128 TECHNOLOGY

WHITE PAPER

Session Smart™ Routing:

How it Works

Contents

Introduction

This document is intended to provide a thorough understanding of exactly how 128 Technology's networking solution works. It's written by our founding technology and product team, and is meant for a technical audience. We've done our best to provide all of the important details and specifics, and to keep the marketing people from sprinkling too much fairy dust over everything.

With that said, a quick recap of what we do and why it matters will provide helpful context for the "how" we'll be focusing on for the rest of this document.

We began with the belief that any network exists to deliver applications and services that businesses need. While legacy network vendors are always happy to sell you another box to get there – for firewalls, load balancing, deep packet inspection, and tunnels – the hardware-centric model their business is built on means more complexity, compromise, and cost for you. This middlebox-driven approach makes it hard to run new services and applications across diverse networks and within the hybrid cloud. It makes it a challenge to support video-intensive workloads, or properly connect today's mobile workforce. And the sheer complexity of it all exposes the business to increasingly sophisticated cyber-criminals and unacceptably high costs of downtime.

Fixing the problem ties back to our second founding observation: That the applications and services running on your network should speak the language of sessions, and that – for the most part – your network doesn't. This language gap turns out to be the root cause of so much of what's broken in networking today, and at the most basic level, that's what we do here at 128 Technology. We make routers "Session Smart™." Our routers speak the language of sessions, and when they're deployed along the network edge, they enable that network to build a closer working relationship with the applications and services it exists to support.

To do this, we first turn the router into software, and then give it the capabilities it needs to understand source, destination, and directionality of bi-directional flows, along with the requirements of named applications, service topology, and business policies. Our routers use this information to plot waypoints through the network in real-time, to better support the businesses they serve, turning the network itself into a service-centric fabric that's more simple, agile, and secure for both enterprises and service providers to operate. 128 Technology makes orchestration fast and easy, while enabling a "zero trust" security model that's simply not possible in the hardware-centric model. The result? Better performance at a lower cost, for businesses large and small—right now.

The key to all this is a three-tiered approach that has at its foundation a revolutionary routing standard called Secure Vector Routing (SVR). Using that standard, we developed the Session Smart™ Router that is the core of our offering, a router that – once deployed across the network – enables a service-centric fabric with dramatic benefits in terms of simplicity, agility, security, performance, and cost.

Let's explore each of these in turn.

3 Service-Centric Fabric

Centralized Orchestration
Control Pane
Zero Trust Networking
Failsafe Application Delivery

2 Session Smart™ Router

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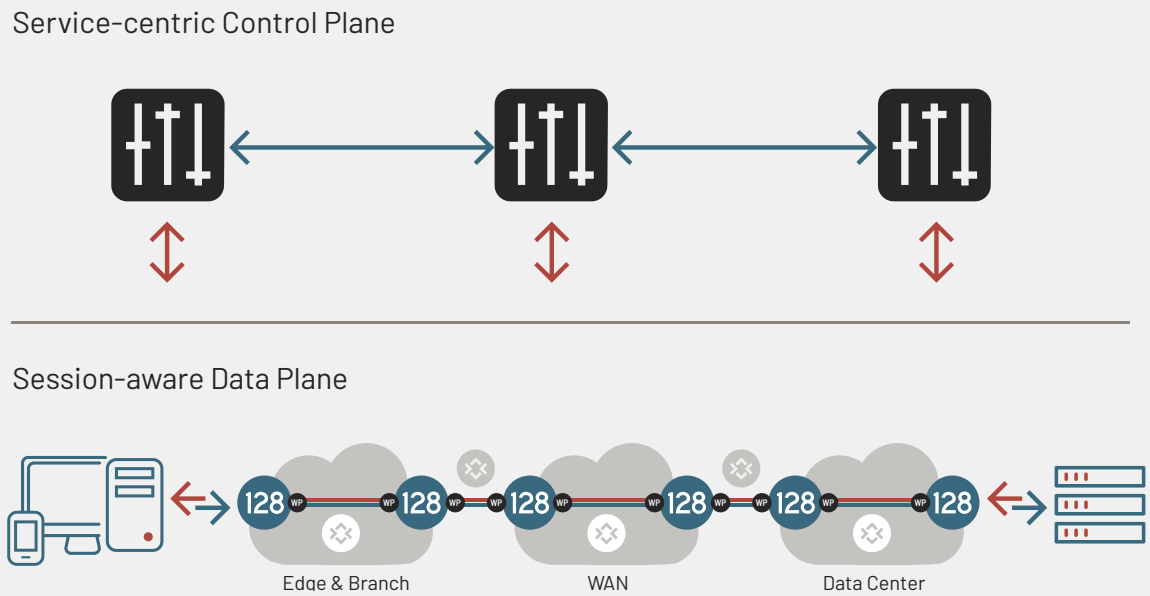
1 Secure Vector Routing

Service Centricity
Directionality
Waypoint Setting
Metadata

Secure Vector Routing

As we said earlier, networks exist to connect users to services and applications, and network design should start with those services at the core. Secure Vector Routing (SVR) is a transformational new routing architecture that enables the network to differentiate the way it delivers applications and services with unmatched simplicity, security, and scalability. It replaces tunnel-based network overlays and inefficient provisioning systems with distributed control, simple intelligent service-based routing, and in-band (data plane) session-based signaling. SVR is fully compatible and interoperable with existing network protocols and architectures, allowing it to be gradually introduced into an existing IP network without affecting the network endpoints or hosts.

