



Turnium SD-WAN Technical Briefing



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Introduction

Turnium software-defined wide area network (SD-WAN) solution allows you to build resilient, cost-effective virtual networks that interconnect the corporate WAN, multi-cloud and hybrid network solutions simply and easily. Turnium also enables uCPE solutions and supports Edge compute requirements as well as integration with existing network orchestrators.

Deploying Turnium provides business continuity and reliable connectivity by aggregating broadband, wireless and fiber links from multiple carriers, and delivers true Quality of Service (QoS) and an exceptional end-user experience.

Key Highlights:

- Benefit from highly resilient connectivity as a foundation for virtual networks that can span regions, countries, and continents easily. Turnium abstracts the management plane from the physical network layer and delivers the functions required to provide advanced multisite networking in software.
- Turnium reduces reliance on incumbent carriers and delivers high performance connectivity without time-consuming carrier negotiations, challenging contract management and lengthy deployment and change processes. Turnium also provides operational simplicity, automating many manual tasks, reducing errors and deployment testing. And with visibility into the performance of all circuits, regardless of carrier, Turnium delivers higher customer experience.

This document is for technical and business readers seeking to learn more about the Turnium SD-WAN solution and its unique advantages.

The Software-only, Carrier Agnostic Virtual Networking Platform

Overview

Traditional networks are controlled by telecom service providers. Most SD-WAN platforms are also controlled by telecoms or black-box hardware by original equipment manufacturers (OEMs) through their use of proprietary hardware or control of the head-end, core network, routing, and IP addressing.

Turnium gives you complete control over building and managing private wide area networks, including routing.

Turnium is the fastest, simplest way to experience reliable managed services, to benefit from multi-cloud deployments and to implement flexible and secure software-defined networks.

Build and Control Virtual Networks Over-the-Top or Hybrid L2/L3 Networks

Turnium enables you to run SD-WAN Core node and Edge node software (CPE) on affordable, open standard, x86 white box devices in bare metal, virtual or container-based environments. This flexibility enables you to manage costs and size solutions effectively for each customer.

Turnium allows you to:

- Deliver secure, multi-site over-the-top (OTT) networks rapidly and support customers securely on multi-tenant core nodes or, for qualified customers, through dedicated deployments.
- Manage a virtual network overlay that provides independence from the underlying carriers and the control needed to deliver a managed, reliable, secure, high-performance network that delivers high quality managed services.
- Create and deliver multi-site private, secure networks easily and simply using multiple internet circuits from any carrier available at the customer site, whether the sites are distributed locally, nationally, or globally.
- Benefit from automatic inter-site routing and inter-data-center routing as well as core node mesh.
- Integrate with Layer 2 Ethernet or MPLS circuits to deliver hybrid networks.
- Host nodes in public¹ or private clouds to enable multi-cloud networking.

¹ Some public cloud providers support networking better than others. Please check with us before attempting to deploy networking solutions that involve public cloud and benefit from our experience. We have also published, separately, guidelines on how to deploy Turnium core and edge nodes in various public cloud providers.

Single Management GUI

All configuration for routing, security, encryption, SD-WAN performance (latency, jitter, packet loss, flap detection), split-tunneling and elastic QoS is software-driven and managed by you through a single GUI on a Management Portal. Command-line interaction is not required, greatly simplifying and reducing the time required for deployment and changes.

The Management Server does not sit in-line with any customer data to ensure data integrity and provides remote configuration and control of all Core and Edge nodes as well as a reporting interface. Turnium can also be fully controlled using API calls.

Multi-Tenant Core SD-WAN Application

Turnium delivers SD-WAN using a Core node type called Aggregators, deployed in your data centers. Aggregators deliver and manage the site-to-core SD-WAN communications, bandwidth management, Quality of Service, bandwidth monitoring and adaptation, and site-to-site networking and routing.

A typical single Aggregator node can support 50 unique sites with 150 to 200Mbps of average traffic per site. The number of sites supported by an Aggregator may increase based on lower average throughput. Multiple Aggregator nodes are deployed to ensure load balancing and minimize impacts of any failover events. Aggregators are configured to failover in pairs.

