LightReading LIVE! WEBINAR

Network Disaggregation at the Edge With the Open SD-Edge Platform

November 11, 2020

Sponsored By: ipinfusion™

Today's Speakers

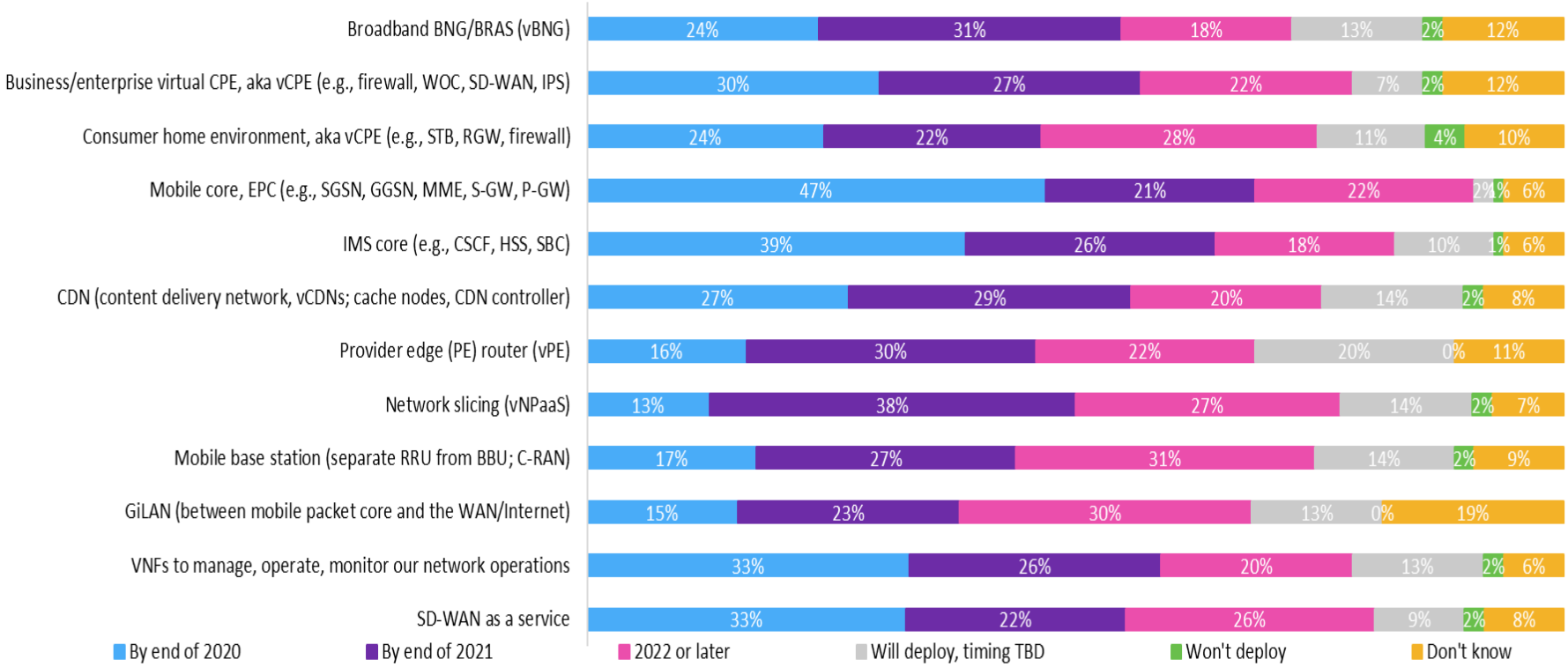
Jennifer Clark,
Principal Analyst –
Heavy Reading

Elad Blatt
CSO
Silicom

Robert Bays
Assistant VP
ATT - Vyatta

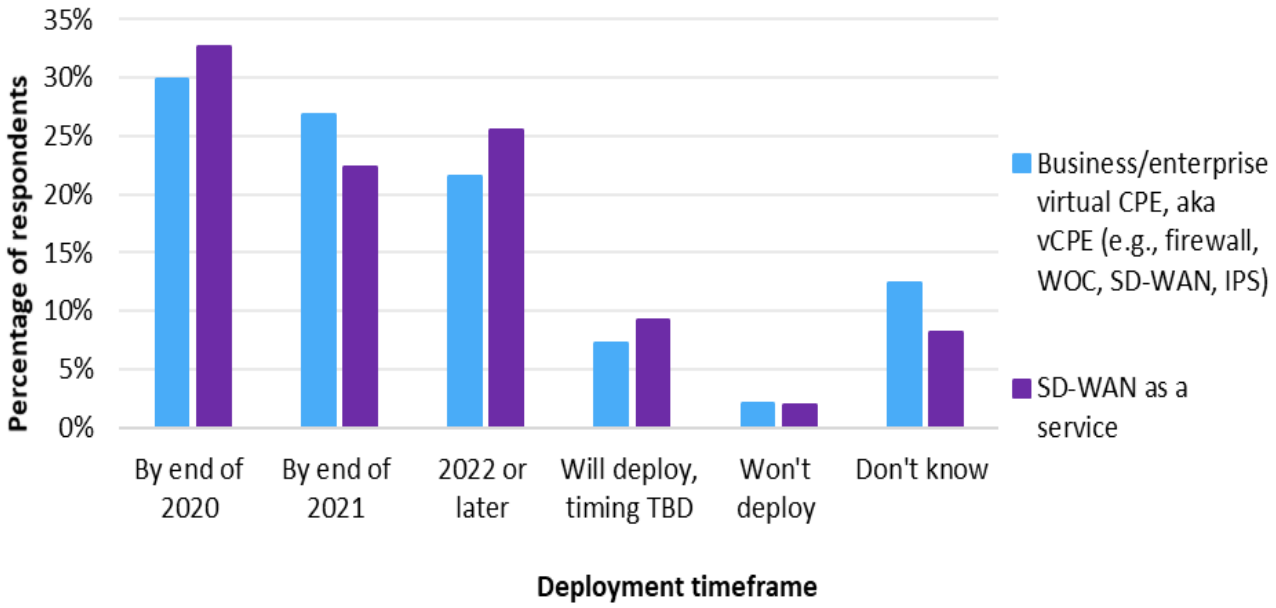
Srikanth Krishnamohan
Director of Product Marketing
IP Infusion

