Solution Brief

Edge Networking

End-to-End Platform to Extend the Network Edge and Deliver Multi-Access Edge Compute

In a joint architecture developed with Intel and Red Hat, the disaggregated SD-WAN solution from Turnium enables the deployment of containers to support edge compute and other containerized workloads.

As businesses of all types and sizes develop new ways to generate value from data, network topologies are evolving at an unprecedented rate. The distributed nature of business computing is a central aspect of that shift, including cloud-native architectures based on containers and cloud-native network functions (CNFs) decoupling workloads from the underlying hardware so workloads can execute anywhere, including on-premises or across multiple clouds.

This combination of distributed hardware and lightweight, platform-independent software is central to taking full advantage of data wherever it resides with optimal agility and flexibility. Compute is being pushed to the enterprise edge so that data can be processed close to its point of origin or use. In a shift from earlier models where all data was sent to a public or private cloud for collective processing, edge computing avoids the bandwidth expense of backhauling large quantities of data. It also eliminates the associated transfer latency, enabling real-time and near-real-time usages, as well as improving cybersecurity by reducing the attack surface associated with transmitting large volumes of raw data.

Software-defined wide-area networking (SD-WAN) enables cloud-native architecture to be extended to the network edge. SD-WAN enables businesses to take full advantage of any combination of transport services, with a centralized control function intelligently and securely directing traffic across the dynamic network topology. In this model, fixed-function network solutions are replaced by software-defined network functions that are implemented as containerized CNFs.

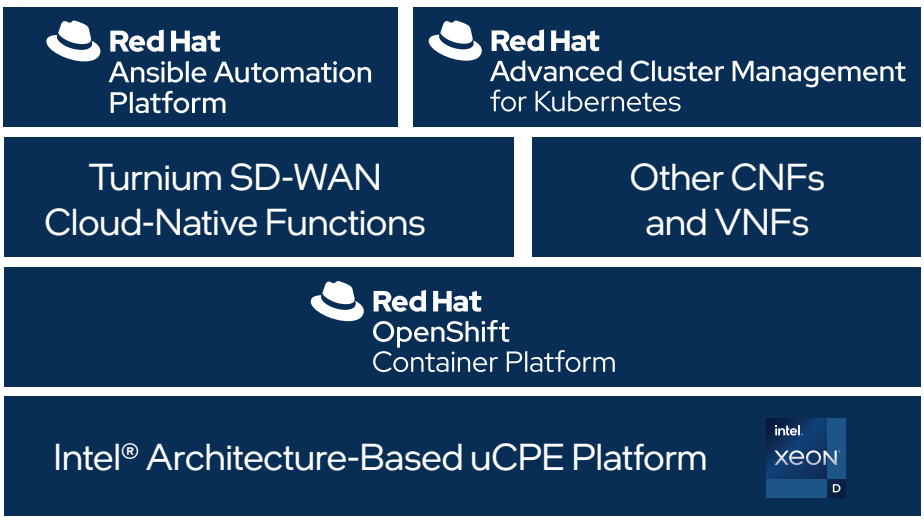

Figure 1. Enterprise edge solution components.

The end-to-end solution architecture from Intel, Red Hat, and Turnium illustrated in Figure 1 helps end customers realize this opportunity as efficiently and effectively as possible. The foundation of this solution stack is universal consumer premises equipment (uCPE) based on the Intel® Xeon® D processor with Red Hat cloud-native infrastructure, automation, and management. Turnium SD-WAN supplies an overlay that reduces implementation complexity and enables simple integration with existing security, operational, and business systems.

Cloud-Native Disaggregated SD-WAN: Turnium

To give end customers complete control over the creation and operation of their virtualized WANs, Turnium provides a resilient, cost-effective SD-WAN platform that easily and transparently interconnects WAN, public cloud, and hybrid resources. Turnium replaces traditional fixed-function devices using a software-only implementation built for Intel architecture-based equipment, across bare-metal, virtualized, and containerized infrastructures. It provides a virtual Layer-3 network overlay for simplified provisioning of high-performance services, maintained independently of underlying hardware and service providers.

