UCPE/SD-WAN OPEN FRAMEWORK

Intel Corporation
Data Center Platform Application Engineering
May 2019

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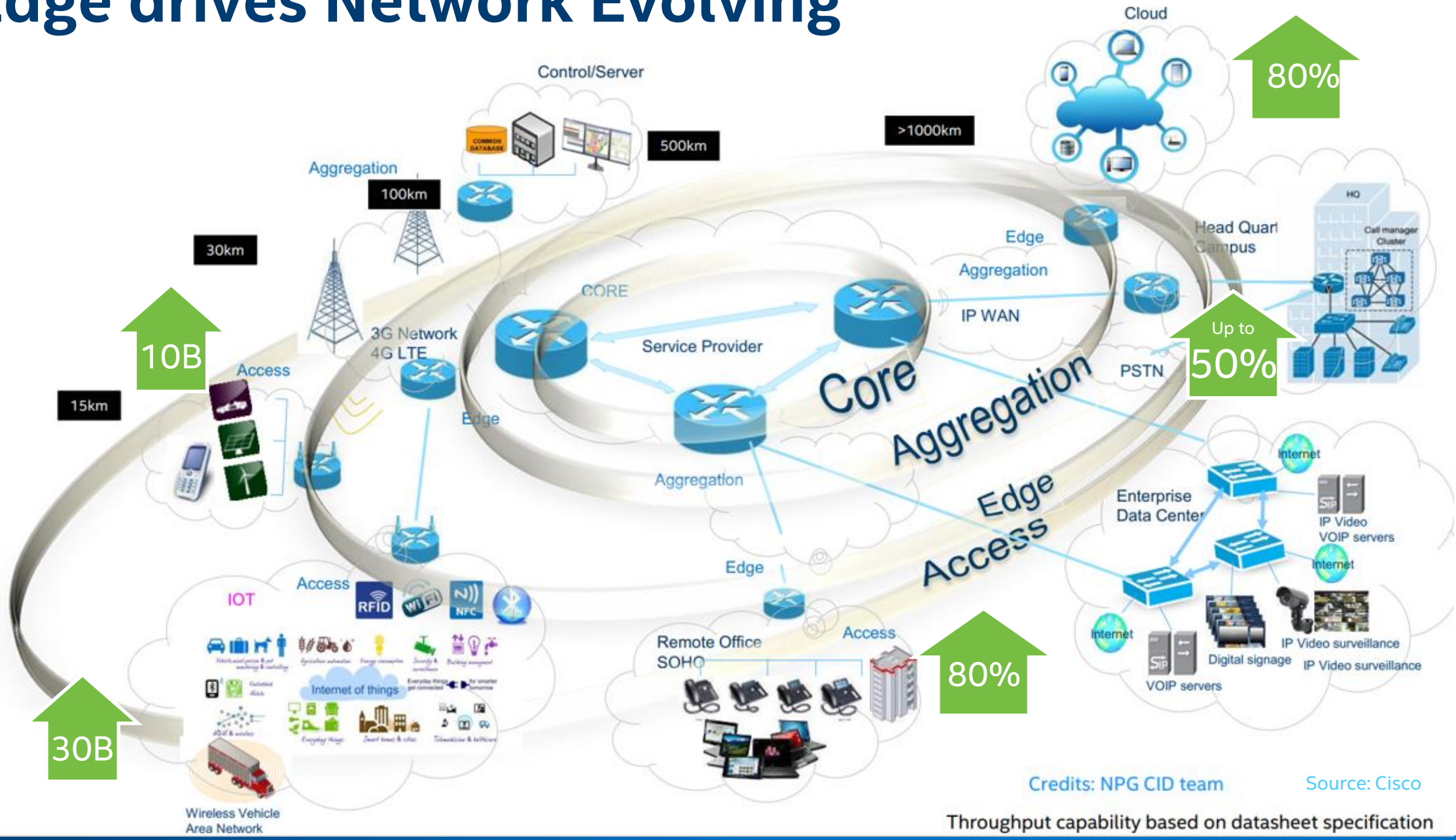
Agenda

- **uCPE/SD-WAN Overview**
- uCPE/SD-WAN Ecosystem Solution Examples
- Intel uCPE/SD-WAN Solutions
- Summary