NFV in a Production Environment: Leading Use Cases



Source: Omdia

Enterprises are Shifting to Managed Services

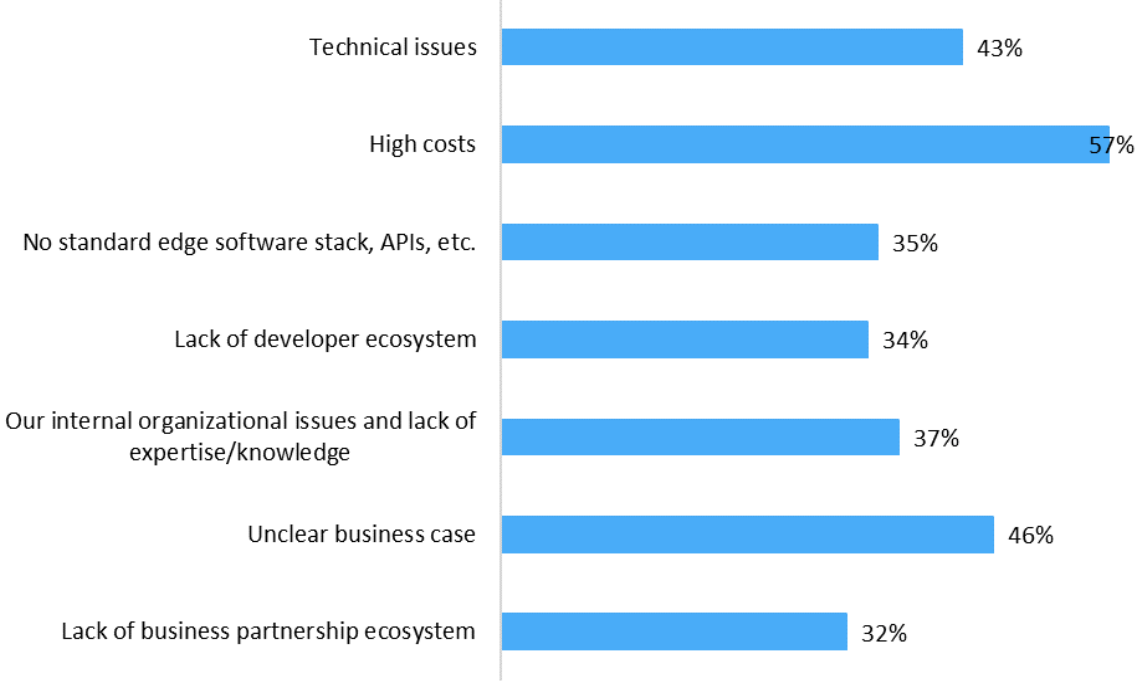


Notes: n=98–102

Enterprises are shifting from DIY vCPE to managed services, supporting the same VFNs but with improved security, performance, reliability and cost

Edge deployment barriers

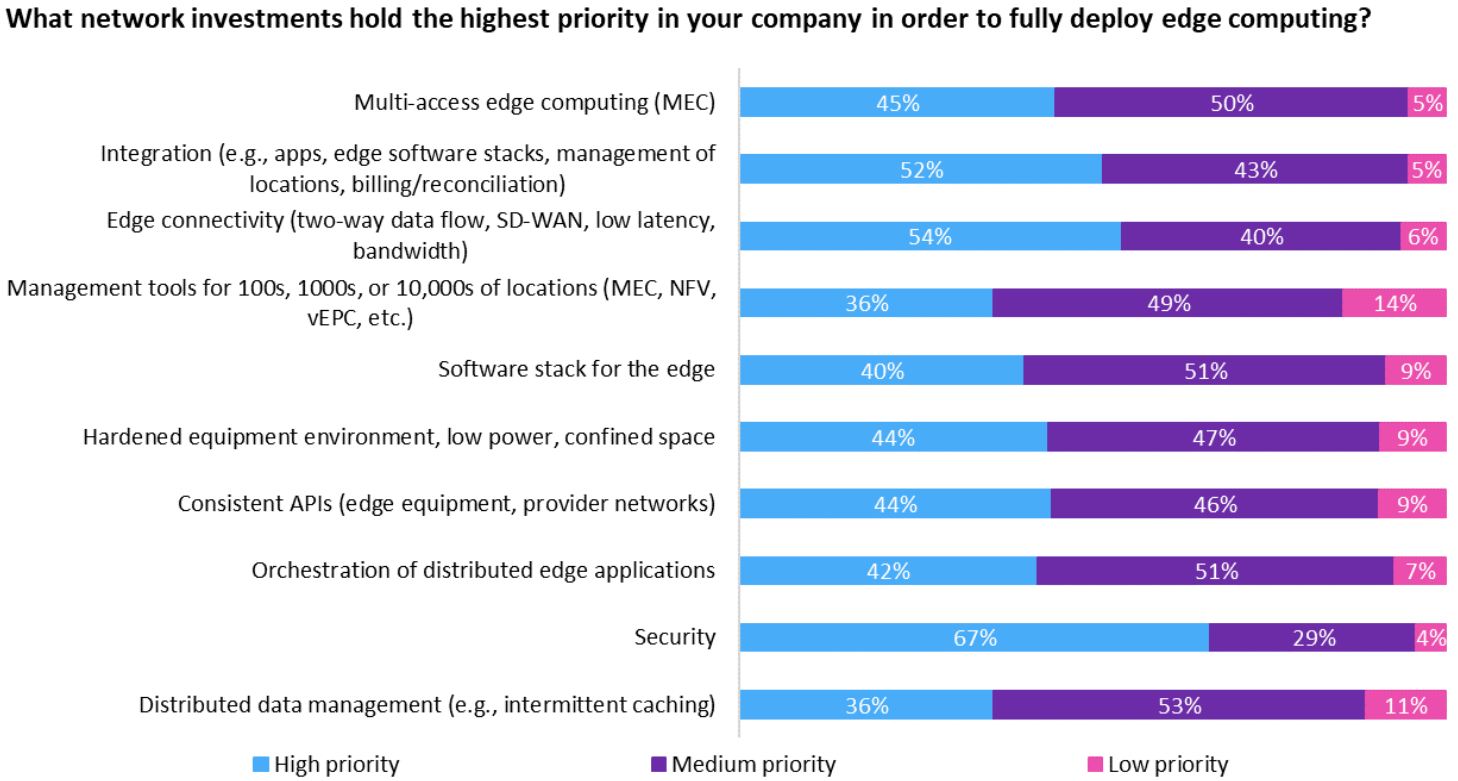
Select the three biggest barriers to deploying edge applications