Use Cases: uCPE and Multi-Access Edge Compute

Deploying multi-access edge compute based on universal CPE enables novel use cases to deliver business efficiencies, in usages such as the following:

- **IoT implementations:** Warehouses, fleet management, agriculture, traffic control, mining
- **Retail:** Security, personalized shopper experience, point-of-sale
- **Manufactoring:** Inventory management, visual verification, analytics
- **Media and entertainment:** On-site vehicle-based broadcasting

Turnium offers resilience without the complexity and expense of multiple private-networking solutions. Service providers deploying Turnium to deliver network-as-a-service (NaaS), as illustrated in Figure 2, abstract away complexity. They also enable their own teams and IT teams at end customers to focus on value-added innovation instead of developing low-level network functionality. It provides outstanding visibility into network functionality and key performance indicators such as throughput, latency, jitter, and last-mile stability, and reduces the time and expense associated with managing the network. Requirements for complex custom networking are reduced while also providing a dynamically defined environment that optimizes performance, security, and reliability. End-to-end encryption protects data in transit.

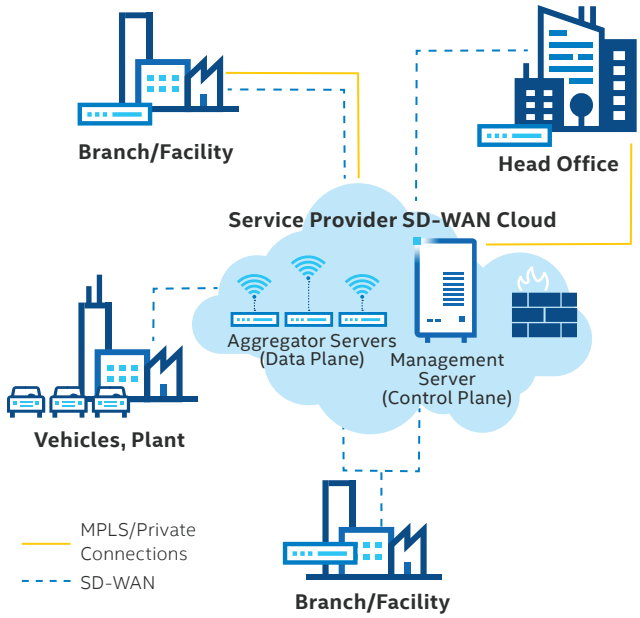

Figure 2. The distributed trusted network as a service (TNaaS) solution.

Load balancing and monitoring on a per-packet basis provides granular control over network paths, improving efficiency and driving optimal value from investments in services and infrastructure. Turnium continually manages how each available circuit is used, tuning the environment to take optimized advantage of all available bandwidth on a moment-to-moment basis and to allow automatic, sub-second failover. The highly flexible and granular quality-of-service (QoS) engine built into the Turnium platform protects the user experience from one end of the network to the other, including edge resources.

Turnium is certified to run as a CNF on Red Hat OpenShift and assures stability and performance while also taking advantage of the broader Red Hat solution stack for automation and management.

Containerization, Automation, and Management: Red Hat OpenShift

The cloud-native foundation for the solution is Red Hat OpenShift, which provides a consistent platform for development and deployment of containerized software across any combination of on-premises, hosted, and public cloud compute nodes. OpenShift helps IT organizations build efficiencies and automation on their paths to adopting modern practices such as DevOps, DevSecOps, and continuous integration/continuous delivery (CI/CD).

Red Hat engineers build OpenShift on top of the open-source Kubernetes foundation, enhancing and extending the platform with added services such as networking, monitoring, registry, and authentication, as well as hardening, testing, and certification for enterprise readiness. OpenShift enhances performance with Red Hat Enterprise Linux CoreOS, an

operating system built specifically to run containers. The platform is developed and distributed using open source to draw on community innovation and help ensure the broadest possible ecosystem of solutions and providers. For the Turnium solution, OpenShift is complemented by additional Red Hat offerings:

- **Red Hat Ansible Automation Platform** supplies the tools to build, deploy, and manage end-to-end automation policy at scale, with streamlined ability to build and share custom automation building blocks as well as prebuilt automation content from a large partner ecosystem. Ansible enables customers to build well-defined, consistent, deterministic automation routines that optimize workflow efficiency.
- **Red Hat Advanced Cluster Management for Kubernetes** provides management and control across the cloud infrastructure, enabling tasks for cluster creation and lifecycle management based on established best practices. A single console gives comprehensive visibility into all clusters and applications, with built-in security policies and integration into CI/CD pipelines.