Edge drives Network Evolving

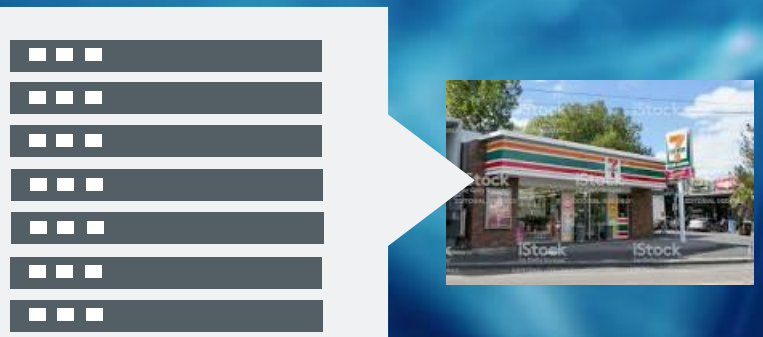


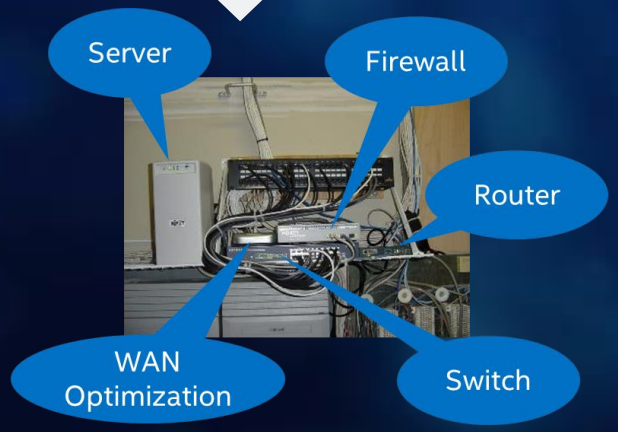
Credits: NPG CID team

Source: Cisco

Throughput capability based on datasheet specification

Branch Offices are complex…





Internet

MPLS

Microsoft Azure
AWS
Public Cloud

salesforce
SaaS
SECaaS, IaaS…
workday.
zscaler

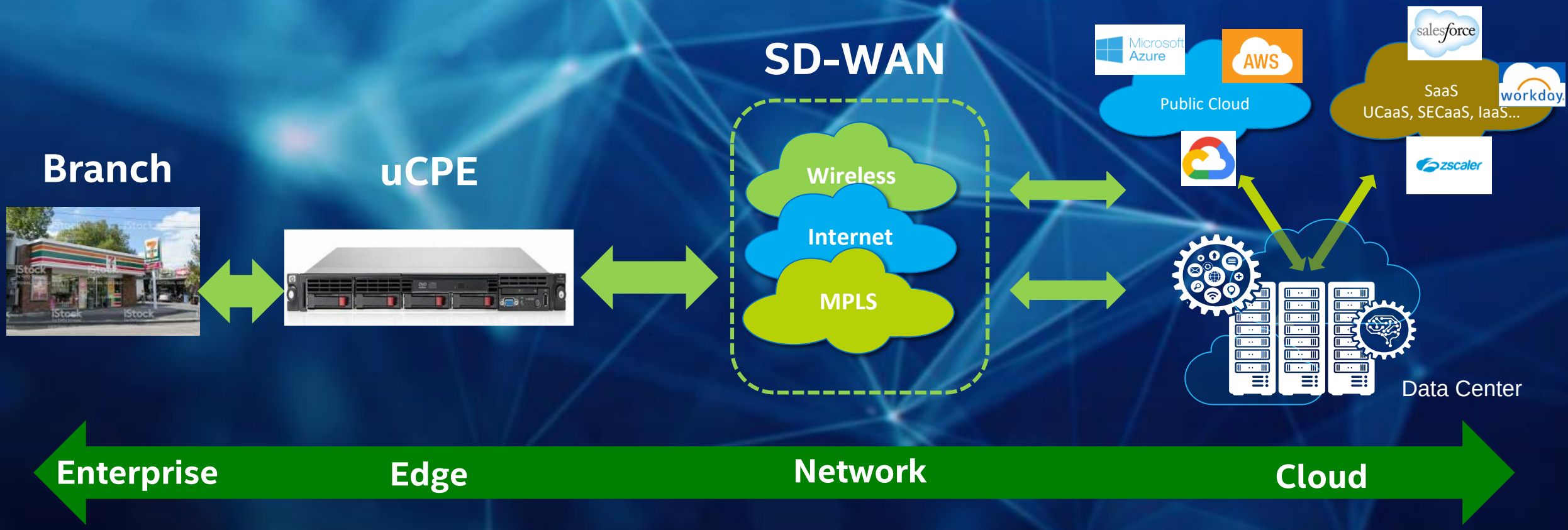
Data Center

Complex Customer Premise

Increasing Bandwidth Demand/Cost

Manual service provisioning and no centralized control

Transform to the SD-Branch



uCPE plays unsurpassed role as Smart Enterprise Edge Platform

SD-WAN/uCPE Market Snapshot

SD-WAN TAM Expansion:

- $3B+ TAM by 2021
- Acquisitions since 2017
- **Security vendors** enter the market: **SD-WAN + Security**

Fragmented market:

- Providers each have proprietary SD-WAN solutions
- Market share splits among multiple solution vendors

Multiple consumption models:

- Enterprise direct leads the deployment currently (vs. CoSP)

VNF/Services as new focus for SD-WAN edge devices/uCPE:

- SD-WAN/uCPE merges router features
- VNF/App on-boarding

BENEFITS OF ADOPTING SD-WAN AT THE BRANCH

SIMPLIFY AND SECURE:

- Collapse multiple functions/devices into a software instance running on IA appliance or cloud
- Add security functions seamlessly

REDUCE TCO:

- Improve cost per bit with hybrid connectivity
- Decrease the number of edge devices for lower overall cost

OPTIMIZE SECURE CLOUD ACCESS:

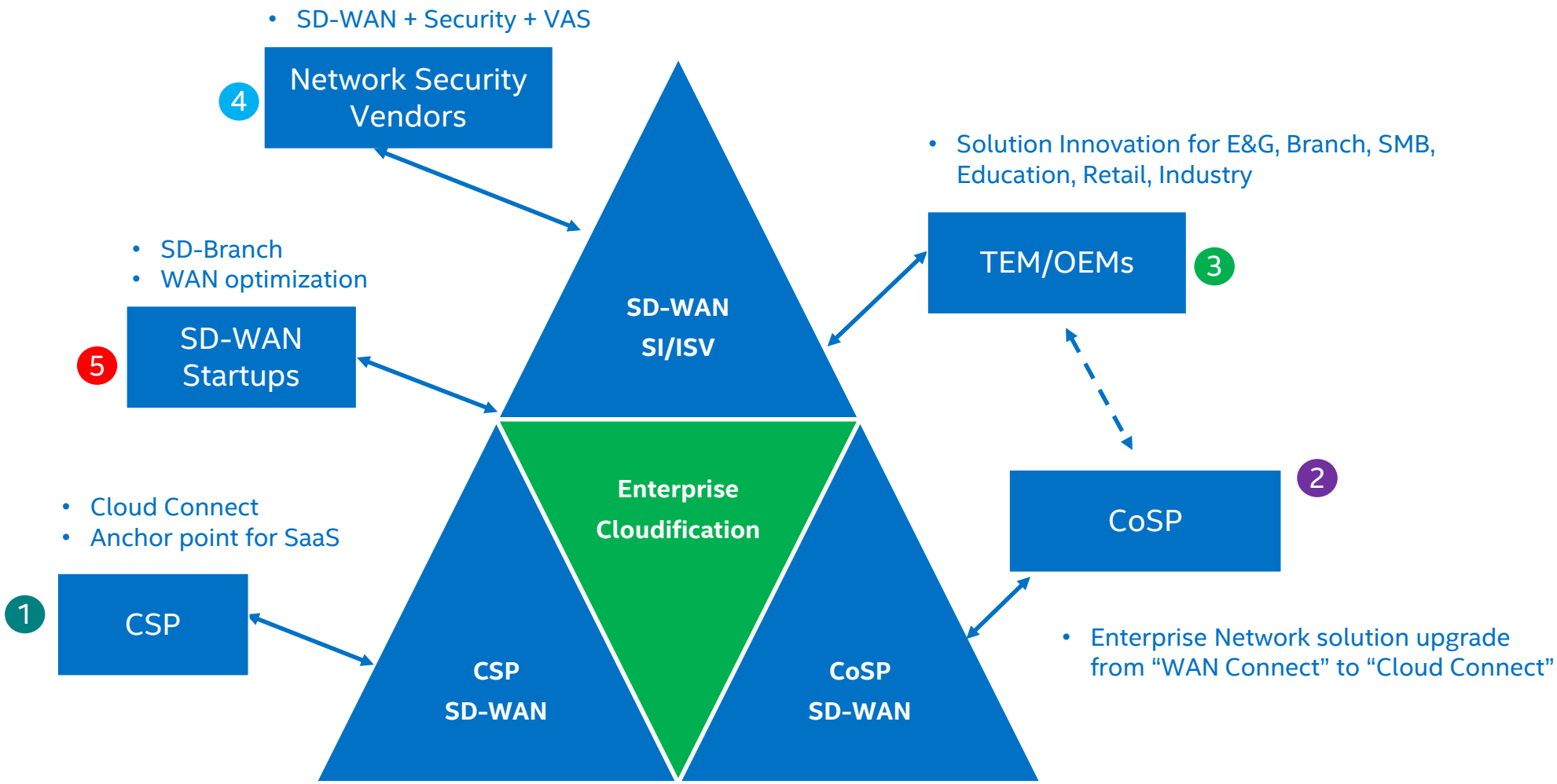
- Deliver cloud to remote offices with SLA and security
- Improve branch-to-head office bandwidth efficiency

IMPROVE APPLICATION PERFORMANCE:

- Improve application uptime by 10x
- Implement AI and machine earning for analytics

Adopt SD-WAN & Security at the Branch Now to Get Immediate ROI

PRC SD-WAN Market Overview



Intel Benefits and Advantages for uCPE/SD-WAN Edge

1 Scalability

From 2 cores to 28 cores
Thin to Medium to Thick Edge
Same infra, same software

2 Consistency

Edge

Private Cloud

Public Cloud

Same infra, same software & workload movement flexibility across the Edge, DC, Public Cloud

3 Performance

Room to Grow
Reliable High Performance

4 Security offloads & SDKs

Hyperscan

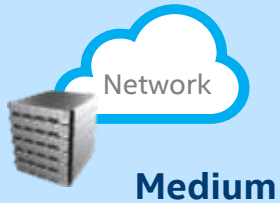
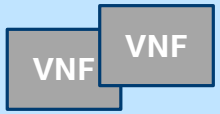
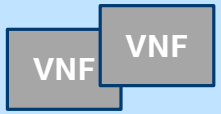
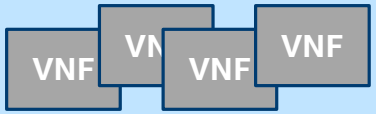
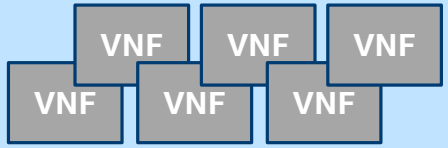
Intel AES-NI