FIGURE 1



SVR comprises two unique control plane and data plane components, the service-centric control plane and the session-aware data plane.

Service Centricity: The Service-Centric Control Plane

DATA MODEL

Services are the heart of the SVR design, and nowhere is that more evident than in its service-centric control plane. At the core of the SVR control plane is a service-based data model, which provides the language for describing the network's services, tenancy, and associated policies. The SVR data model is global and location independent, meaning every router in an SVR fabric shares the same service-based policies and topology, at all times—no matter where it is. The service-centric data model is expressed in YANG and exposed via northbound REST and NETCONF APIs to deliver a full suite of application and orchestration integration services.

SERVICE AND TOPOLOGY EXCHANGE PROTOCOL (STEP)

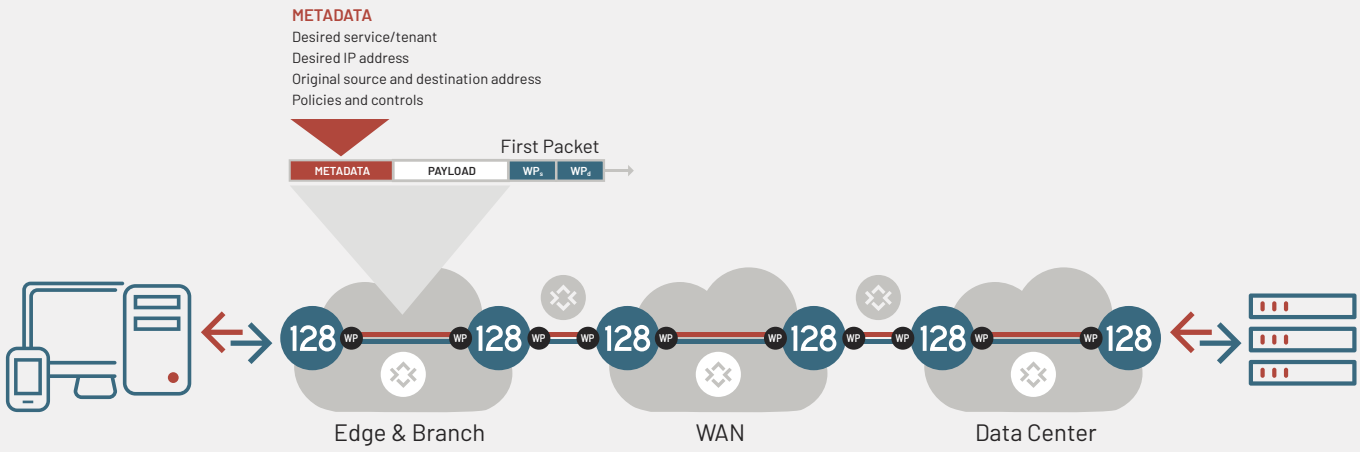
SVR defines the industry's first control plane protocol designed specifically for service-based routing and topology: Service and Topology Exchange Protocol (STEP). STEP works to describe connectivity between all routers, exchanging details about each service and its reachability. Traditional routing protocols distribute information that enables routers to select optimal paths between two nodes on a network based on IP addressing. STEP distributes information about services, service state, reachability and policy enabling SVR routers to select optimal path to a service wherever it may reside, based on service-specific policy and real-time network and service state. Think about WAZE for networks. STEP does not require you rip out your existing routing protocols, rather it co-exists with your existing underlay allowing you to innovate-in-place.

Session-Aware Data Plane

The session-aware data plane makes dynamic forwarding and policy decisions based on SVR's distributed service-centric control plane, the unique attributes and policies of sessions, and real-time network monitoring. SVR-based routers, deployed at network edges, transform a stateless L2 fabric or L3 network data plane into one that is fully session-aware. This is made possible through the combination of three features: session detection and control, waypoint setting, and session-based signaling (metadata). A session-aware data plane creates end-to-end route vectors that are:

- **Deterministic** – Session traffic is steered in segments between waypoints, with enforced flow symmetry, all without tunnel-based overlays.
- **Secure** – Each route vector controls the directionality of the session when it's initiation. Every session is authenticated at each hop. Payload encryption is defined per service and applied per session.
- **Dynamic** – Paths are established dynamically based on application policies and network state. Statically provisioned stateful tunnels are replaced with a model based on session state, where sessions are created on-demand and terminated when they're no longer needed. Link and endpoint session load balancing is native.
- **Multi-tenant** – Hierarchical multi-tenancy and secure segmentation is supported end-to-end across network and NAT (network address translation) boundaries.

FIGURE 2



SESSION DETECTION AND CONTROL

Session Classification and State

SVR classifies each Transmission Control Protocol (TCP) or User Datagram Protocol (UDP) session based on the unique source, destination, and application characteristics of the session. Security, quality, routing, and session control policies are applied on a per-session basis to deliver deterministic routing end-to-end. Session state is dynamically established by each router based on service routes, policy, and the observed performance of the connections between each SVR-based router.