- Currently, specialized deployments can deliver gigabit speeds per site and technologies are in development to deliver greater than a gigabit.
- Aggregators scale horizontally, and additional Aggregator nodes can be deployed in any data center or cloud environment to support geographic expansion.
- Turnium scales easily and is cost-effective to enable customers to deploy across all their sites, branches, vehicles, or cloud services.

IP Addresses – IPv4 or IPv6

All sites delivered using Turnium use your IP addressing and NAT to enable private addressing space and support Private Wide Area Networks (PWAN – private multi-site networks enabled by Turnium) for all your clients without requiring a massive number of IP addresses or worrying about overlapping subnets.

Turnium supports dual-stack IPv4 and IPv6 addressing to accommodate legacy networks while enabling growth for the future. While many deployments do not use IPv6 today, Internet of Things (IoT) deployments will require the large addressing space that IPv6 provides. Turnium can use both IPv4 and IPv6 at the same time, depending on End-Customer requirements.

High-Level Solution Architecture

Turnium is designed to deliver high availability core SD-WAN infrastructure across multiple data centers. Core and Edge nodes operate independently of the centralized Management Server or Orchestrator. No customer data flows through the Management Server.

Turnium architecture includes:

1. The Management Server. The Turnium Management Server is the command/control GUI that you use to manage all customer deployments, detect issues, configure new sites, conduct changes, and provide reporting.
2. Software on Core nodes and on Edge nodes. Turnium runs the same software image on both Core and Edge nodes, making deployment simple. This software establishes the SD-WAN connection between site (Edge) and your SD-WAN Core nodes. Both node types self-configure based on a node key generated by the Management Server when the initial records are created in the Management Server.

Core nodes provide:

- a. Link aggregation and tunnel management (QoS, failover, encryption, bandwidth adaptation, traffic/packet balancing across multiple circuits or links).
- b. Routing between the Core nodes (Aggregators) and between the Core nodes and your core routers and gateways.
- c. Core SD-WAN node mesh is delivered using an automated mesh between core nodes built by Turnium SD-WAN. This is referred to as Managed Mesh because the SD-WAN software manages the mesh. Unmanaged Mesh is provided to support custom designs. Core nodes can be in multiple data centers and geographies.
- d. Multi-tenancy to support multiple end-customers and end-customer branches or sites in their own private, secured, routable IPv4 or IPv6 space.
- e. Re-use of subnets across private spaces.