5 Network Specific SoCs & Roadmap

Intel Xeon-D

Intel NIC

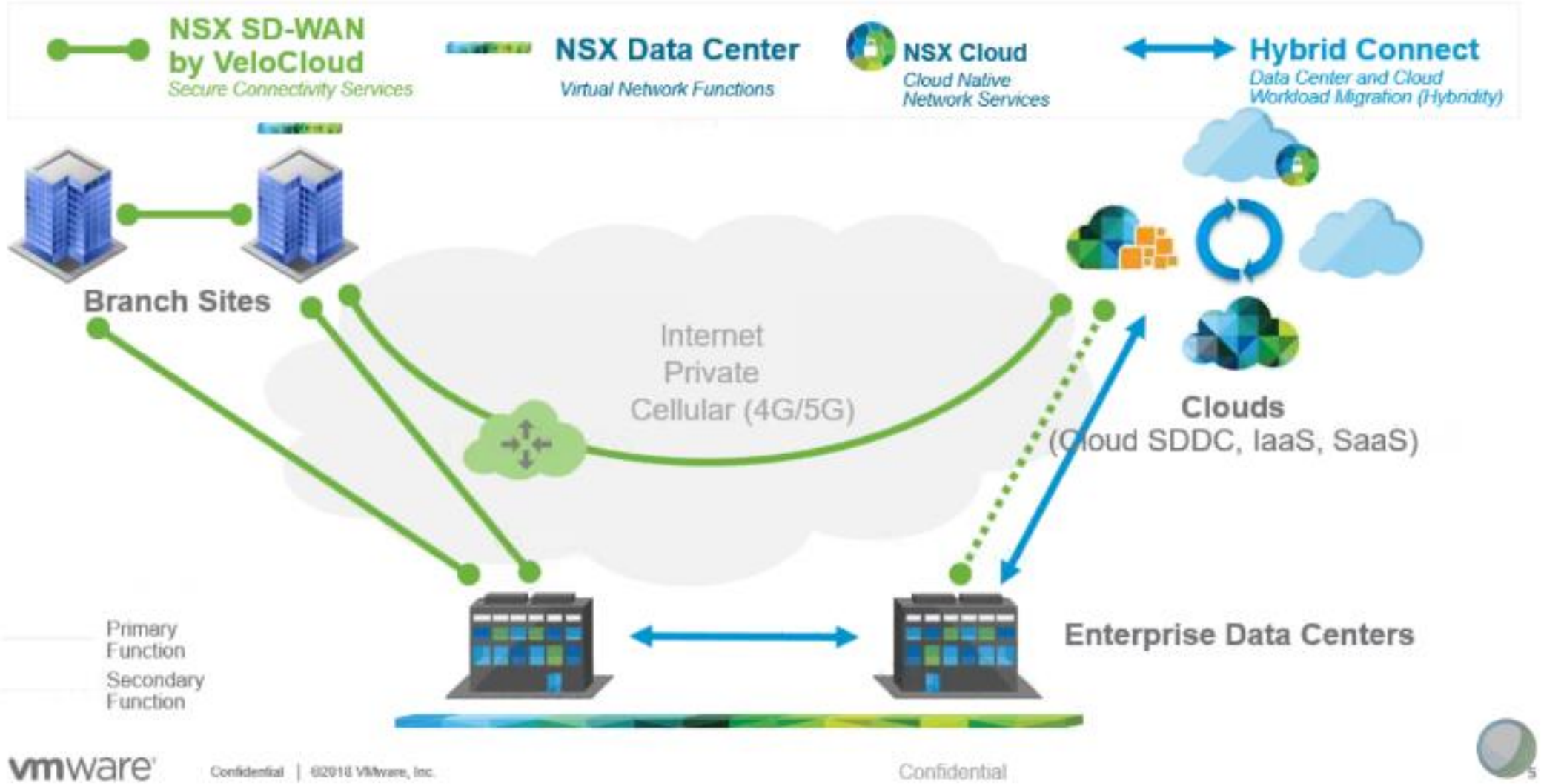
uCPE Deployment models and Advantages

VNFs @ POP/DATA CENTER	Routing, VPN, FW, CGNAT, WiFi CTRL, SD-WAN CTRL	Routing, VPN, FW, IPS, SBC, CGNAT, WiFi CTRL, SD-WAN CTRL	FW, IPS, CGNAT, SBC, SD-WAN CTRL	WAN Accel, SD-WAN CTRL
SERVICE PROVIDER / ENTERPRISE	 **SOHO**	 **Small Branch**	 **Medium Branch**	 **Large Branch**
VNFs @ CPE	SD-WAN, VPN, Routing	DPI, SD-WAN, VPN, vRouter	DPI, VPN, WAN Accel, SD-WAN, WAC, vRouter	Routing, VPN, WiFi CTRL, WAN Accel, FW, IPS, SD-WAN, vRAN
	 **1-2 VNFs**	 **1-4 VNFs**	 **2-6 VNFs**	 **6+ VNFs**
INTEL® TECHNOLOGIES TO DRIVE PERFORMANCE, SCALE, & SECURITY	**Intel Atom® Processors (2-core)**	**Intel Atom Processors (4-core or 8-Core)**	**Intel Atom Processors (12-core to 16-core)** **Intel® Xeon® D Processors**	**Intel Xeon D Processors** **Intel® Xeon® Scalable Processors**

- Data Plane Developer Kit
- Intel® QuickAssist Technology
- Hyperscan
- Intel® Virtualization Technology
- Intel® AES New Instructions
- Intel® Run Sure Technology
- Intel® Trusted Execution Technology
- Intel® Platform Trust Technology

SD-WAN/UCPE ECOSYSTEM SOLUTION EXAMPLES

SD-WAN / uCPE Solution Example: NSX SD-WAN by VeloCloud



Intel and NSX SD-WAN by VeloCloud Joint Value

NSX SD-WAN by VeloCloud software
- Optimized for Intel® architecture (IA) and runs only on x86
- Utilizes technologies such as DPDK, Intel® AES-NI, and Intel® QAT for faster packet processing and encryption/compression

SD-WAN Edge Hardware: NSX SD-WAN by VeloCloud Edge series
- Based on IA (Intel Atom® processor C2000/C3000 to Intel® Xeon® processor D-1500)
- Supports Intel QAT for encryption/compression
- NSX SD-WAN team-Intel working on a new low-end solution

SD-WAN Edge Hardware: Dell EMC Virtual Edge Platform (VEP)
- Based on IA (Intel Atom processor C3000 to Intel Xeon processor D-2100)
- Optimized for SD-WAN and virtual edge, supports Intel QAT
- VEP 4600 is the only appliance in the market based on the latest Intel Xeon processor D-2100
- Intel closely working with Dell on VEP 1400 design (general availability October 2018)