Source: Omdia

- Today, operators are faced with three top challenges to deploying edge:
  - High costs
  - Unclear business case
  - Technical issues

Edge Investment: Everything is a Priority



Source: Omdia

LightReading LIVE! WEBINAR

Network Disaggregation at the Edge With the Open SD-Edge Platform

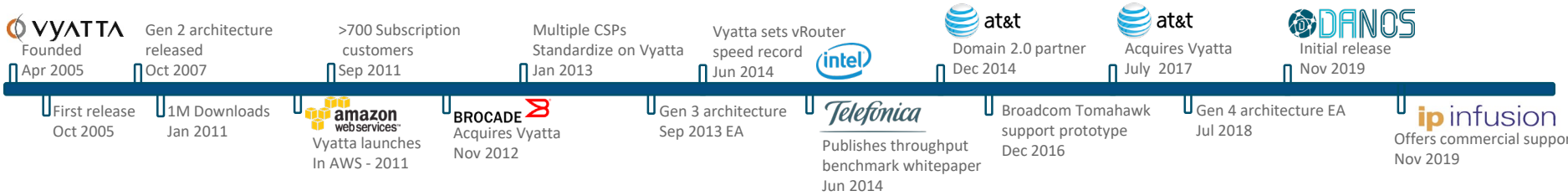
Q&A

ip infusion™

DANOS Vyatta Edition

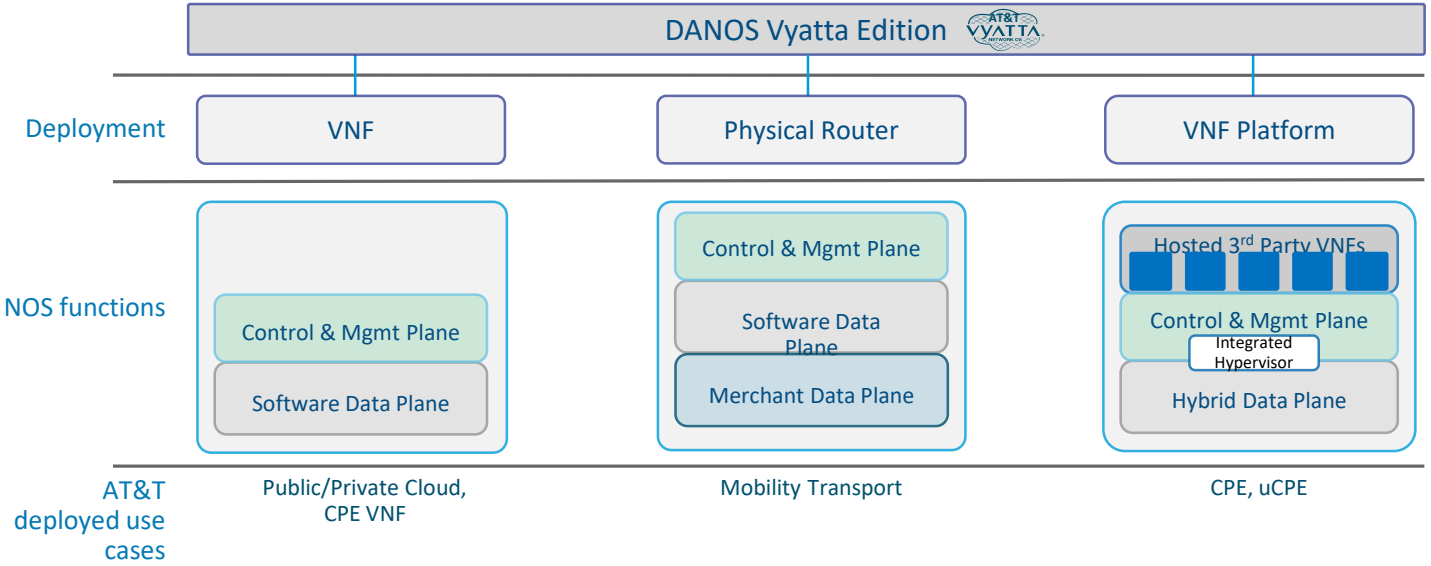
2020-11-11.1

What is DANOS Vyatta Edition?



- Vyatta was created in 2005 as an open source network operating system running on commodity hardware
  - Original investment thesis was that a fully open source Linux based router could compete in the edge router market segment
- Company growth exploded with the large scale adoption of cloud computing
  - Engineers realized the need for network segmentation and services in cloud environments
  - First virtual router in AWS launched in 2011
- Over 700 customers by September 2011
- Vyatta was acquired by Brocade in Nov 2012
  - Next generation development was closed source after acquisition
- 2013 Gen 3 architecture introduced high speed, low latency DPDK based software forwarding using general purpose hardware
- Named AT&T Domain 2.0 partner in 2014
- Vyatta was acquired by AT&T in July 2017
- 2018 launch of Gen 4 architecture introduces hybrid merchant silicon / software forwarding
- November 2019 DANOS open source release
- IPinfusion provides commercial support for DANOS Vyatta Edition

How can DANOS Vyatta Edition be deployed?



Why DANOS?