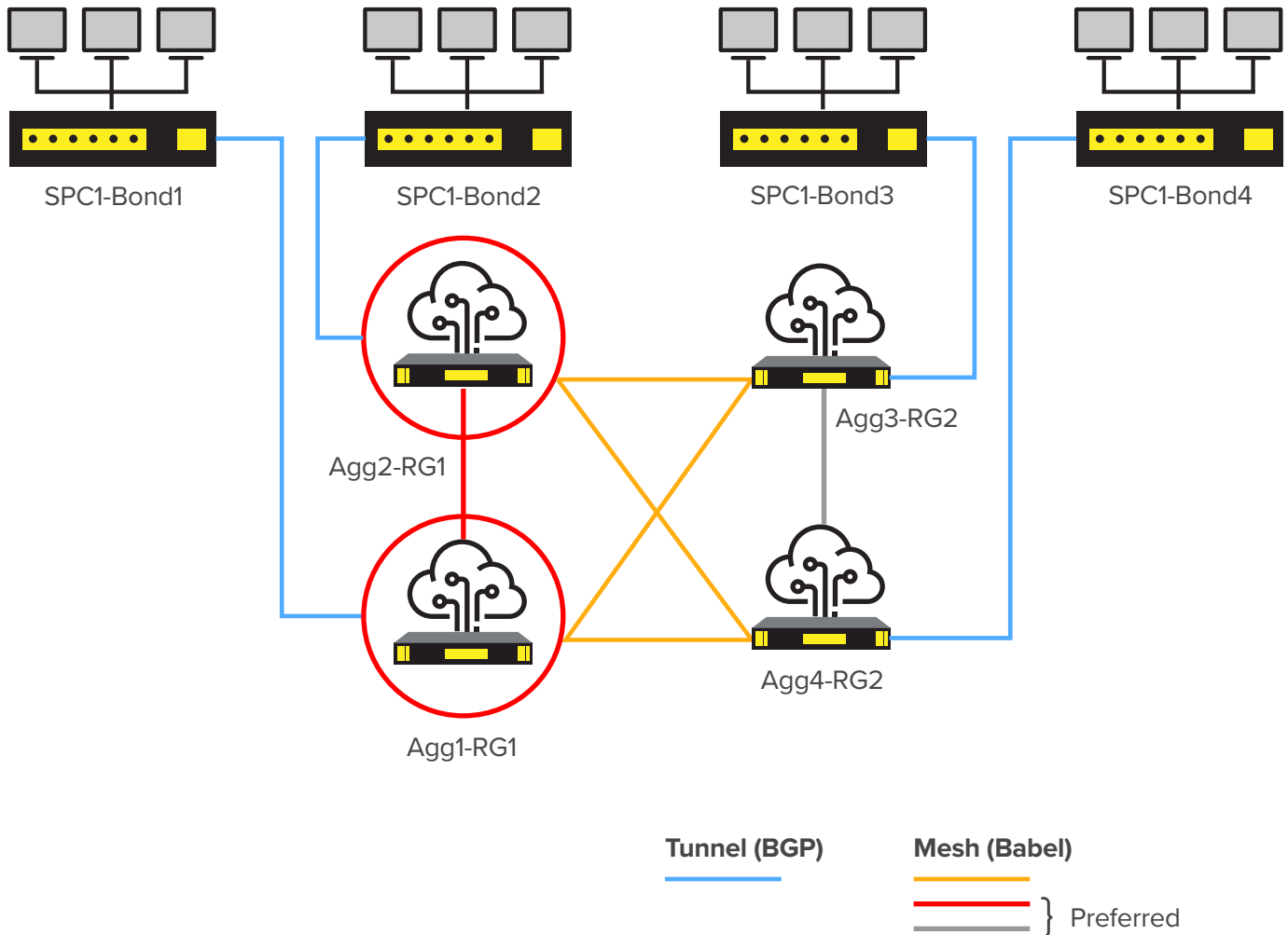
Edge nodes provide:

- a. Physical link aggregation and interface between the WAN and the customer LAN at each site.
- b. Tunnel management (QoS, failover, encryption, bandwidth adaptation, tunnel bypass).
- c. The option to virtualize or containerize applications running alongside Turnium on the same CPE to take advantage of CPE capabilities and network placement for Edge compute or uCPE applications.

The diagram on the next page illustrates a two-data center deployment of Turnium in a Managed Mesh PWAN design.

- Core Agg1 and Agg2 are in one data center while Agg3 and Agg4 are in another data center.
- The Core nodes are shown in a mesh configuration for both instance and geo-redundancy.

In this diagram, all sites are in the same customer private space, labelled SPC1. There are four sites, each with multiple WAN links in the SD-WAN, networked together privately and securely. Traffic between each of these sites, which could also be data centers, is transmitted across multiple underlying carrier last-mile circuits and networks, delivering higher reliability and availability. The inherent design of using per-packet balancing across each circuit at each site provides built-in security against data interception (man-in-middle attacks). Data can also be encrypted for further security using DTLS.



Data centers can be connected by dedicated, partner-owned circuits or connected over the Internet using VXLAN tunnels created by Turnium. Core node Aggregators are meshed for high availability in this Managed Mesh PWAN design.

End-customer sites connect to a Primary Aggregator using multiple physical circuits aggregated into a single, virtual SD-WAN connection. Sites failover to a designated Secondary Aggregator, which can be in the same Data Center as the Primary or in another. The SD-WAN to each site is established between the Edge and Core nodes (Aggregators).

Why it Matters

Turnium delivers a network with meshed core nodes for a highly resilient and simple architecture that reduces the complexity of deploying networks while helping to deliver business continuity.