High-Density Edge Compute: Intel® Xeon® D Processor

The Intel Xeon D processor is built specifically to provide high-density compute within the power and thermal constraints that are common at the network edge. Delivered in a power-efficient system-on-chip (SoC) form factor, the highly integrated platform delivers outstanding compute and AI performance married with integrated networking and security capabilities.

- **Compute performance.** In addition to high per-core performance, the processor features hardware acceleration for demanding workloads including deep learning and encryption.
- **Hardware-based security.** Cutting-edge security features include protected execution enclaves based on Intel® Software Extensions and memory encryption based on hardware-generated keys.
- **Advanced networking.** Integrated Intel Ethernet optimizes throughput, latency, and power, with advanced features such as Remote Direct Memory Access (RDMA) and Dynamic Device Personalization (DDP).

Performance Characterization: Containers versus Bare Metal

To fully assess this solution, architects must verify that deployment of Turnium SD-WAN on cloud-native infrastructure provides parity of performance with a corresponding bare-metal implementation. Testing by Finnish IT services firm Tietoevry compares results from Turnium SD-WAN deployed to an OpenShift cluster as a containerized application versus a direct installation on top of the uCPE device operating system.

The test topology simulates the common use case of a WAN network that connects two branch offices by means of a tunnel established between the branch uCPEs. The key metrics assessed are data throughput between uCPEs and CPU utilization on the uCPE hardware. From each branch, the uCPE connects to the Turnium Aggregator, the control-plane entity that enables creation and management of secure SD-WAN tunnels between uCPEs. The solution considers both local and remote (cloud) placement of the Aggregator to provide a more complete representation of potential deployment scenarios. For the testing, the Trex packet generator connects to the uCPE LAN port and simulates traffic to mimic normal production communication.

Throughput testing compares transmission of both UDP and TCP traffic flows when the uCPE is deployed on bare metal versus a containerized implementation, using both a local and cloud-resident Turnium Aggregator, as illustrated in Figure 3. To ensure that the results represent the varied traffic flows that different business applications and services generate, testing also considers different frame sizes, from 64 to 1400 bytes. Across all these topographical and traffic-class factors, only minor differences are observed between the bare metal and container deployments.

Comparison of the processor resources consumed by the solution between the containerized case versus bare-metal deployment is illustrated in Figure 4. CPU utilization is assessed at the same range of frame sizes as in the throughput testing. Red Hat OpenShift impacts CPU utilization at a constant rate of approximately 1.5 percent overhead across frame sizes.