Assured Path Symmetry

SVR ensures that bi-directional sessions follow the same path. Traditional routers use a stateless per packet "hot potato" forwarding approach with no notion of session. With SVR, all packets associated with a session are routed along the same path, no matter which way they're traveling. This symmetric flow enables packets to be intelligently routed, sessions to be controlled, and traffic to be proactively analyzed. It also prevents unauthorized flows from using a given path.

Session Directionality

Session directionality forms the foundation of SVR's secure routing and segmentation model. It enables an SVR fabric to behave as a zone-based firewall. As every SVR route defines the direction of session at initiation, each route becomes a secure vector that tightly controls access to the destination or service. In short, secure vector routing unifies access control and security policies during routing.

WAYPOINT SETTING

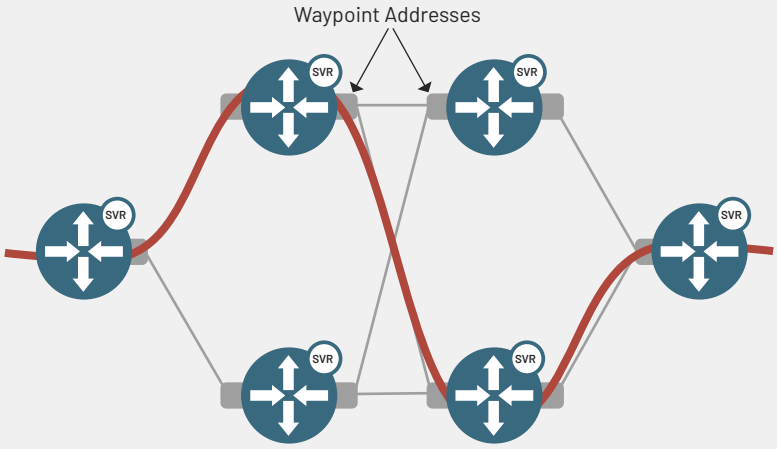
SVR architecture defines a location independent and segmented approach to routing and addressing based on waypoints. Waypoint addresses (or simply "waypoints") are IP addresses configured on secure vector routers that are used to govern sessions across network paths.

Waypoints are separate and distinct from the IP addresses and named services that identify end-to-end network sessions between devices and services. Secure vector routes define the path (e.g., set of routers) each session must follow within an SVR topology. Every SVR-based router can be reached by one or more waypoints, and Bi-directional Forwarding Detection (BFD) is used to test connection and path attributes between the waypoints.

The waypoint-based routing with SVR is inherently segment based, meaning that end-to-end route vectors can be created based on multiple router (or waypoint) hops. Since each SVR router maintains an overall view of the topology and service-based policies, dynamic multi-segment paths can be established. Ephemeral session state in each router along the path guarantees symmetric communications.

SVR's waypoint-based routing is location independent and therefore supports mobility. All communications are addressed by two addresses, one for location (e.g., nearest secure vector router) and the second for identity (service name or IP address). Destination hosts or workloads are no longer bound by unique fixed IP addresses. This enables global service addressing, allowing one application or service to share the same public IP address across multiple locations, and workload mobility, allowing workloads to maintain their address when in motion.

FIGURE 3



METADATA

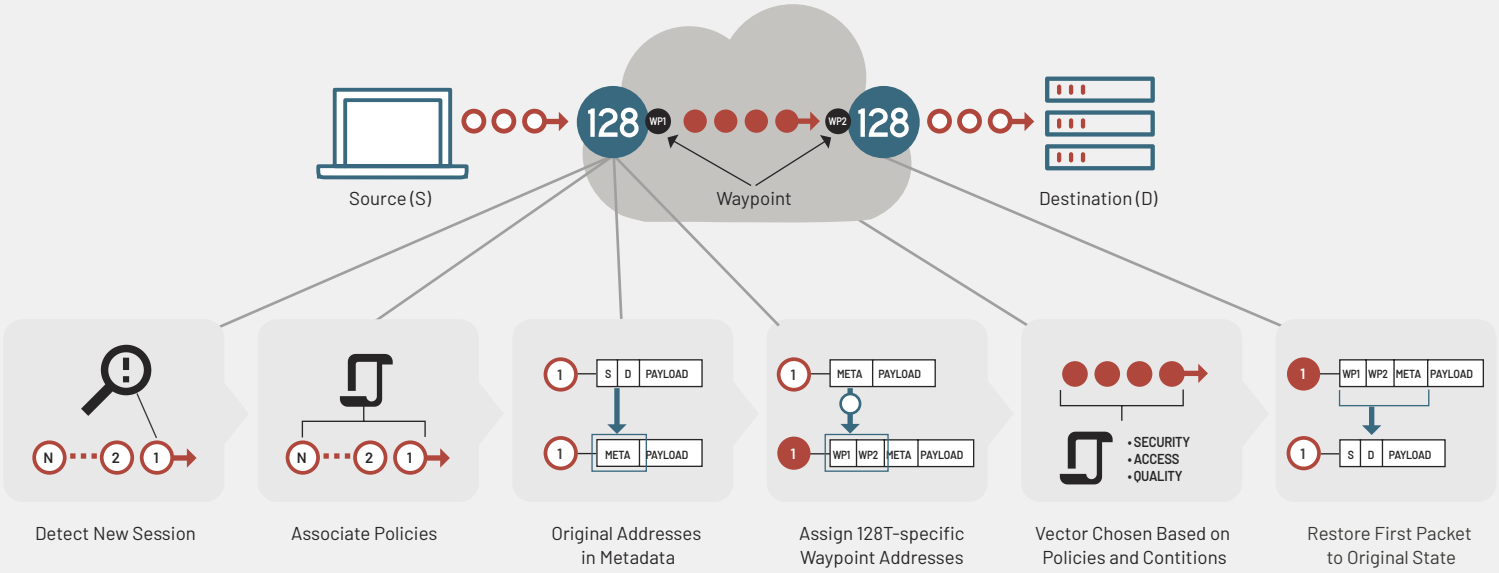
To establish a symmetric flow, the ingress secure vector router adds metadata to the first packet of each session. This metadata is used to signal information about a session including original IP addresses, tenant, and policy information. The metadata is only included when the SVR router is aware that there is another secure vector router downstream and, from there, all packets for that session follow the same path. Reverse metadata is included in the first packet on the return path for the same session. The metadata is only included in the initial packets sent between the two SVR routers. The exchange of metadata is always digitally signed to prevent tampering and can be optionally encrypted.