- AT&T wants to build a carrier community around a standardized, open source, telco grade WAN Network Operating System to
  - Lower operational costs through code reuse and by simplifying onboarding, operation and maintenance of network devices across carrier networks
  - Create opportunities for standardized commodity WAN hardware
  - Foster an ecosystem of innovation where third party application developers can create value added applications for a common NOS

- But why do we need yet another open source NOS? DANOS Vyatta Edition:
  - Is focused on Telco WAN network features and operational models
  - Provides familiar interface and administration tools to easily fit into existing networks and deployments
  - Has been tested, certified and deployed at scale in production in the AT&T network
  - Proven highly scalable and performant software data plane and support for merchant silicon forwarding
  - Supports multiple deployment models; merchant silicon switching/routing, x86 based CPE, cloud and virtual functions, edge to core
  - Built from the ground up to support yang/netconf
  - Well defined APIs to facilitate third party applications
  - Regular binary releases to support the user community

- To bootstrap the ecosystem, AT&T released a subset of the Vyatta NOS as DANOS through Linux Foundation

- Commercial support is critical to DANOS success with end users
  - IPinfusion has offered to work with AT&T to provide commercial support for DANOS through the DVE product offering

DANOS vs DVE Feature Overview

Control plane

- AAA
  - ACM/RBAC, RADIUS, TACACS+
- Chassis manager
- Config sync
- Diamond client
- DNS
  - Host config, Dynamic DNS, DNS forwarding
- DHCP
  - Clientv4/v6, DHCPv4/v6 relay, DHCPv4/v6 server
- DMVPN/NHRP
- GUI
- LLDP
- Logging
  - Remote syslog, journalbeat
- NTP client
- Cellular modems
- Multiple image support
- ONIE
- Path monitor
- Policy based routing
- PTP
- Route Broker
- SNMPv1/v2/v3 server
- SSH/Telnet server
- TWAMP client/server
- Virtual Distributed Router
- Vyatta Component Infrastructure
  - Netconf, CLI, REST, Operational mode infrastructure
- Vyatta routing protocol stack
  - BFD, BGP (v4/v6 unicast, vpnv4/6 unicast, 6PE), IGMP, LDP, MLD, MSDP, Multicast, OAM, OSPFv2, OSPFv3, PIM/PIM6. RIPv2/RIPng, RSVP-TE, Static – replaced with FRR in DANOS
- FRR routing protocol stack
  - BGP, MPLS-LDP, OSPF, OSPFv3, static
- Virtual routing and forwarding (VRFlite)
- Virtualization
  - uCPE (xConnect/vhost), VNF virtualization support, VNF probes
- Zero touch provisioning

Hardware data plane

- Merchant silicon forwarding abstraction layer (FAL)
  - Broadcom
    - Hurricane 3, Hurricane 3MG
    - Qumran AX, MX
    - Jericho 2
  - Marvell
    - 88E6190X
- L3 ACL support
- CPP, Storm Control
- L2 switching
  - Marvell, Broadcom (Hurricane 3/MG, Qumran – AX/MX, Jericho 2)
- IP Unicast Forwarding
  - Broadcom (Qumran –AX/MX, Jericho 2)
- IP multicast forwarding
- Mirror ports
- PTP
  - 1588 default profile, 8275.2
- Router centric configuration model
  - L3 config directly on ports (QAX, QMX, J2)
- Hardware packet capture
- Interface breakout
- QoS
  - Shaping, LLQ, WRR, WRED
  - RFC3260, RFC2472, RFC2475, RFC2597
- Spanning tree
- GRE Tunnels
- LAG
- BFD
- VLAN, 802.1Q
- VRF

Software data plane

- BFD
- Bonding/LACP
- Bridging
- CPP
- Data plane vector API
- DHCP client
- Deep packet inspection
- Forwarding abstraction layer
- Stateful Firewall(v4|v6)
  - ACLs, ALGs, Stateful Failover, Zone Based
- Loopback interface
- MPLS (LSR, LER, 6PE, 6VPE, - RFC3032)
- MPLS OAM (ping, traceroute – RFC8029)
- Stateful NAT(v4|v6)
  - ALGs, Stateful Failover
- NAT64/NAT46
- NPTv6
- CGNAT
- Policy based routing
- PPPoE
- QoS
  - Shaping, LLQ, WRR, WRED, policing, marking
  - RFC3260, RFC2472, RFC2475, RFC2597
- Packet capture
- Reverse path forwarding
- SPAN/RSPAN/ERSPAN
- Spanning tree
- Transceiver instrumentation – SFF8636, SFF8472
- Tunneling
  - GRE (L2 & L3 bridging), IPIP (IPIP, IPIP6, IP6IP, SIT), L2TPv3, VXLAN/VTEP
- Unnumbered interface
- Virtual distributed router
- VPN
  - IPsec
    - IKEv1/2, ESPv3, policy based, route based (VTI), remote access client/server
  - DMVPN, IPsec (interface based/vti), IPsec (policy based), OpenLDAP auth,
  - OpenVPN
    - Site-to-site, remote access client/server
- VRRPv2/v3
- VLAN
  - 802.1q, QinQ
  - VLAN modify – push/pop/swap
- VRF and virtual feature point interfaces

* Items in red are supported in Vyatta, but not DANOS

DANOS – How do I get involved?

Community

- https://danosproject.org
- Initially supported use cases
  - x86 VNF router (iso)
  - x86 hardware CPE (iso)
  - Broadcom Qumran AX Cell Site Router (ONIE)

Confluence

- User documentation and setup guides
- Links to binary images (iso, ONIE)
- Developer API and build instructions