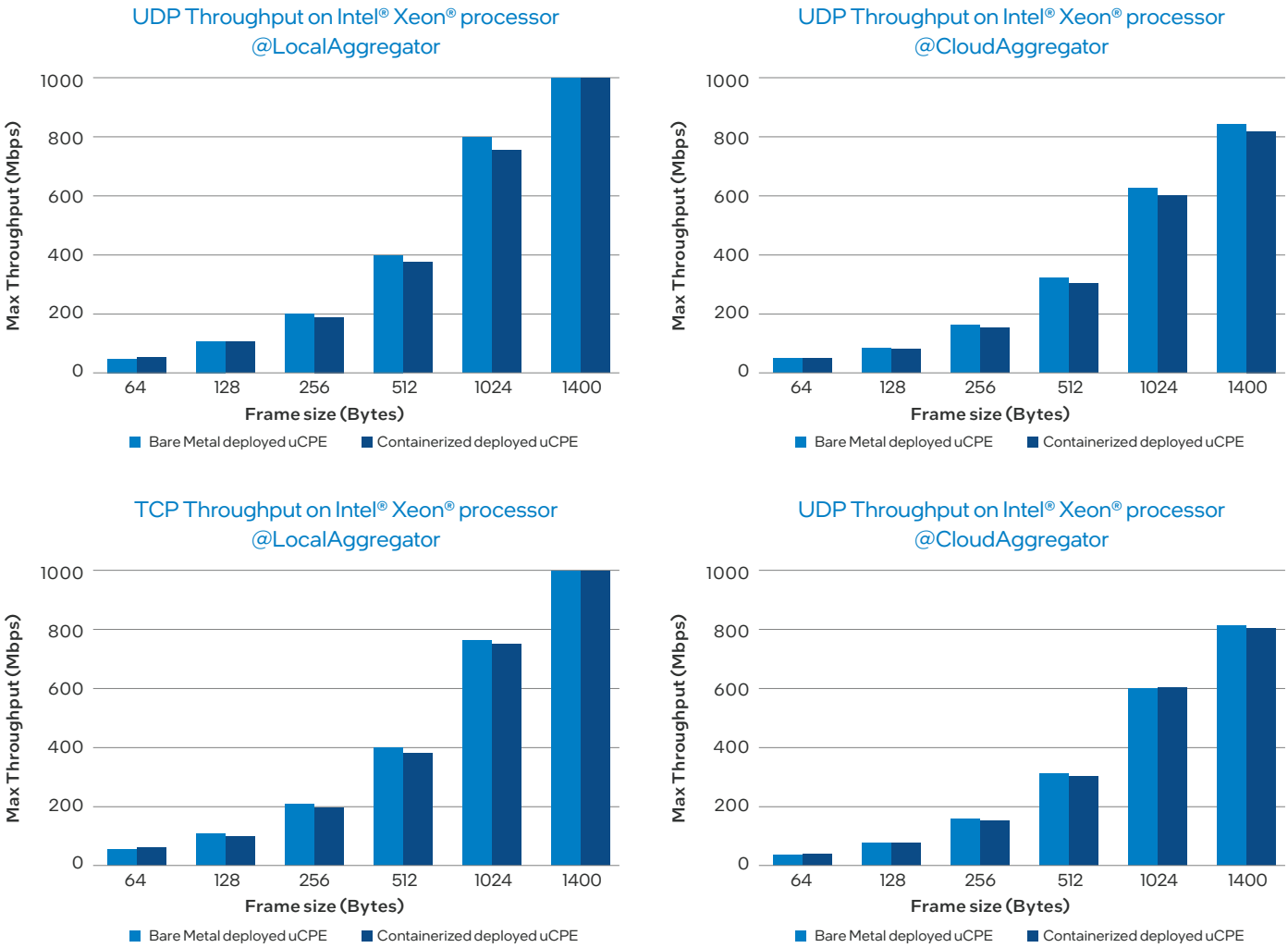

Figure 3. Maximum throughput measured for local and cloud-based aggregator SD-WAN solution.[1]