The forward metadata includes information about the original source IP address and port, original destination address and port, the tenant associated with the origin of the request, desired class of service, and other policy and control information. The reverse metadata includes utilization metrics and possible service class modification information.

PUTTING IT ALL TOGETHER—SESSION-BASED FIRST PACKET PROCESSING

The first packet of each session serves to establish an end-to-end path across the network, defining waypoints based on the secure vector routers it crosses along the way. It also initiates a single end-to-end session from ingress to egress secure vector router that is transient in nature. The remaining packets that are part of the session are sent along the same path without any form of tunnel overhead. Let's take a closer look.

FIGURE 4



When the first packet corresponding to a new TCP or UDP session arrives at an SVR-based router, it determines the appropriate route corresponding to the session. If a route is found:

- The SVR-based router translates the source address of the packet to its own egress waypoint IP address. The destination address of the packet is translated to the waypoint address of the destination SVR-based router.
- The SVR router adds metadata to the packet. This metadata includes the original source and the destination addresses of the packet, along with other policy and control parameters. The metadata is then signed and optionally encrypted based on policy.
- The packet is then forwarded to the waypoint address of the next secure vector router.
- At the last hop SVR-based router, once authenticated and authorized, the original packet contents are restored, and it's forwarded to the final destination.
- Subsequent packets from the same session are automatically recognized and forwarded in the same way, but without "first packet processing."
- Similar to above processing, SVR adds metadata to the first reverse packet, which follows the same

> SVR adds metadata to the first reverse packet and follows the same path as the first forward packet. Now, complete path symmetry is established.

128T NETWORKING PLATFORM ARCHITECTURE

Our platform is comprised of two primary components: the 128T Session Smart Router and the 128T Conductor. Together, they form a single logical control plane that is highly distributed, and a data plane that is truly session-aware. The 128T Networking Platform supports a wide range of deployment models scaling from a small branch office to a high capacity edge router to a hyper-scale software-defined data center.

128T CONDUCTOR

The 128T Conductor is a centralized management and policy engine that provides orchestration, administration, zero-touch provisioning, monitoring, and analytics for distributed 128T Session Smart Routers – while maintaining a network-wide, multi-tenant service, and policy data model.

128T SESSION SMART ROUTER

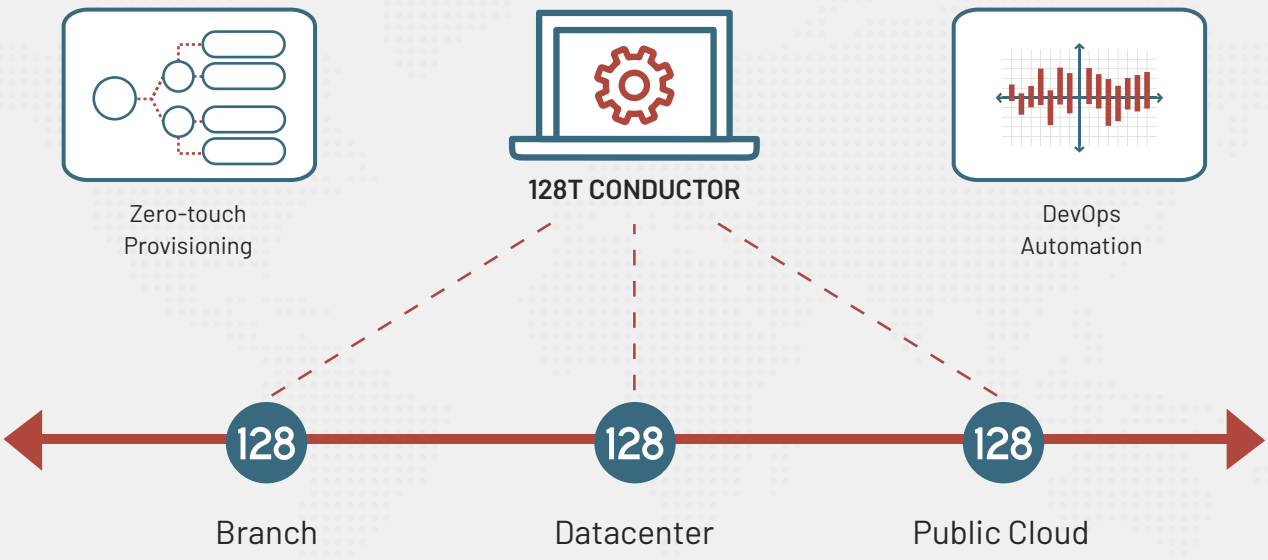
The 128T Session Smart Router is a software-based router based on innovative Session Smart technology and Secure Vector Routing (SVR) capabilities developed by 128 Technology. The Session Smart Router is a key piece of the 128T Networking Platform, and together with the 128T Conductor, enables enterprises and service providers to build service-centric fabrics that enable new levels of simplicity, agility, security, performance, and savings.