VeloCloud Edge Series

VEP 1400
GA Oct '18

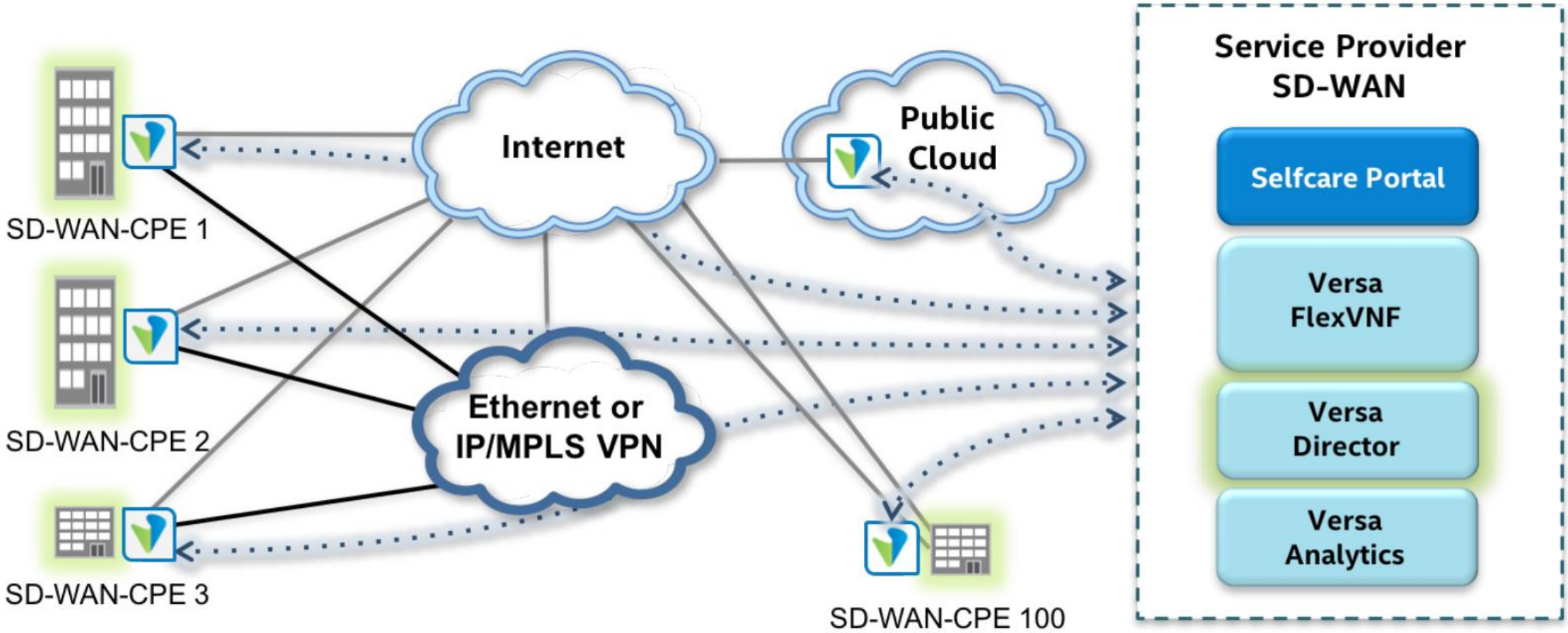
VEP 4600

PowerEdge RS-640

Vendor	Product	SME	Medium Branch	Large Branch	DPDK	AES-NI	QAT
VMWare NSX SD-WAN by VeloCloud	Edge Series	Edge 510, 520 Atom C2358	Edge 540, 520v Atom C2558	Edge 840 (Xeon D-1518) Edge 2000 (Xeon E5-2680 v3)	Yes	Yes	Yes
Dell EMC	Virtual Edge 4600	VEP 1400 (GA Oct '18) (Atom C 3000)	VEP 4600 (Xeon D-2100)	VEP 4600 (Xeon D-2100) PowerEdge RS-640 (Xeon E5 v4)	Yes	Yes	Yes

Versa SD-WAN

FlexVNF deployed on SD-WAN-CPE scalable from Intel Atom (C2000, C3000) to Xeon-D, or VM on server

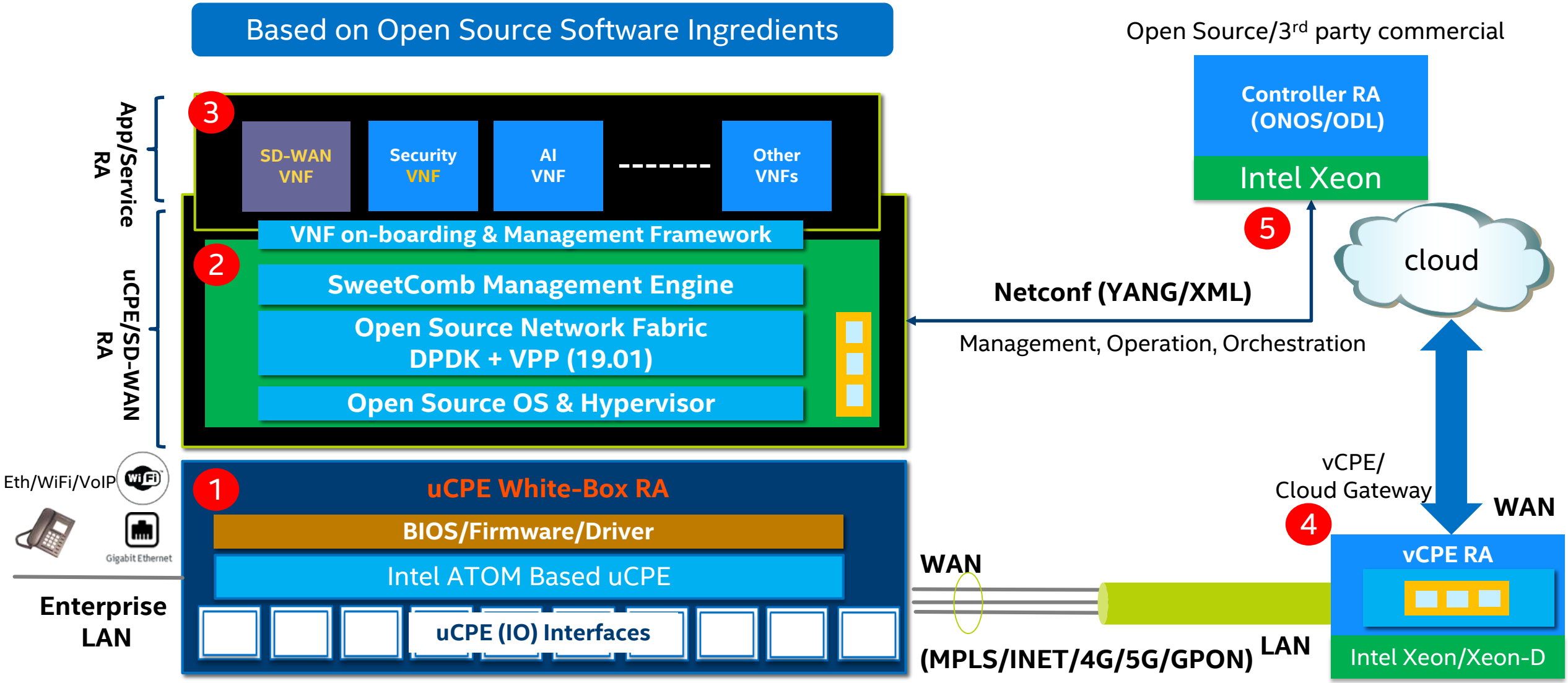


Source: Versa White-Paper

Agenda

- uCPE/SD-WAN Overview
- uCPE/SD-WAN Ecosystem Solution Examples
- **Intel uCPE/SD-WAN Solutions**
- Summary

