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24 Gigabit SD-WAN
Unlocking New Use-Cases using Intel® Processors and Turnium SD-WAN to Build Networks

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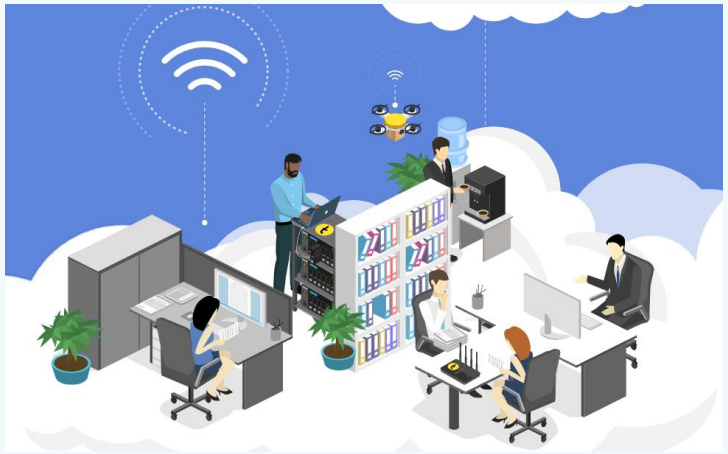
Agenda

- Introduction
- SD-WAN is Important to Service Providers
- The Gigabit+ Challenge
- Intel Lab Testing
- Achievement Unlocked
- Key Technology Concepts
- New Use-cases and Sales Opportunities
- Summary

Introduction

- Turnium develops and licenses a Software-Defined Wide Area Networking (SD-WAN) platform.
- Delivered through a global channel of ISP, MSP, Cloud SP, and Communication Service Providers.
- SD-WAN uses software running on standard servers and white-box customer premise equipment instead of proprietary hardware-based technology.
- The software builds and manages point-to-point and mesh networks for single site and multi-site customers.
- Any internet connection or other circuit (e.g. L2) can be used in the SD-WAN to connect businesses to data, applications, and customers.
- Every Service Provider should use SD-WAN to add managed connectivity to their portfolios and deliver a better customer experience.



SD-WAN Enhances Service Provider Customer Experience

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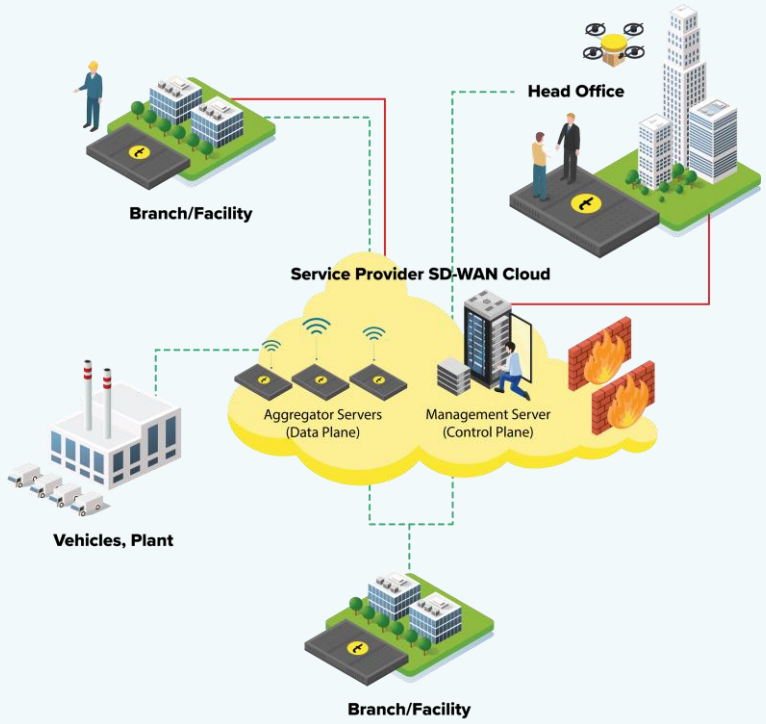
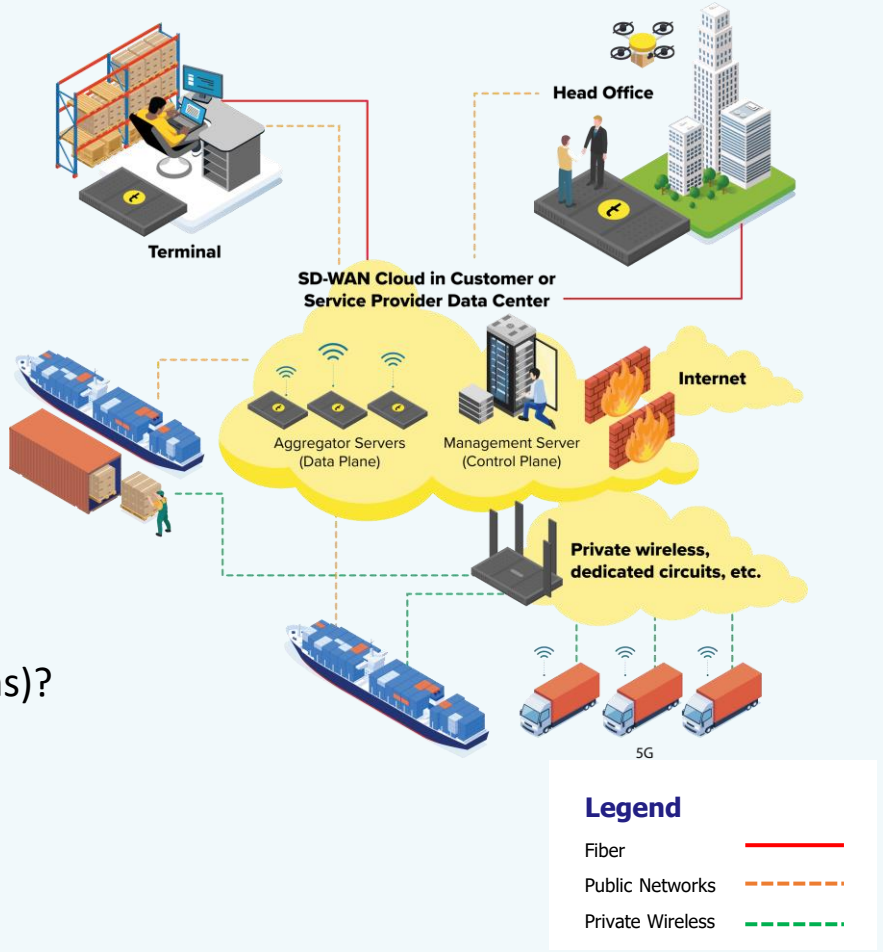
- Manage connectivity.
  - No need to own network or set up NNI.
- Flexible connectivity.
  - Use any available option: broadband, fiber, LTE, 4G, 5G, Starlink.
- Automate network programming.
  - Reduce time to deploy and decrease time to revenue.
- Business continuity.
  - Real-time cross-circuit failover across multiple carriers.
- Visibility to connectivity conditions.
  - Identify and resolve trouble tickets faster.
- Bundle with Voice, Video, Contact Center, Applications.
  - Differentiate offers, drive wallet-share, value-add MRR.