SESSION SMART TECHNOLOGY – WHAT IS IT?

128T's Session Smart Technology puts session awareness and state where it belongs, in the router. Why? Sessions are the language of applications and services. Nearly every use of a network involves a stateful exchange of information between endpoints known as a session. Session Smart Technology bridges the gap between networks and the applications they exist to deliver.

Session state is not new to networking, it exists in most standalone network functions such as firewalls and load balancers. Putting session state in the router opens the door to integrating network functions natively into routing. Session Smart Technology is the foundation of SVR.

FIGURE 5



100% SOFTWARE-BASED AND CLOUD READY

The 128T Session Smart Router is 100% software-based and can be deployed on general-purpose computing platforms allowing a wide range of deployment models—from remote branch offices to high-capacity network edges to hyperscale data centers and the cloud.

The software runs on any commercial off-the-shelf (COTS) platform or white-box customer premises equipment (CPE) whether physical or virtual. It can also be run in virtualized hosted private clouds and in public clouds including Amazon Web Services (AWS), Azure, or Google Cloud Platform for providing secure cloud on-ramps and other intra-cloud routing functions. For deployment in private clouds, the software works with leading cloud management platforms including OpenStack and VMware's vCloud Director.

APPLICATION VISIBILITY AND CONTROL

Application Classification

The 128T Session Smart Routers operate on the principle of applying intelligent heuristics to classify thousands of applications from network traffic without decryption. The routers can identify traffic in all routers—not only at the edges. They can also share previously detected traffic information among themselves for quick detection. With a range of fast acting methods that can enable early detection, the 128T Session Smart Routers allow networks to offer top-of-the-line end-user experiences, protection, and reporting.

Application Visibility

Session Smart Routers provide fine-grained session-based analytics and reporting, delivering maximum visibility into how applications and the network itself are performing. Application and network performance analytics are available via the 128T GUI and RESTful APIs, and IPFix-based session detail records are generated on a per-session basis.

Application Control

128T Session Smart Routers apply application-specific routing and policies across the network using a simple contextual data model that is based on named services and tenants. Service-based policies including access, security, and Quality of Service (QoS) are all designed to guarantee that applications meet intended service level agreements (SLAs) with the required degree of network security.

QUALITY OF SERVICE

Within a 128T Router, the QoS toolset offers several functions that bring best-in-class quality of experience to end-user applications. The toolset enables differentiated services based on a class model, along with features such as intelligent path selection, fast failover, prioritization, shaping, duplication, and error correction across the network.

NATIVE NETWORK FUNCTIONS AND SERVICE CHAINING

128T Session Smart Routers integrate multiple middlebox capabilities (security, routing, firewall, VPN, and load balancer) into a single routing platform. This simplifies the overall network architecture and minimizes the costs and deployment time for new network functions.

Network Stateful Firewall

128T Session Smart Routers natively deliver key stateful network firewall capabilities, including:

- **Deny-all Routing:** SVR surpasses traditional network security with a zero trust deny-all routing model; meaning that no session is permitted without explicit policies to allow it. Directional service routes and multitenant access control lists become one in the same.
- **DoS/DDoS:** 128T applies Denial of Service (DOS) and Distributed Denial of Service (DDOS) protection to every session passing through the 128T Routers, not only at the edge but wherever 128T Session Smart Routers are deployed. The context-specific nature of 128T Session Smart Routers allows them to provide better analytics and logging to track and discover these attacks.
- **Network Address Translation:** By default, the 128T Platform will double NAT (NAT both the source and destination IP port) of the packet before sending the packet out of a public interface. Double NAT allows 128T to hide information about the source and destination IP port of the flow, keeping the IP port information completely private to the enterprise. Additionally, 128T also supports source and destination NAT (44,64,46) on a per-session basis.
- **Encryption and VPN:** Per-session encryption and per-packet authentication are supported between all instances of the 128T Platform. Encryption is performed using AES256 and per-packet authentication is performed using HMAC-SHA256-128. Combined with multi-tenant segmentation, the 128T Session Smart Router delivers scalable multi-site VPN.