Jira

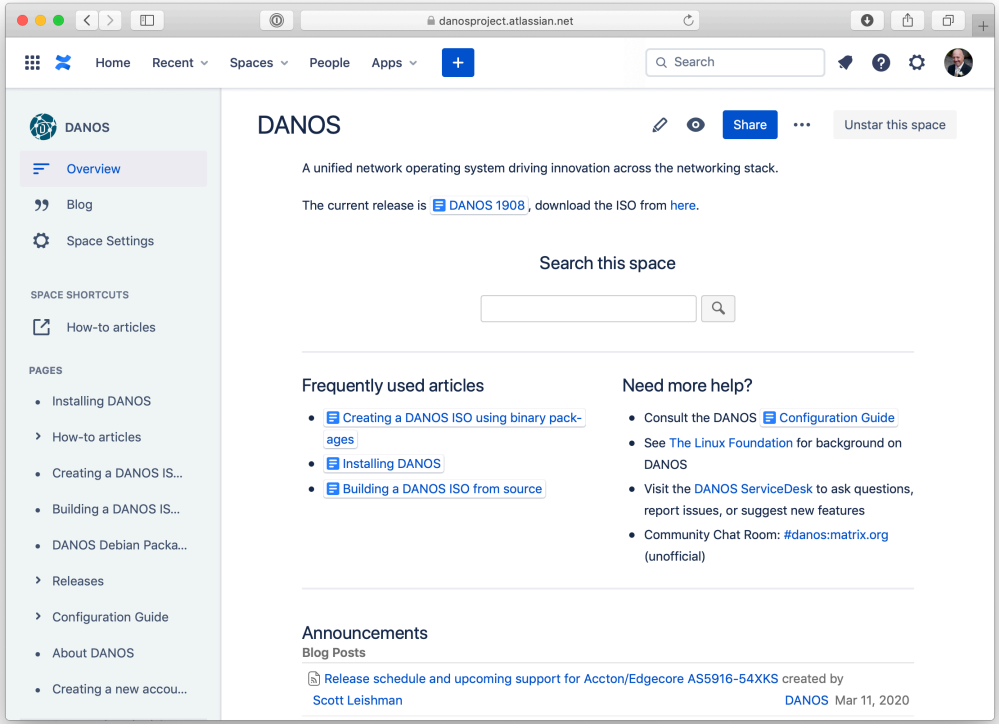
- Issue tracking and community questions

GitHub

- DANOS development is done in GitHub directly - upstream first
- Pull requests require developer certificate of origin

Package repository

- Debian package repository setup to allow developers to build iso from binary packages rather than source
- Automatically updated with packages built by Vyatta's continuous integration




AT&T

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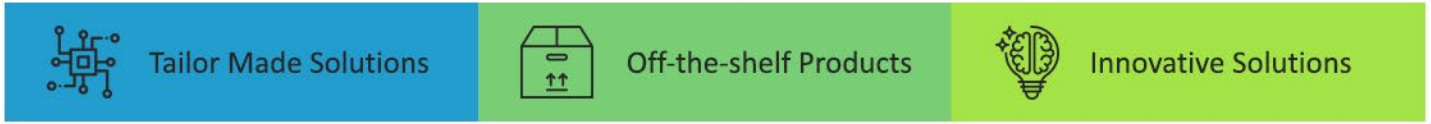
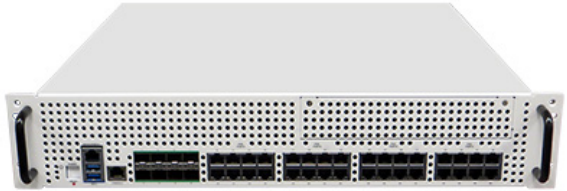


November 2019

uCPE Modular Lineup

IA3000 Series
Intel® Atom® C3000

ID1100 Series
Intel® Xeon® D-1500



ID1200 Series
Intel® Xeon® D-1500

ID2100 Series
Intel® Xeon® D-2100

intel select solution

2 core Atom® → 16 core Xeon®

1G Ethernet → 100G Ethernet*

* FPGA offload available

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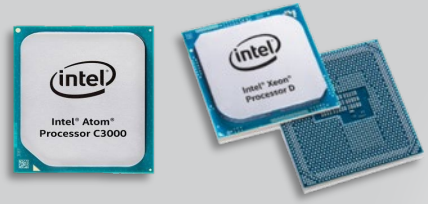
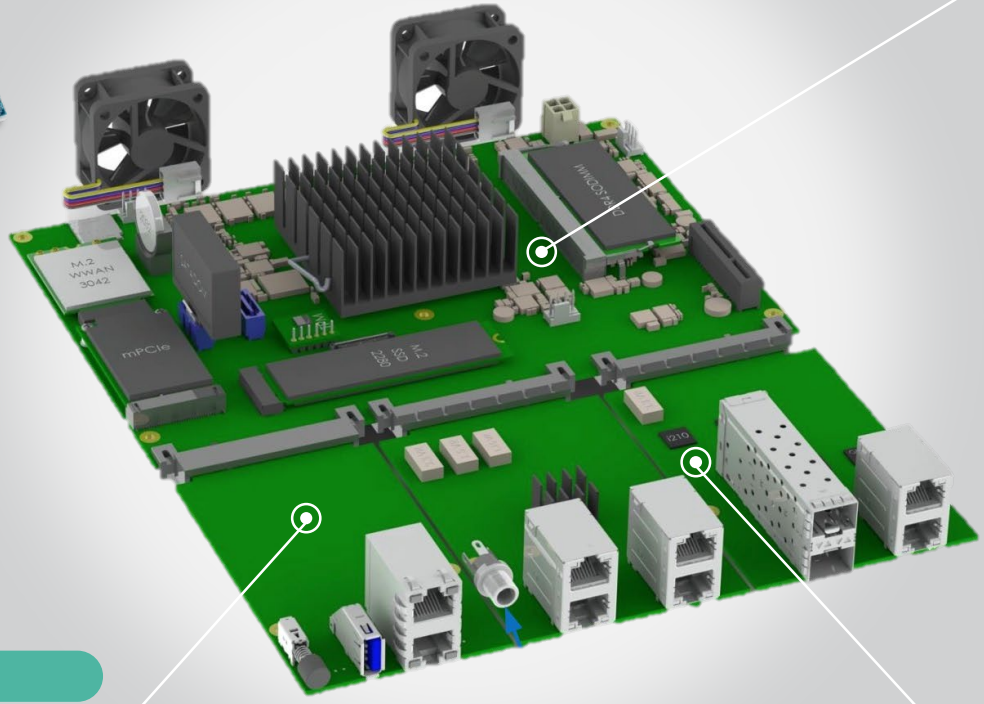
uCPE Modular Platform