High Efficiency SD-WAN

Overview

Turnium builds SD-WAN connections between customer sites and your network over top of any type of available network connection: L2 or L3 fiber, broadband coax (DOCSIS), broadband copper (DSL) or wireless (fixed wireless or LTE/4G/5G).

Multiple connections from multiple service providers can be aggregated into the SD-WAN. Customers can use the connectivity options existing at each site or add new circuits at each site. Using multiple carriers provides built-in route, core network, and access network redundancy, helping to deliver survivability and business continuity in case of carrier outages.

The SD-WAN Turnium delivers is a fully featured SD-WAN network with high efficiency link aggregation, automated performance management based on circuit jitter, latency, packet loss and flap detection. It provides bi-directional elastic Quality of Service to prioritize packets when present, as well as sub-second session-level failover across circuits in the SD-WAN, encryption, and a TCP Proxy.

Greater than 90% Efficient Link Aggregation

Turnium link aggregation technology combines the bandwidth of multiple circuits from multiple carriers to deliver over 90% of the available bandwidth into the SD-WAN.² Turnium can aggregate connections of any type —fiber, coax, copper, fixed wireless or LTE/4G/5G.

Link aggregation efficiency over 90% is unique and few, if any, competitors reach this level of efficiency. Highly efficient link aggregation optimizes use of existing network resources, reduces the need for additional bandwidth and provides a higher Return on Investment on network spend. Link aggregation sends traffic across all available circuits simultaneously, delivering high reliability in real-time, without the complications and cost of designing and deploying active/failover network designs.

Per-Packet Link Load Balancing

Turnium delivers link aggregation using per-packet load balancing techniques. This approach breaks the packet stream originating from a site's LAN into multiple packets that are distributed across all available circuits connecting the site to the SD-WAN core.

² Available bandwidth is different from the advertised bandwidth due to overheads consumed by transmission protocols including TCP, IP, Ethernet, MPLS.

The Turnium software loaded onto the CPE at each site manages packet distribution across the multiple circuits in the SD-WAN virtual tunnel based on a choice of algorithms (see below).

As the data stream from the LAN is managed at a packet-level, Turnium can proactively and automatically change how each circuit in the SD-WAN is used, removing, or adding it back into the SD-WAN based on its performance. This provides superior stability, efficiency and uptime compared to competitor solutions that use Forward Error Correction (“FEC”). FEC duplicates priority packets across the circuits in the SD-WAN, decreasing efficiency by increasing network saturation.

Packet-based balancing, plus Link Aggregation and Sub-second Same-IP failover, delivers exceptionally reliable connectivity and continuous end-user access to remote applications, cloud services and the Internet, while delivering real-time application, session, and business continuity. Packet-based balancing also provides internet security at an architectural level making it more difficult to intercept, data and securing against man-in-the-middle attacks.

Three options can be selected to change how packets are allocated to links dynamically:

1. Weighted Round Robin is a simple algorithm that balances traffic across legs in proportion to their configured speeds. For example, in SD-WAN site connection with a 3 Mbps circuit and 6 Mbps circuit, one third of the traffic will be sent on the 3 Mbps circuit and two thirds of the traffic will be sent on the 6 Mbps circuit. Weighted Round Robin is a good choice for SD-WAN site connections using circuits of the same type, bandwidth, and latency, or where many people are using the internet and network at the same time, such as in a large office network.
2. Flowlet is an algorithm that minimizes packet reordering by splitting bursts of traffic in a single flow into sub-flows called “flowlets”. Each flowlet is assigned to a single circuit. The flow may be assigned to a different circuit after an idle period.
3. Intelligent Delay Managed Packet Queuing (IDMPQ) is an algorithm that constantly analyzes circuit delay, speed, queue size, and traffic characteristics to make packet distribution decisions that minimize packet reordering and delay variation. IDMPQ is an excellent choice for SD-WAN site connections using different types of circuits at the same time, such as DSL and Cable broadband connections.

The per-packet load balancing technology used in Turnium is unique in the SD-WAN marketplace. Other vendors have concentrated on session allocation, which creates a much slower failover environment and forces the vendor to deploy technologies like Forward Error Correction (“FEC”) to compensate for the variable quality of Internet circuits.