- **Adaptive Encryption:** While performing encryption of the application traffic, the session-oriented nature of 128T Routers can detect whether the traffic is already encrypted using TLS/HTTPS or by IPsec. If the application traffic is already encrypted using IPsec or TLS, 128T won't re-encrypt the packet, which eliminates the overhead associated with double encryption.
- **PCI-DSS and HIPAA Compliance:** 128T session-based routers provide true Zero Trust Security (ZTS) and a hypersegmented network architecture, allowing organizations to achieve PCI-DSS and HIPAA compliance requirements.
- **FIPS 140-2 Compliance:** 128T Session Smart Router is FIPS 140-2 Level 1 certified.

Link and Server Load Balancing
The 128T Session Smart Routers utilize optimized server heuristics and path monitoring to ensure that application traffic loads are optimally balanced across preferred links to desired application servers. Real-time criteria include server loads, maximum session rate, packet loss, latency, and jitter.

Service Function Chaining
In addition to natively supporting service functions, 128T Session Smart Routers support service function chaining (SFC) with standalone third-party service functions like next generation firewall and WAN optimizer. Both static and dynamic SFC capabilities are supported. 128T Session Smart Routers can be deployed as part of a network function virtualization (NFV) solution either at the edge (virtual CPE) or in the data center.

Interoperability with Existing Routing
128T's Session Smart Router is fully compatible and interoperable with existing network protocols and architectures. It uses traditional routing protocols such as Border Gateway Protocol (BGP) among many others to effectively communicate with existing routing elements, learn and distribute routes, and forward network traffic.

Service-Centric Fabrics

128T Service-Centric Fabrics Overview

Enterprises and Service Providers deploy 128T Session Smart Routers together with the 128T Conductor tocreate end-to-end service-centric fabrics seamlessly across any network infrastructure. 128T Service-centric fabrics offers a single networking solution for multiple use-cases in a number of areas including:

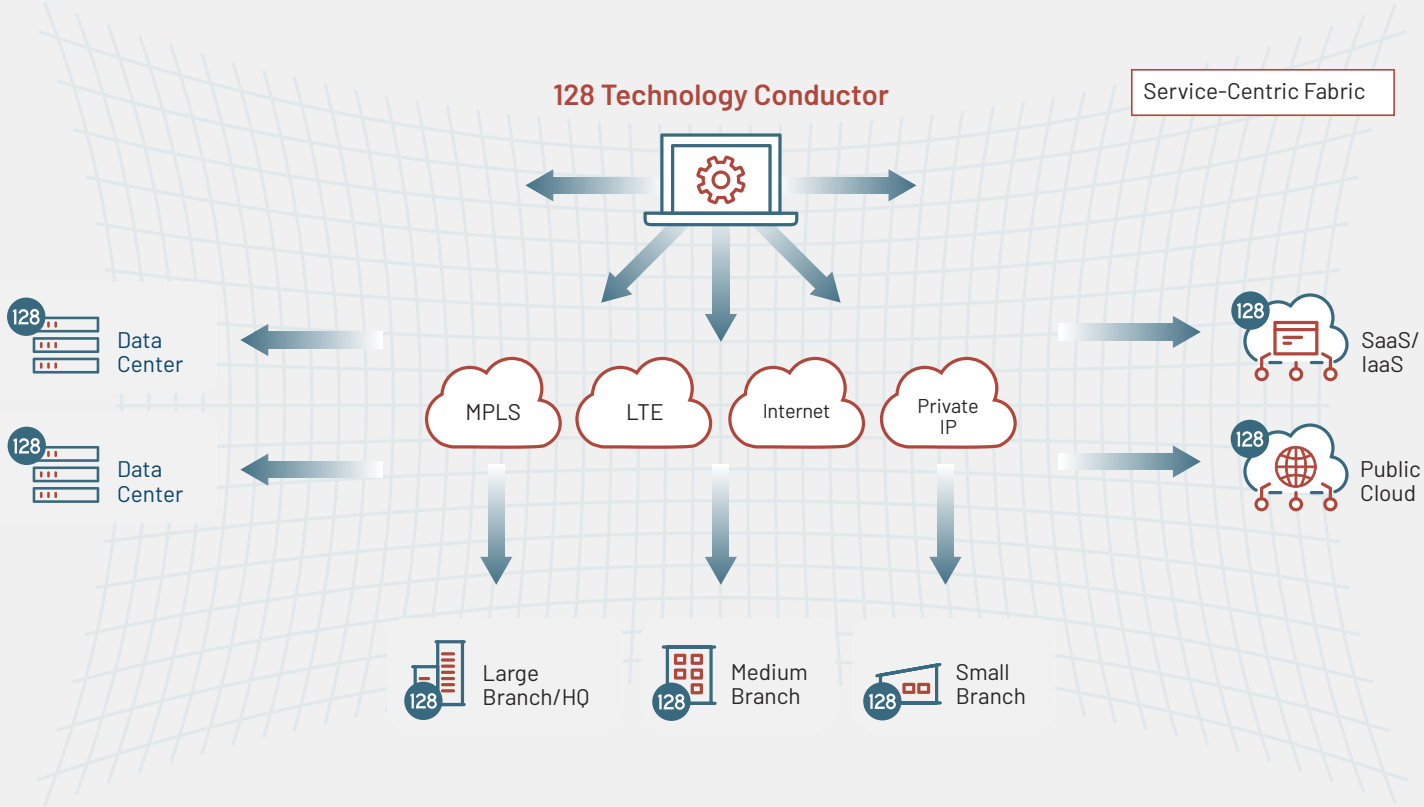
Strategic Network Capabilities: SD-WAN, Virtual Edge, NaaS and WAN refresh