- Intel® Atom™ and Intel® Xeon® D
- RAM
- eMMC
- Dual power supply
- PCIe Slot
- LTE/WIFI

- BMC

- IO
- Customized

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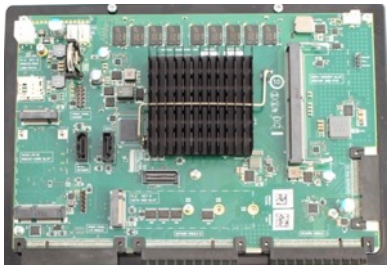
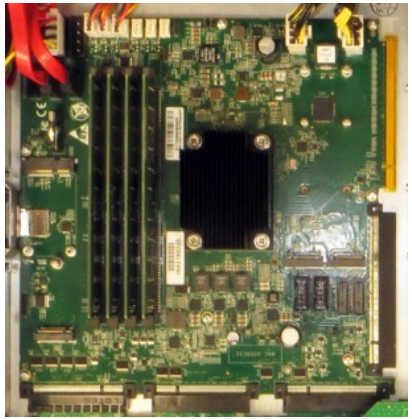
uCPE Compute Boards



Intel Atom C3000
“Denverton”



Intel Xeon-D
“Broadwell-DE”

Intel Xeon-D
“Sky Lake-D”

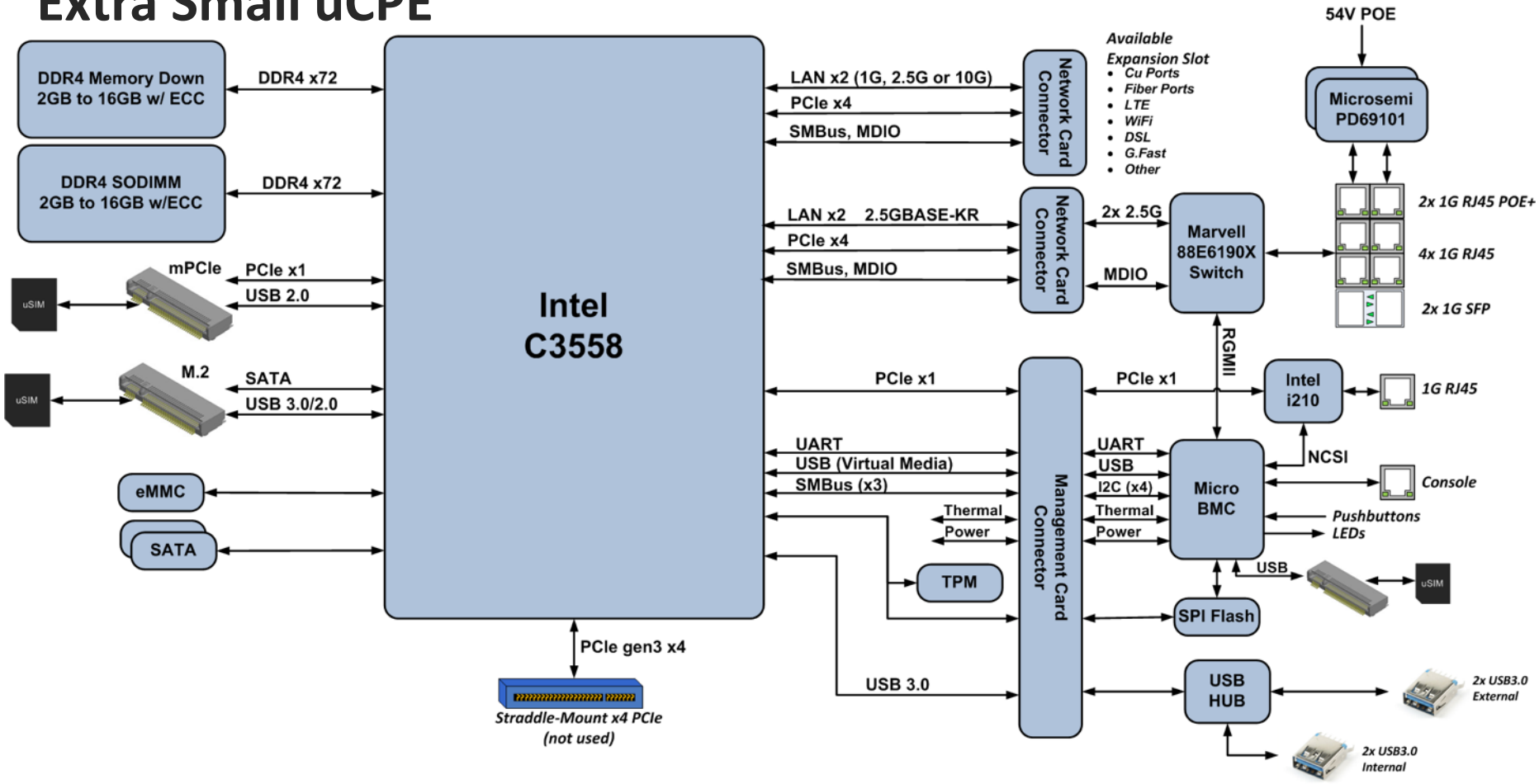
In Development

Intel Xeon-D
“Ice Lake-D”

Extra Small CPE

EXTRA SMALL	
CPU	Intel® Atom™ 4 Core C3558
Memory	8GB DDR4 ECC
Storage	64GB eMMC
Switch Silicon	Marvell 88E6190X
Switched Ports	LAN: 4 RJ45, (2 with PoE+) WAN: 2 RJ45 & 2 SFP
Non-Switched Ports	1 RJ45 (Shared with BMC)
BMC	Yes, uBMC
TPM	Yes, Infineon SLB 6970 TPM 2.0
QAT	Included in Intel®'s Denverton
USB	2 External
Serial Console	1
Power	Single, with Dying Gasp from BMC
Form Factor	Desktop