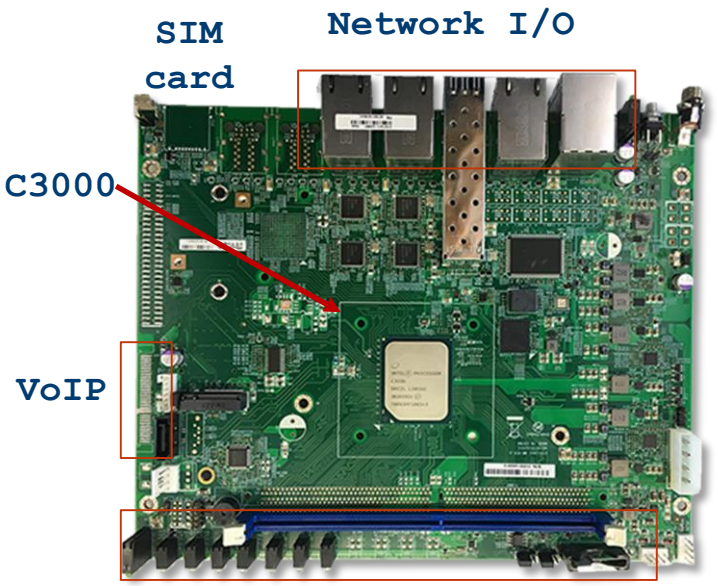
Open uCPE/SD-WAN Open Framework



Sub entry uCPE White-box Reference Solution

Fully scalable solution (duplicate, customize, enhance)

Open



Status Panel
(System, Cloud, Wireless, Failure)

Small-Box ("Black-Box")

SKU #1

SKU #2

1st uCPE White-box Designed in PRC
(Standard, Modular, Open)

Component	Feature
CPU	Intel C3000 (2C/4C, QAT)
Memory	DDR4 (2G~32GB), ECC Optional
Storage	eMMC (8/16GB), SATA
Network I/O	2xCombo GbE + 4/6x RJ45 GbE
Wi-Fi	Mini-PCIe (dual band, 802.11ac)
LTE/5G	M.2/Mini-PCIe. Up to 2x LTE
GPON	Yes, SFP module
VoIP	Yes (Expansion Module on 4C board)
Console	Serial Port (RJ45)
USB	2x USB 2.0 Host
Status	SW-Defined (GPIO/LEDs/Buttons)
Form Factor	Desktop/Rack-mount Kit
Certification	partial region

CentOS ubuntu OpenWrt Wireless Freedom DPDK DATA PLANE DEVELOPMENT KIT .io

intel

5G uCPE Specification Brief

Base Platform

- Intel C3000 Network SoC (2~16 Cores)
- 2~32G DDR4 memory
- 8/16G eMMC
- QAT acceleration for IPSec
- Ethernet: 2x Combo GbE, 4/8x RJ45 GbE, all independent & manageable
- Software Defined Front Panel

Device Prototype

Wi-Fi Features

- Intel WAV654 802.11ax chipset, high performance with PCI-E3.0 interface
- Compatible with 802.11 a/b/g/n/ac/ax
- Single module simultaneous 2.4 and 5GHz dual band
- Access Point feature supports up to 256 clients

5G Features

- 5G Sub 6GHz M.2 Module
- Support 4G Network
- NSA and SA Network

Software

- CentOS, Ubuntu, OpenWRT Optimization
- Open Source SD-WAN Dev Kit
- DPDK/VPP supported
- Wi-Fi and 5G device driver pre-integration

Use Cases

- Cloud Connect and Cloud Acceleration
- 5G SD-WAN/uCPE, SD-Branch
- Enterprise/Cloud Network Edge
- Cloud VR, Cloud Gaming and 8K video acceleration
- IoT/eMBB