FEC is deployed to compensate for the packet loss or jitter that occurs in broadband Internet circuits by duplicating voice or video packets over multiple circuits. Instead evaluating circuit performance and sending packets over the best circuit, FEC floods all circuits with multiple sets of packets with the hope that eventually all the required packets will reach the other end. In the end, this increases network traffic unnecessarily.

Automatic Leg/Circuit Performance Tuning

Turnium can automatically detect characteristics of the individual circuits that comprise the SD-WAN tunnel to a site and rate-shape them. This is critical to delivering stability, performance, and quality of service for end-users and applications including voice and video.

Bandwidth Adaptation and Performance Management

Turnium SD-WAN is highly robust and adapts automatically to changes in the performance of the underlying physical network. Bandwidth Adaptation automatically removes circuits from each site SD-WAN connection that exceed jitter, latency and packet loss limits and re-aggregates the circuits once their performance is restored. Circuit flapping is also detected and managed.

Elastic, Bi-Directional Quality of Service

User application performance and experience is managed through bidirectional quality of service (QoS). In Turnium deployments, the Core and Edge nodes manage both sides of any Internet, broadband, wireless or fiber circuit, enabling QoS to be applied on both upstream and downstream packets. This allows real-time prioritization of voice and video packets, or designated packets from other applications.

QoS is applied to each SD-WAN connection at a per-site level in an elastic fashion, meaning that bandwidth reservation is only applied when packets tagged as Priority or Real-time are present. If no such packets are present, other classes can use all bandwidth available in the SD-WAN.

Elastic QoS ensures that the customer receives full access to all available bandwidth and is not compelled to purchase additional bandwidth to support fixed QoS allocations. In addition to QoS, sub-second failover across circuits in the SD-WAN or to circuits designated as Failover (e.g., metered wireless circuits) ensures that real-time applications stay connected.

The QoS engine in Turnium SD-WAN is preconfigured with four QoS classes (Real-time, Interactive, Routine and Bulk) to facilitate simple deployment. Additional classes can be created on a per-customer level to support unique requirements.

Sub-second, Same-IP, Session Failover

All circuits in Turnium SD-WAN are active all the time and any circuits that fail are automatically removed from the SD-WAN within 300 milliseconds. Circuits can also be set to a standby Failover status (not fully active) and added to the tunnel within 300ms. This is commonly done when metered circuits such as wireless LTE/4G/5G are being used to complement primary landline circuits but need to be available to provide backup and business continuity.

Turnium uses unique IP address space for user data transport to remove the dependency on the underlying IP addressing at a link or physical circuit/ISP level. This helps to ensure that a site's connectivity to the Internet or the SD-WAN is continuous and that all session-based applications remain active. From an end-user perspective, this means that telephone calls or video calls will remain connected and not abruptly terminate if any underlying circuits in the SD-WAN, delivering business continuity and customer satisfaction.

Security & Encryption

All packets transmitted across the SD-WAN tunnel are encapsulated in a proprietary UDP-based tunnel. This protocol is architected for efficiency, performance, and security.

SD-WAN traffic in Turnium is protected through packet-based link load balancing and industry standard encryption algorithms. This technology distributes packets from data flows across the multiple circuits in the tunnel connecting each site to the Turnium SD-WAN network, making data intercepts less likely. Packets can be further protected by activating AES128 or AES256 encryption on SD-WAN connections.

TCP Proxy

This built-in performance-enhancing proxy greatly increases throughput and is helpful when aggregating or creating a SD-WAN using diverse types of Internet connections, such as ADSL + Cable, or when a connection has high jitter or varying bandwidth. The TCP congestion control algorithm defines the behavior of proxied TCP connections. Currently, there are 14 different algorithms from which to choose when configuring a bond on the Management Server.

Why it Matters

High efficiency tunnels enable Turnium to deliver network designs that:

- **Manage costs by using network resources efficiently:** Over 90% of the available bandwidth of each circuit in the tunnel is available for use in the tunnel. Other SD-WAN vendors typically deliver 60-70% efficiency, requiring more bandwidth to be purchased per site, driving up customer costs.
- **Deliver uptime through sub-second failover:** As all circuits are used simultaneously, there is no manual configuration or delay waiting for circuits to activate automatically and it is easy to achieve 99.999% uptime without resorting to expensive carrier-based solutions.