Extra Small uCPE



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Small and Medium CPE

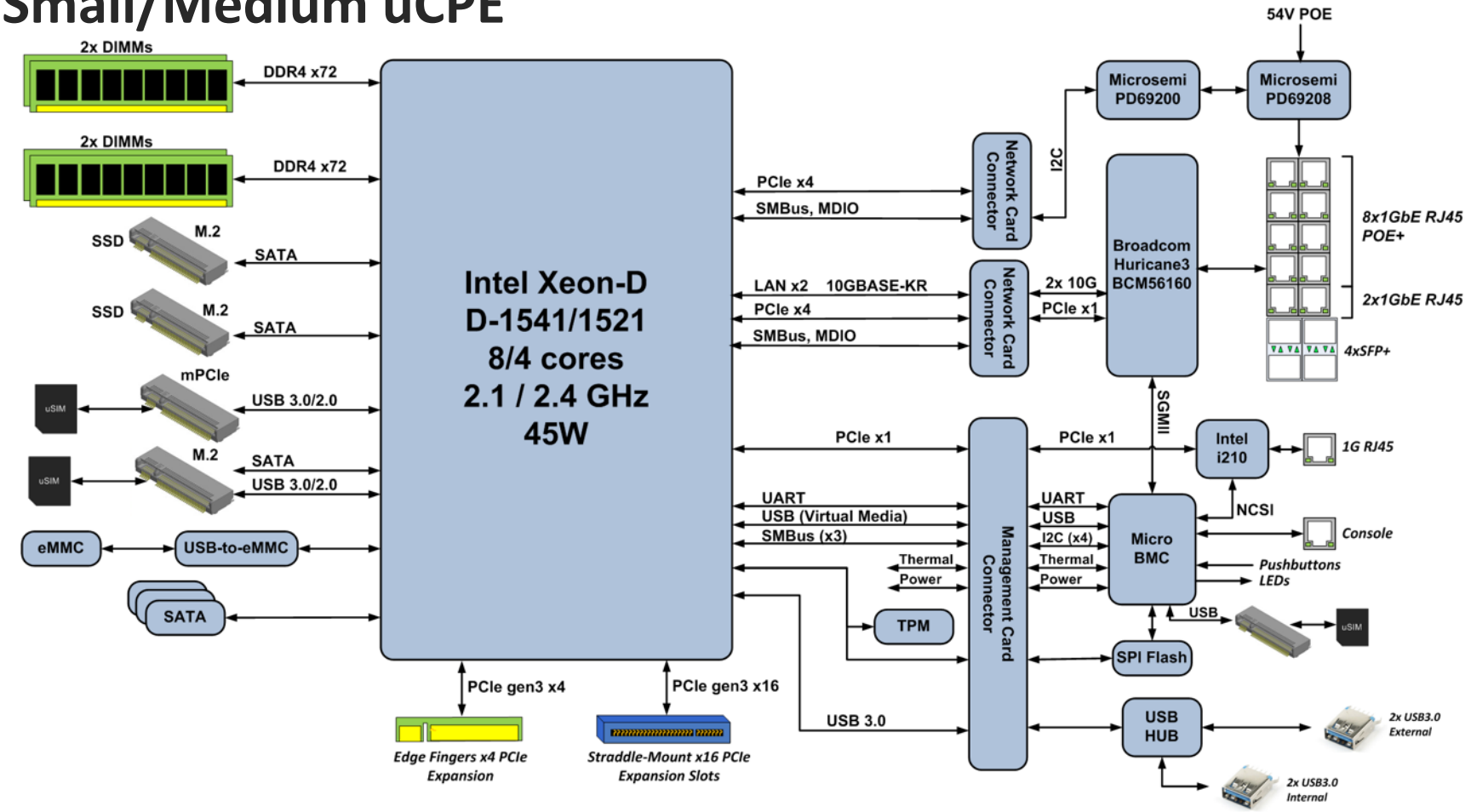
SMALL

CPU	Intel® Xeon™ D 4 Core 1521
Memory	16GB DDR4 ECC
Storage	200GB SSD Primary
Switch Silicon	Broadcom H3 BCM56160
Switched Ports	LAN: 8 RJ45 LAN, 2 SFP+ (4x PoE+) WAN: 2 RJ45 & 2 SFP+
Non-Switched Ports	1 RJ45 (Shared with BMC)
BMC	Yes
TPM	Yes
QAT	No
USB	2
Serial Console	1
Power	Single, with Dying Gasp
Form Factor	1RU

MEDIUM

CPU	Intel® Xeon™ D 8 Core 1541
Memory	32GB DDR4 ECC
Storage	400GB SSD Primary
Switch Silicon	Broadcom H3 BCM56160
Switched Ports	LAN: 8 RJ45 LAN, 2 SFP+ (4x PoE+) WAN: 2 RJ45 & 2 SFP+
Non-Switched Ports	1 RJ45 (Shared with BMC)
BMC	Yes
TPM	Yes
QAT	No
USB	2
Serial Console	1
Power	Dual Redundant, with Dying Gasp
Form Factor	1RU