uCPE White-box Product Line Up

D2100/D1500 Series




C3000 Series



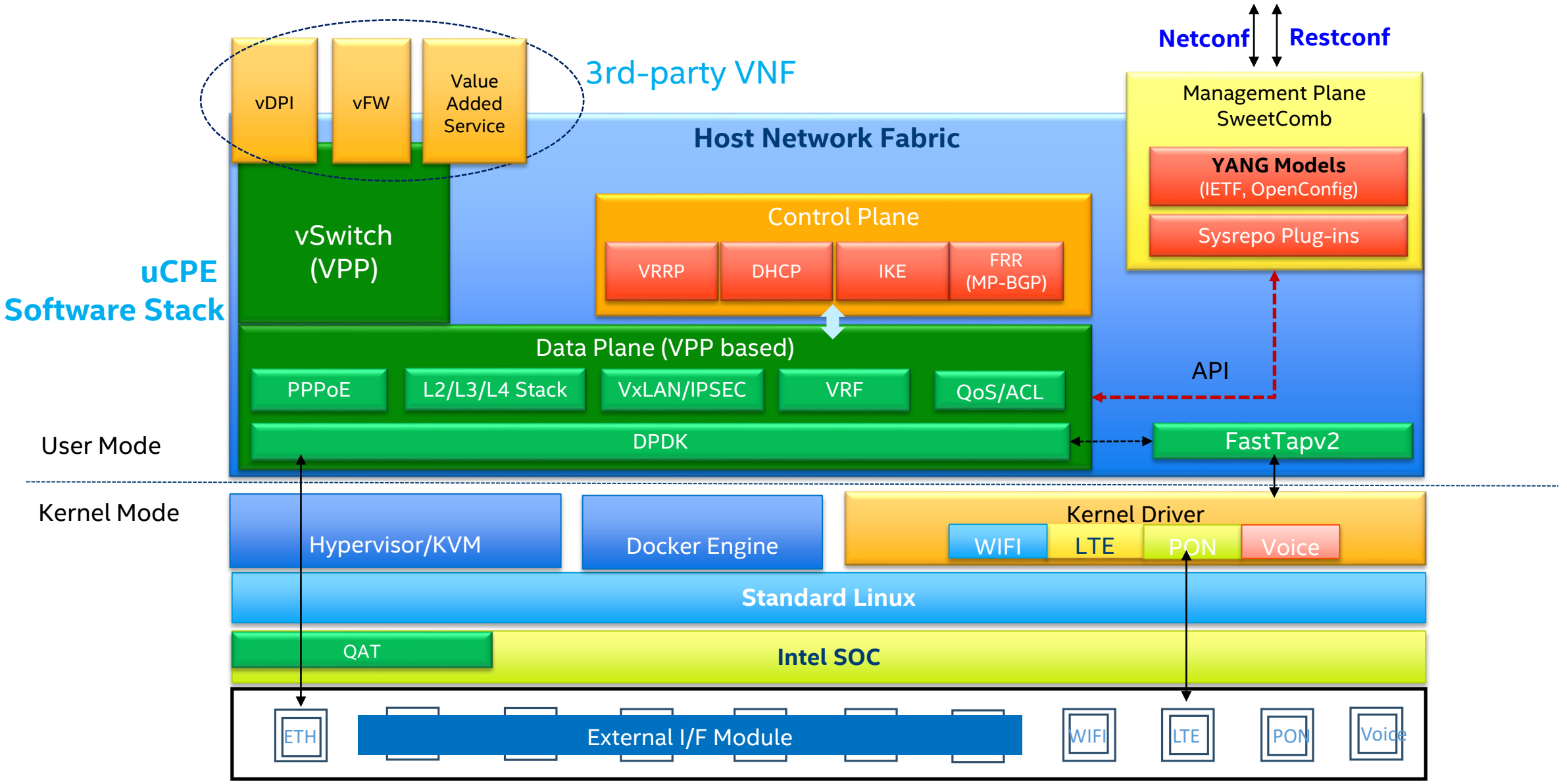


C2000 series




uCPE/SD-WAN	NGFW	UTM	App Delivery

uCPE/SD-WAN Software Reference Architecture (RA)



uCPE SDK Overview

LINUX BSP

CentOS 7.x
Device Drivers (QAT, WiFi, LTE)
Footprint Optimization
Computing Resource Management

TOOLKIT

Developer Environment
Compiler, linker
Cross-compiling
Installer, packaging, deployment
User and Developer Guide

NETWORK STACK

DPDK + VPP
IPSec VPN, VxLAN, NAT
QoS, ACL
Real-time Traffic Analytics
Tapv2, DHCP, DNS

VOIP + WIFI

VoIP
DSP based, up to 16x POTS
Wi-Fi

REMOTE MANAGEMENT

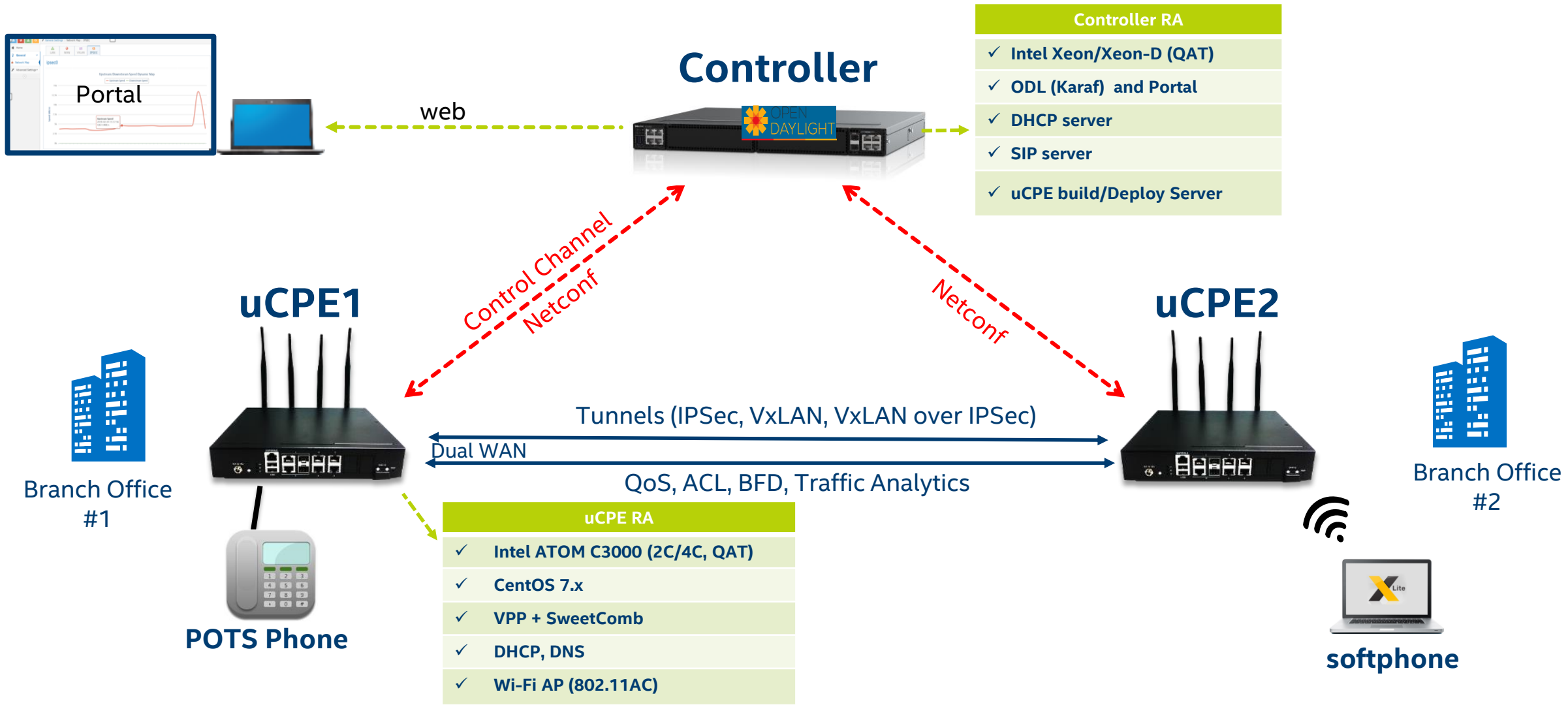
Local Management Portal
SweetComb Mgmt. Engine
Netconf + IETF YANG model
SDN Controller (ODL) Support

