performance over wired infrastructure by 5 – 100 times
- Accelerate application performance over wireless infrastructure by 10 – 1,000 times
- 100% Bandwidth Utilization supports more users of virtual applications and remote desktops. ADARA WAN Acceleration increases the performance of Citrix applications such as ICA / Xen and Microsoft applications such as file sharing, Exchange and SharePoint as well as any TCP-based application, including file transfers, email, SSL, ERP, CRM, CAD, data backup and storage replication.
- Reducing re-transmissions by 1,000 times
- Increase Bandwidth utilization by 500 %
- Accelerate, Encrypt and Secure WAN Traffic
- Optimized TCP
- Optimized UDP

WAN Virtualization

- Bonds multiple WAN links together to create a single, secure, logical link

- Expands WAN capacities
- Enables real-time policy based concurrent use of multiple circuits
    - Bond MPLS circuits with lower-cost Internet access options including low-cost flexible broadband connections
    - Aggregating the bandwidth of each circuit
    - Multiplying the bandwidth available for reliability of high-priority application traffic
    - Includes automatic rerouting of application traffic
    - Ensures continued application performance regardless of fluctuations in network conditions
    - Multiplies available bandwidth for all services; UDP, TCP, as well as both repetitive (cacheable) and non-repetitive (un-cacheable) data.

WAN Optimization

- Reduce Bandwidth usage
- Faster Application Response Time
- Integrated WAN Acceleration / Virtualization
- Multiple Rich set of Policy Selectors
- Configurable Dictionary
- Industry leading level of Optimized Compression

ADARA SD WAN

- CAPEX and OPEX Savings
- Industry-leading performance scalability technology and features
- Automated Disaster Recovery and Prevention
- Traffic Engineering with/without MPLS
- Improved Virtual Desktop Performance for Branch and Remote Users
- Improved End-User QoE

- Integrates into ADARA Industry leading Content and Streaming Content Delivery
- desktop
- Service Level Agreement Guaranteed Enforcement ensures high performance for
- mission critical applications
- Supports Cloud deployment and migrations
- Integrated Security
- Simplified IT Management
- Full application visibility

Use Cases

Compared to alternative solutions which are not real time performance based, ADARA SD WAN on AWS combines Performance Based WAN Virtualization through MultiPath over Multi Service provider Connections, Network Load Balancing, Content Routing and Switching, WAN Acceleration through TCP Performance Acceleration, WAN Optimization through Performance Based Data Deduplication and Compression, IPsec VPN, Business Policy Routing, Deep Packet Inspection, and more, with modular deployment as AMIs conveniently available via the AWS Marketplace.

ADARA supports Central Management and a single policy or multi policy framework.

ADARA SD WAN AWS Public Cloud AMIs and Private Cloud VNFs can be managed directly by the ADARA Sky SDN Controller or any standards based OpenFlow Controller

ADARA SD WAN AWS Public Cloud AMIs and Private Cloud VNFs can be managed as part of the ADARA Direct Connections Interconnection Platform.

ADARA SD WAN AWS Public Cloud AMIs and Private Cloud VNFs can be managed by the ADARA CloudFabric Cloud Management Platform which implements:

Full Public Cloud Management through AWS APIs for EC2, ECS, S3m and IAM, and features AWS CloudFormations for Automated Deployment, AWS Auto Scaling and AWS ELB.

Full Private Cloud Management through a complete OpenStack Private Cloud Software Build to administer on-premise SD WAN deployments

Full Hybrid Cloud Management for all Compute and Network functions.

ADARA SD WAN enables myriad essential and compelling use cases that not only support the immediate needs of today's Clouds and Cloud customers, but also the ongoing evolution of Cloud Computing and Networking.

Production in Public Cloud– Enterprises can enjoy High Performance and High Availability Cloud services by leveraging AWS as an Infrastructure- as-a-Service (IaaS) offering for production delivery of applications with ADARA enabling High Performance service from AWS to Enterprise on –premise and Private Clouds and High Availability networking through ADARA SD WAN. AWS as an Infrastructure- as-a-Service (IaaS) and ADARA support scaling on demand (AWS Auto Scaling) to support any level of production demand.

Hybrid Cloud Designs – Enterprises can create Multi-Cloud High Performance and High Availability service at the Computing and Network levels between Public and Private Clouds. This enables capacity-on-demand from the Public Cloud; from the perspective of the customers, employees and suppliers requests are served from the Enterprise. The full suite of ADARA SD WAN capabilities can be leveraged on AWS.

Business Continuity – Enterprises can enjoy High Performance and High Availability Enterprises by leveraging AWS as an Infrastructure- as-a-Service (IaaS) offering and ADARA as part of their disaster recovery and business continuity plans can rely upon ADARA SD WAN running both on-premise and within AWS to continuously monitor availability and performance of both enterprise datacenters and AWS environments.

Development and Testing – Enterprises can operate multiple VPCs; Test and Development, Staging and Scaling, Production and Optimization, and share resources between the VPCs and on-premise and Private Clouds. This speeds time to production and improves quality and assurance.