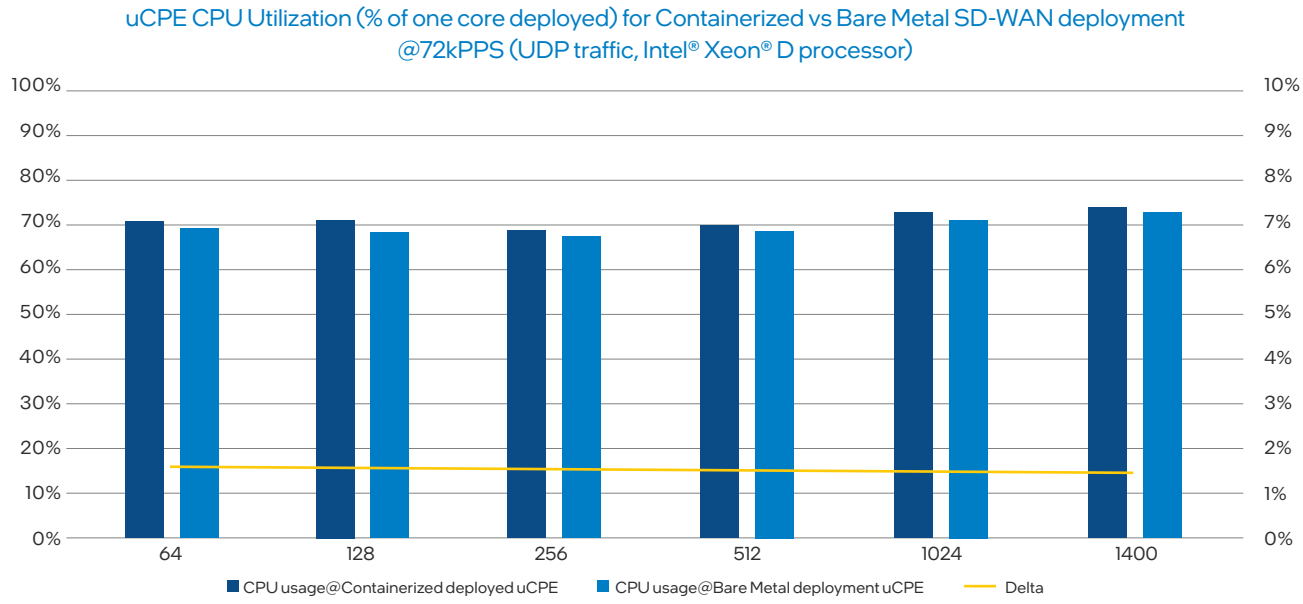

Figure 4. uCPE CPU Utilization for containerized vs bare metal SD-WAN deployment.[1]

These results demonstrate that Red Hat OpenShift provides a low-friction platform for deploying the Turnium SD-WAN solution using cloud-native infrastructure. End customers can advance their network transformation journeys without compromise, fully realizing cloud flexibility, agility, and efficiency benefits with outstanding performance. The Tietoevry study concludes that the solution "delivers the performance needed for Edge Compute while also delivering the scalability, flexibility, ease of deployment, and automation that service providers require."[1] In particular, the study finds that the solution provides business and technology advantages along the following vectors:

- **Ease and flexibility of deployment,** based on centralized orchestration and management, with automated mechanisms and accelerated time to market for new services.
- **Scalability** to accommodate varied and changing needs, across Intel architecture-based platforms and a wide ecosystem of uCPE providers, provisioning workloads flexibly on general-purpose devices.
- **Performance** with only a marginal impact on throughput and CPU load from the containerized deployment, providing room to grow and capacity to run additional workloads alongside Turnium SD-WAN.

Conclusion

Realizing the full benefit of edge computing requires network operators to reassess solution stacks with primary attention to agility and flexibility. The NaaS solution from Red Hat, Turnium, and Intel provides an open approach to building future-ready distributed networks. Testing verifies that the solution offers end customers outstanding performance along with the benefits of cloud-native implementation including agility, flexibility, and scalability.

Looking ahead, the open solution architecture gives businesses the ability to tailor their implementations to specific needs while drawing on proven design patterns. That open foundation interoperates with best-of-breed components such as Intel® Smart Edge Open, a cloud-native software toolkit that can benefit this solution with deep optimizations for Intel architecture.

That interoperation enables architects to draw on the broad Intel Smart Edge Open ecosystem of reference solutions for common use cases, powered by a certified Kubernetes stack. This flexibility enhances end customer control over their environments, putting them in control of their cloud-native journeys with the benefit of Turnium to deliver edge services dynamically.

More Information

Intel® Network Builders – **networkbuilders.intel.com**

Red Hat Ecosystem Catalog: Turnium SDWAN – **https://catalog.redhat.com/software/container-stacks/detail/5e98770d3f398525a0ceb138**

Turnium: Cloud-Native Disaggregated SD-WAN – **https://turnium.com/cloud-native-sd-wan/**

Solution provided by:

intel + turnium + Red Hat

[1] Tietoevry, 2022. "Software Defined Enterprise Edge over Cloud-Native Infrastructure with Uncompromising Performance."

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