Multi-cloud Fabric and Data Center Interconnect

Security: Zero Trust Networking, Secure Branch/Edge

128T Service-centric fabrics stretch to anywhere 128T Session Smart Routers are deployed, whether it's at the branch, in the data center, within a co-location facility, or in the public cloud. Secure Vector Routing forms the network routing engine for service-centric fabrics and are completely tunnel-free. In addition, they are natively service aware; multi-tenanted; and maintain a vast knowledge of service availability, topology, and policies. 128T Service-centric fabric is built from the ground up on the principles of zero trust networking. This means that network security is no longer painted onto the perimeter of the network but is rather baked into the network fabric itself. 128T Service-centric fabrics are centrally managed and orchestrated by the 128T Conductor with a central pane of glass application that enables network visibility, strong analytics, automated policy provisioning, and zero touch deployments. 128T Service-centric fabrics are open and programmable through northbound RESTful and Netconf APIs.

FIGURE 6

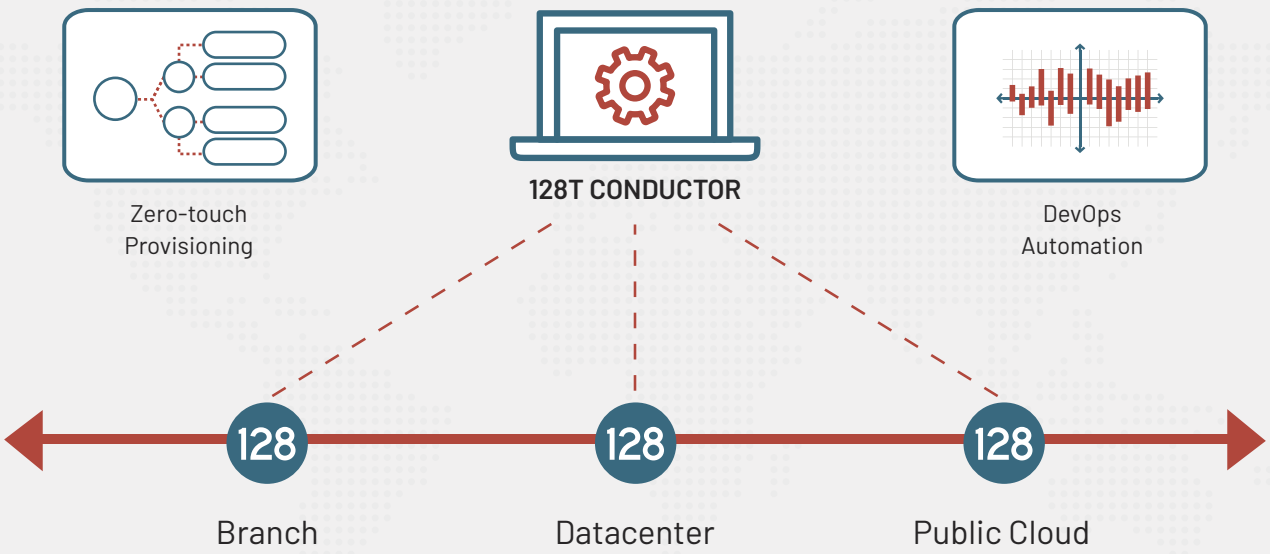


Enterprises and service providers can achieve the following benefits with 128T Service-centric fabrics:

- **Simplicity** – No tunnels, no overlays, no more hardware centric networking
- **Agility** – Faster deployment, improved application resiliency, and better responsiveness
- **Security** – Zero trust model with deny-all routing plus authentication, encryption, and segmentation
- **Performance** – Less overhead, more scalability, and dynamic optimization
- **Savings** – Reduced bandwidth, connectivity costs, third-party point tools, CapEx, and OpEx

CENTRALIZED ORCHESTRATION AND CONTROL—THE 128T CONDUCTOR

FIGURE 7



The 128T Conductor is a platform that provides fabricwide central administration, provisioning, monitoring, analytics, network-wide visibility, and automation with a consistent visual user experience. The 128T Conductor is a separate application from the 128T Session Smart Router and operates from any location with secure connectivity to the Session Smart Router in the fabric. From a central point, the 128T Conductor provides administrative functions including zero touch installation to enable rapid deployment of new instances across a network. It also enables automated network-wide, zero touch software upgrades and centralized key and entitlement management. The 128T Conductor greatly simplifies wide scale deployment by enabling zero touch provisioning (ZTP), where non-IT users can quickly add network connectivity to a new branch site. The 128T Platform supports numerous service-aware features to simplify provisioning, including auto-configuration, back up, versioning, and auditing. From a central point, the Conductor ensures consistent policy and service management. For broader service integration the Conductor also supports northbound Netconf and REST interfaces to third-party OSS/BSS.