A Game Changer

Link aggregation efficiency over 90% is unique. From an end-customer perspective, high efficiency optimizes expenses and increases reliability.

Configure Private, Secure Wide Area Networks Simply and Easily

Turnium enables private, secure, and optionally encrypted, routed networks to be configured and deployed easily between multiple end-customer sites. No command-line programming is required to deploy these networks, reducing errors, and dramatically increasing the speed of network deployment and changes or reconfiguration.

Using the Graphical User Interface (GUI) in the Management Server, your staff can quickly enter the necessary values to create a new customer site, add bandwidth, or activate features at an existing site. A simple click then saves the configurations, writes them to the Core Aggregator nodes in that customer space and pushes the necessary configurations to the CPE. If CPE are not connected or deployed at customer sites, once the CPE come online, the configuration is automatically downloaded to the CPE.

Turnium delivers this advanced capability in a simple, easy-to-use fashion that enables networks to be delivered quickly and efficiently.

Setting up a Private Wide Area Network (PWAN) involves:

- Configuring Core nodes and Edge nodes using the GUI (this includes use of address space, assigning gateways and overall network design).
- Testing the network and the connection to each site (link aggregation or bonding) using built-in Automatic Link Tuning.
- Configuring bandwidth adaptation.

PWAN Options

There are two options to deploy PWAN using Turnium software:

1. PWAN Managed Mesh
2. PWAN Unmanaged Mesh

These PWAN options enable networks that feature a high degree of automation and simplicity to react to changing customer network designs and reduce the complexity of SD-WAN deployments while providing control to deliver custom network designs.

Unmanaged Mesh requires network engineering to deploy due to the increased flexibility it provides to create custom Private WAN topologies. Unmanaged Mesh will enable BGP between CPE and Aggregators in the customer SD-WAN automatically.

Managed Mesh uses a combination of VXLAN interfaces and dynamic routing protocols to deliver Private WAN routing with Core nodes (Aggregators) peered directly to each other. Managed Mesh Private WAN automatically creates a VXLAN mesh between all Aggregators (one for each space). It configures the Babel dynamic routing protocol on the mesh so that all Aggregators communicate routes for the mesh space, with Aggregators preferring routes within the same routing group. It also establishes BGP between CPE and Aggregators in the customer SD-WAN automatically.

A distinct mesh is established for each Managed Mesh Private WAN customer space. The mesh expands and shrinks to include and exclude Aggregators as CPE belonging to a Managed Mesh Private WAN space are added or removed.

There are no statically configured gateways in Managed Mesh Private WAN, and no PWAN NAT is done in the SD-WAN. Instead, Aggregator interfaces and protocols can be created to peer with external routers as needed.

Benefits

Benefits of Turnium PWAN

The Private Wide Area Networking (PWAN) capability in Turnium provides all the benefits of dedicated, leased line networks with higher flexibility, ease of deployment, manageability, and visibility at a lower cost.

By capping or reducing spend on existing dedicated circuits, such as MPLS, and replacing them with a combination of secure, encrypted, and resilient broadband, wireless or lower-cost connections, Turnium can increase network performance and deliver built-in failover.

Managed Mesh reduces the number of hops between endpoint and destination, and as Core node Aggregators and CPE/Bonders peer with external routers directly, PWAN networks can fully integrate with other, existing, networks using dynamic routing.

By distributing packets across multiple physical circuits from multiple carriers to create the SD-WAN, the likelihood of data intercepts is minimized as all circuits would need to be compromised.

- a. Set-up and configure multi-site, private, secure networks easily and quickly.
- b. GUI-driven provisioning, including dynamic routing.
- c. Integrate SD-WAN with existing corporate network designs.
- d. Cap or reduce spend on expensive, inflexible dedicated networks, especially to sites or branches with high-cost sensitivity that still need to be on the secure corporate network.

Open Architecture, White-box Hardware:

Turnium is designed to provide the highly flexible deployment options.