The Gigabit+ Challenge

- Service Providers need multi-gigabit support.
  - Gigabit is commonplace and affordable in major markets.
- Customer expectations.
  - “If I buy gig, I get to use it.”
  - Speed helps cloud applications perform as if onsite.
- Turnium’s v6.x code base supports 100's of megabits.
  - Easily provides 500-750Mbps.
  - Satisfies most practical use-cases.
- How fast will v7.x go? Will it support multi-gigabit (and customer expectations)?
  - Our goal is close to 100Gbps.
  - Support for high-speed last-mile **and** backhaul connectivity.
  - Complete, end-to-end networks within Turnium SD-WAN.
  - Retaining multi-tenant, vastly expanding scalability of nodes.



Intel Testing: Solving the Gigabit Challenge

- Internal testing showed 10x improvement using v7.0 code on Intel Atom® C3558 core and edge nodes.
  - Compared to v6.x code.
  - Significant improvement. Achieved 3Gbps throughput (v7.x code) compared to 300Mbps (v6.x code).
- Performance testing in the Intel Test Lab at Rio Rancho.
- Test both v6.7 and v7.0 software for comparative performance benchmarks in high performance network environment.
- Test environment was:
  - Intel® Xeon® Gold 6430 Processor.
  - 2.1GHz (Base) 3.4GHz (Turbo).
  - 100GbE Intel® Ethernet Network Adapter E810.
  - 100Gbps network.
- iperf 3 and 4 parallel streams to generate network traffic.

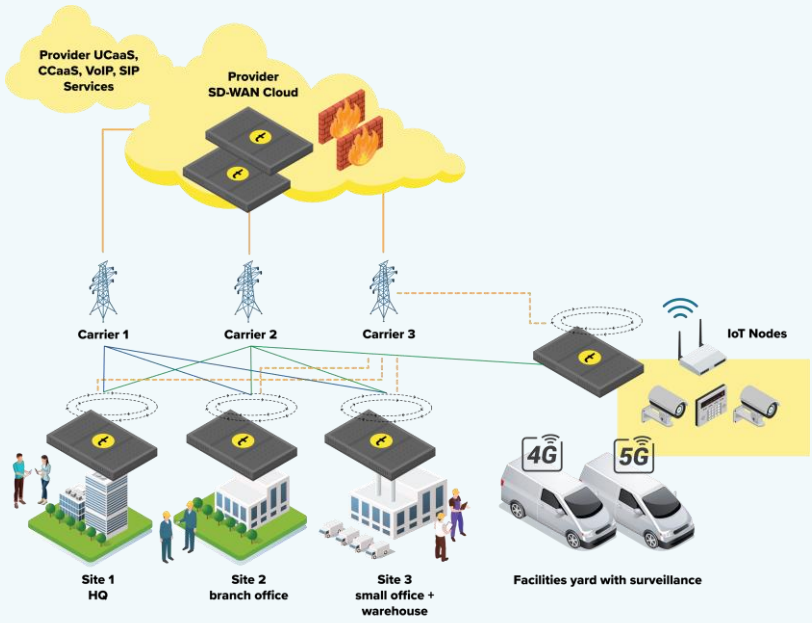
Achievement Unlocked: 24Gbps Performance

In the Intel Test Bed at Rio Rancho, our code performed well!