MULTIPATH ROUTING AND FAILSAFE APPLICATION DELIVERY

Multiple paths often exist between peers within large enterprise and service provider networks. These multiple paths can be used to reroute traffic in case of failures or link performance degradation. Multiple paths or hybrid networks are deployed, as in SD-WAN use cases, to dynamically offload traffic from expensive MPLS links to lower cost broadband or LTE links, while maintaining strict SLAs.

128T Session Smart Routers provide application and policybased multi-path routing, intelligent path monitoring, and lossless application delivery capabilities. These capabilities combine to ensure application traffic is optimized across multiple paths while forming a failsafe delivery model that ensures application traffic is delivered despite failures.

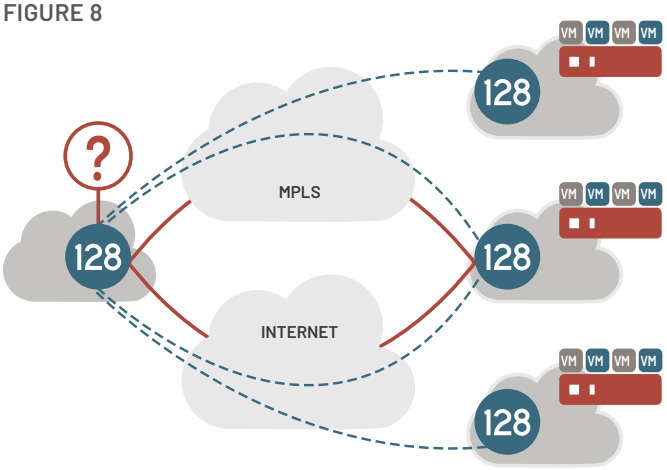
Application and Policy-based Multipath Routing – 128T Session Smart Routers send application traffic along the most optimal paths based on application-specific SLA policies and observed network performance (e.g., across MPLS and low-cost broadband or LTE connections).

Intelligent Path Monitoring – Link and path performance is monitored in real-time using enhanced BFD to determine jitter, latency, and loss for each path.

Lossless Application Delivery – Sessions and bandwidth are optimized along the desired path or multiple paths. Key capabilities include:

- **Multi-path Session Migration** – Rapidly migrate existing sessions from primary to secondary paths in the event of network brownout conditions or failures

FIGURE 8



- **Multi-path Session Redundancy** – Mitigate quality problems due to excessive packet loss, and duplicate packets and send in separate redundant streams on multiple links
- **Multi-path Session Maximization** – Bond multiple paths into single logical connection

ZERO TRUST NETWORK SECURITY

Zero Trust Security (ZTS) is key to 128T's approach. Originating from Forrester a few years ago, the zero trust model for security ends the notion that any packet should be considered above suspicion. 128T Service-centric fabrics shift from legacy perimeter-based security to the zero trust model with the following components:

Zero Trust Routing Fabric: The session-oriented approach assumes no user, traffic source, or connected network - regardless of what it is and its location on, or relative to, the corporate network—is to be trusted. Session smart routers are deployed to create zero trust and service-centric fabrics where routes become directional firewall rules and deny-all routing model. No application, device, or user may initiate a session on the zero trust fabric that is not explicitly allowed based on business policies. All routes and sessions are authenticated, and all session traffic is dynamically encrypted end-to-end.

Service-Centric Hypersegmentation: Hypersegmentation offers almost limitless hierarchical tenancy and fine grained per-service access policies with a global multitenanted data model. Hypersegmentation is free of any dependency on overlay networks. Best of all, it does this over the existing network infrastructure, irrespective of public/private network boundaries, broadcast domains, and administrative boundaries.

Native Session-Stateful Security Functions: Branch and data center security architectures are simplified with 128T Routers. That's because they natively support session L2-L5 stateful firewall functions including DoS/DDoS protection, NAT, encryption, VPN, and traffic filtering. Where advanced firewall functions are needed, dynamic service chaining of third-party firewalls is supported.

Security Policy Automation and Scale: The 128T Conductor centrally manages service-centric and tenant-based security policies that are expressed in the language of business, resulting in automated and simplified network security policy management. This reduces security OpEx and overall risks due to user error since security policy management is simple and scalable across thousands of sites.

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ABOUT 128 TECHNOLOGY

At 128 Technology we help our customers radically reinvent their digital futures based on a new model for virtual networking called Session Smart™. Session-smart networking enables enterprise customers and service providers to create a service-centric fabric that's more simple, agile, and secure, delivering better performance at a lower cost. Whether your enterprise is moving your business to the cloud, modernizing the WAN edge, seeking more reliable unified communications or pursuing an industrial internet of things (IIoT) initiative, session smart networking re-aligns networks with digital transformation initiatives.