Hardware Agnostic with Multiple Deployment Methods

Turnium is not dependent on proprietary hardware, either in the network core or at the customer edge. This increases the supportability of Turnium and reduces costs, enabling savings for end-customers.

Turnium can be deployed on bare metal x86 servers, in virtual environments (KVM, Hyper-V, vSphere) or in container types (NSPAWN, Podman, Docker) using orchestration types such as Kubernetes and OpenShift.

Open Architecture, API and Containers for Multi-Cloud Containerized Deployments

Turnium can be deployed in public and private clouds, enabling you to bring workloads in any environment into a customer's Private Wide Area Network. CPE nodes are easily deployed in any cloud environment while Turnium core nodes can be deployed effectively in IBM Cloud and, in special circumstances, in Azure or AWS, as well as in other cloud environments.

You can also deliver dedicated Turnium instances to qualified enterprise customers. These customers can host and control their own Core and Edge nodes and in certain circumstances, may also host their own Management Server.

Turnium Edge nodes can be delivered in containers and orchestrated through Kubernetes-based tools such as Red Hat OpenShift. Turnium is CNF certified for Red Hat OpenShift. Container deployments enable rapid deployment, remote configuration changes, and remote management to enable uCPE solutions and flexible deployment of Edge compute applications.

Optional Containerized WAN Optimization

Turnium SD-WAN also includes the option for a light-weight container-based integration. Turnium SD-WAN reduces compute overhead by eliminating the need for a hypervisor on the node and by making use of Kubernetes-compatible container management platforms to deploy and manage the containers. Turnium has applied DevOps principles in the development of its containerized SD-WAN solution and facilitates updates and upgrades with little required downtime.

Production deployment: Replify

Replify WAN Optimization increases the effective or perceived performance of existing wired and wireless WAN connections through protocol optimization, block-level de-duplication, and compression. When the appropriate keys are provided, Replify safely and securely accelerates SSL connections using the latest and most secure TLS protocols and features. Replify's Caching Engine provides Block Level De-duplication by identifying bytes suitable for caching and efficiently hashes, stores, and then transports the bytes to the connected Replify node.

The caching engine uses advanced rolling hash and indexing techniques to locate blocks and transport small block references in place of the original data quickly and accurately. Replify takes care of the integrity and synchronisation of the cache data, ensuring the correct data is always delivered quickly and efficiently to the client.

Unlike a traditional cache, the Replify engine works across protocols and for uploads and downloads. This means a file that is cached by Replify from an email attachment, will also be offloaded if the same file is uploaded or downloaded via HTTP or a file server.

End-to-End Visibility Supports SLA and Troubleshooting

The simple and powerful GUI in Turnium enables technical and customer service staff to see if circuits in the SD-WAN specific to a site are up or down, stable, or unstable, and easily demonstrate and chart the performance of the SD-WAN to show customers what is going on with their connectivity.

- This visibility simplifies trouble resolution, can assist with identifying issues with underlying carrier connectivity and help with carrier billing disputes. With end-to-end visibility to network performance, regardless of carrier, you can simplify trouble resolution.
- Where customers are purchasing Managed Services from other providers, Turnium enables you to deliver a managed SD-WAN connecting multiple MSPs, Data Centers or Cloud services. you can manage the entire SD-WAN, managing application performance and providing failover and business continuity at each site, as well on each connection to the range of MSP, Data Centers or Cloud instances being used.

About Turnium

Turnium Technology Group, Inc. delivers its software-defined wide area networking (SD-WAN) solution as a managed cloud-native service and as a white label, containerized, disaggregated software platform that channel partners host, manage, brand, and price. Turnium SD-WAN is available through a channel partner program designed for Telecommunications Service Providers, Internet and Managed Service Providers, and Value-Added Resellers.

For more information, contact sales@ttgi.io.

The logo for Turnium Technology Group Inc. features the word "turnium" in a lowercase, white, sans-serif font. Below it, the words "TECHNOLOGY GROUP INC." are written in a smaller, uppercase, white, sans-serif font. The background of the entire page is a dark, abstract graphic with diagonal streaks of yellow and green light, suggesting a digital or network environment.

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