- **24Gbps** (per core) achieved using beta v7.0 code.
- **1.85Gbps** achieved using production v6.7 code.
- **13x** improvement compared to v6.7 code.
- Significant win, setting up additional future improvement!
- Extremely happy with these results, especially as v7.x code scales significantly:
  - **1,000s** of edge nodes per core node (network will limit sooner).
  - **100,000s** of edge and core nodes under management.

Key Technologies in Turnium SD-WAN

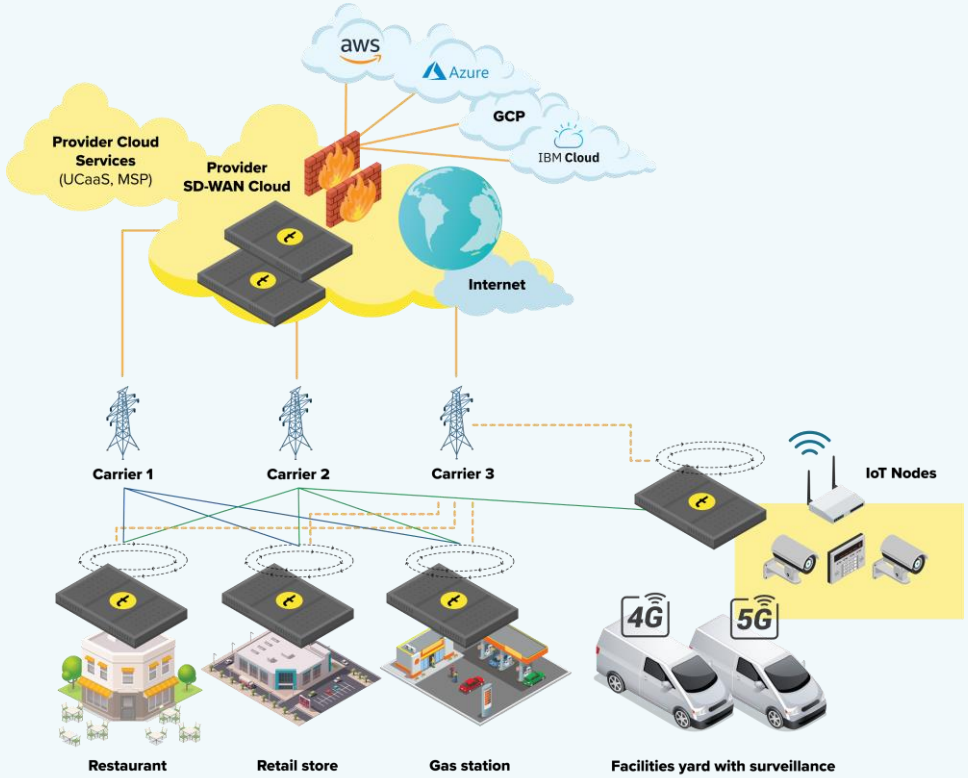
- Latency and ordering is important for SD-WAN performance.
- Packet processing time budget (1300 byte packets, 3GHz clock):
  - 1Gbps: 1.3 microseconds, 3,900 cycles
  - 10Gbps: 130 nanoseconds, 390 cycles
  - 100Gbps: 13 nanoseconds, 39 cycles
- We had multiple options. We tested them.
  - If you have heard of it, we probably have a prototype using it.
- Multi-core/multi-CPU does not help to improve single streams.
  - To retain ordering in multicore requires expensive synchronization.
- We improved control plane performance.
  - Main improvement was switching from JSON to binary messaging.
- We built a new routing engine specifically for SD-WAN.
  - Turnium Expressive Routing Engine (TERE).



New Sales with Turnium SD-WAN

24Gbps+ sets Turnium channel partners / service providers up for new sales opportunities and future growth.

1. Network-as-a-Service platform for channel partners.
    - Managed backhaul circuits.
    - Managed high-speed (multi-gigabit) tunnels over the internet.
2. Large scale, high-volume edge node deployments.
    - Retail, PoS, IoT.
3. Multi-gigabit connectivity with failover for regional, national, or international sites.
    - Combinations of 1Gbps circuits or 2/5/10 Gigabit circuits.
4. Better business continuity.
    - High-speed failover.
    - High-speed site-to-site mesh.
    - Unlimited groups of core nodes.



Summary

- 24Gbps results from testing in Intel Test Lab at Rio Rancho (100Gbps environment).
- On our way to ~100Gbps performance.
- Unlocks new sales opportunities for Turnium partners.
- Enables backhaul support and high-speed last-mile support within the Turnium platform.
- Continues to enhance Service Provider ability to bundle SD-WAN to enhance their customer experience, differentiate, drive new MRR.

For more information

- www.turnium.com

Thank you to the Intel Partner Alliance and staff at Intel Test Bed at Rio Rancho for your support!

Questions & Answers

THANK YOU

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