POC

Router/Gateway
GUI based Portal
Wireless, VoIP service
SDN Controller Integration
High Performance

Intel® Architecture-Based
Platforms Support

Open uCPE/SD-WAN E2E PoC



Data Plane Features

- Wi-Fi
  - Kernel mode device driver
  - Support WLAN QoS, security, 4+ SSID
- VoIP
  - PC to Phone, Phone to Phone
- IPSec with IKEv2
  - IPSec NAT-T
  - QAT acceleration
  - AH and ESP
- VxLAN Tunnel
  - VxLAN over IPSec
  - Multiple VxLAN tunnels
- QoS
  - Per flow rate limitation (bi-directional)
  - IP/TCP/UDP/VxLAN based Flow
- ACL
  - MAC/IP/Port based filtering
  - MAC and IP bundling check
- NAT/NAPT
- ICMP
- VLAN
- Dual WAN
- Link quality
  - BFD
- Analytics
  - Computing resource: CPU, memory
  - VPN, WAN, LAN, Session based
- Services
  - DHCP
  - NTP
  - HTTP Server services

Management Features

Local Management

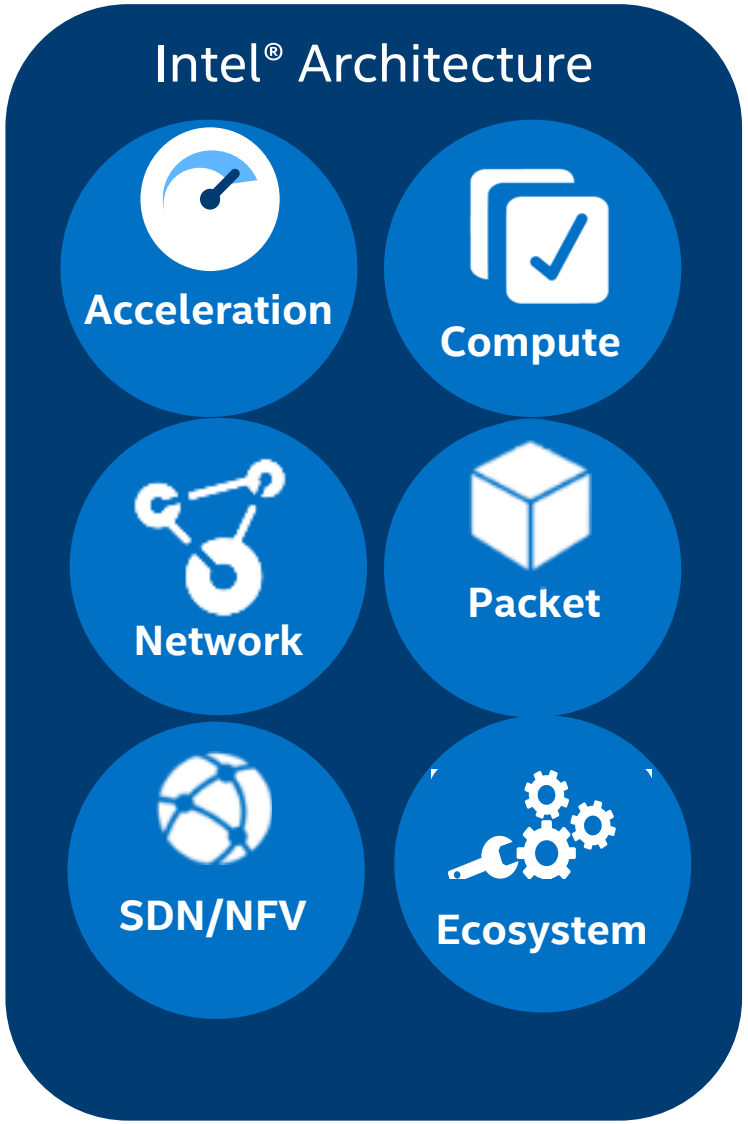
- CLI (Console) based
- UI (Web Service) based
- WAN management (IP, DNS)
- LAN management (IP, DHCP, DNS)
- Wi-Fi management
- Traffic analytics

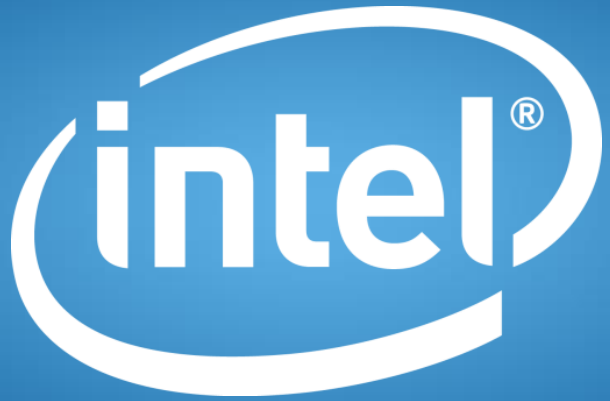
Remote Management Engine (ME)

- Support Netconf
- Support SDN/SD-WAN controller (Open Daylight)
- Support YANG Model
- ME integration with VPP (API based)
- Plug-in
  - QoS, Bridge, Routing rule, IPSec, VxLAN, IKE, NAT, statistics, Wi-Fi, VoIP, VLAN
  - Device Management

Summary

- Intel is investing to make networks faster, more secure and agile
- uCPE/SD-WAN Open Framework Solution, based on open source ingredients will complement commercial solutions and enrich ecosystems
- SD-WAN/uCPE evolves to multiple VAS driven use cases includes SD-WAN + Security and SD-WAN + IOT

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