Small/Medium uCPE



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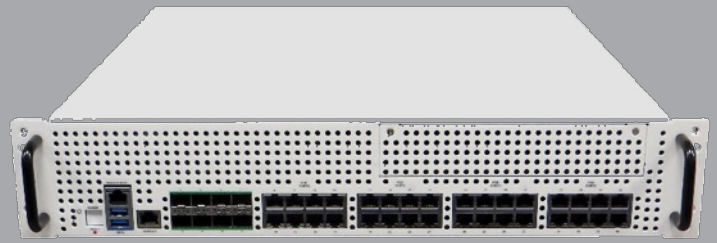
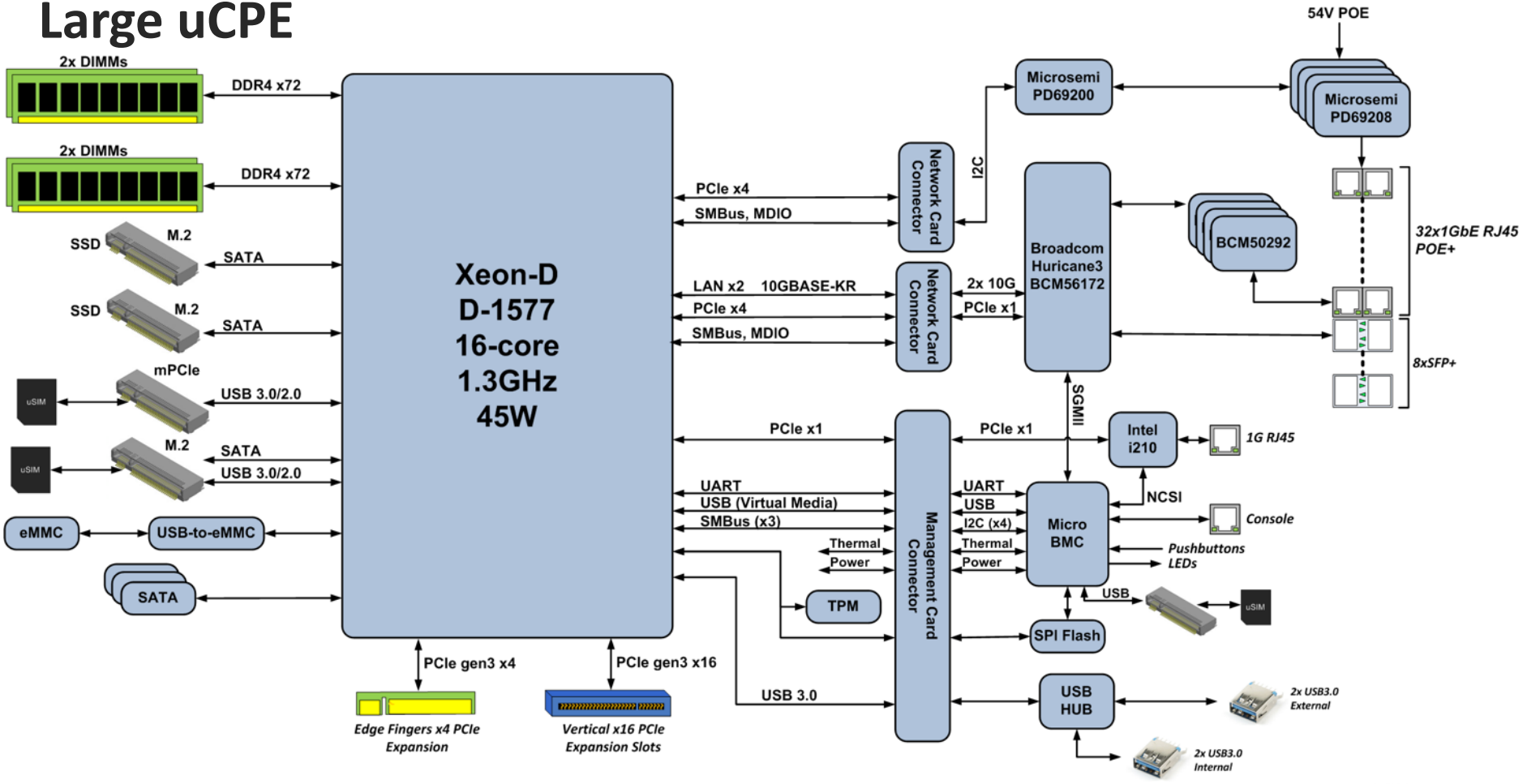
Large CPE



LARGE	
CPU	Intel® Xeon™ D 16 Core 1577
Memory	64GB DDR4 ECC
Storage	100GB SSD Primary 2*3 HDD Secondary
Switch Silicon	Broadcom H3 BCM56172
Switched Ports	LAN: 24 RJ45 1GE LAN, 4SFP+(24x PoE+)
Non-Switched Ports	1 RJ45 (Shared with BMC)
BMC	Yes
TPM	Yes
QAT	No
USB	2
Serial Console	1
Power	Dual Redundant, with Dying Gasp
Form Factor	2RU

Large uCPE



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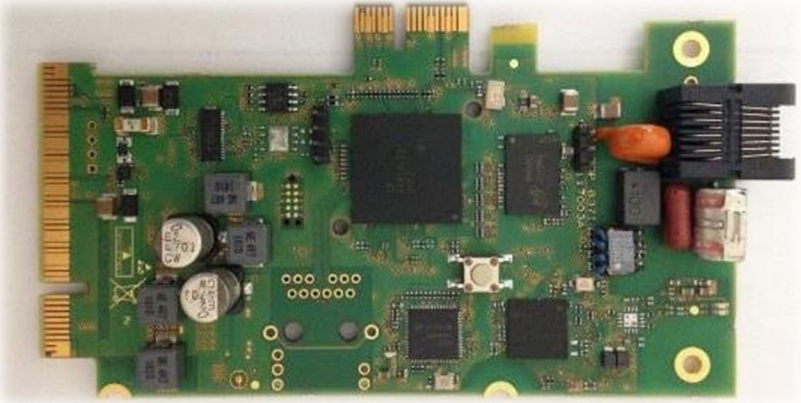
uCPE Modular Platform

- xDSL Module develop by 3rd party
- GFAST.PCIE.359



VDSL module

200+ Mbps or 5 Kilometers

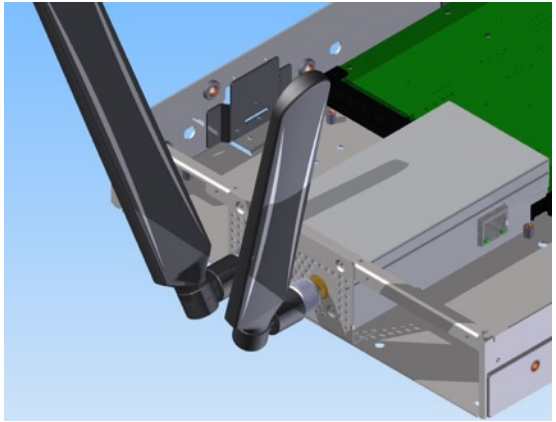
- **Data rates up to 200+ Mbps downstream and upstream on twisted pairs using a bandwidth up to 30 MHz**
- **VDSL2: ITU-T G.993.2 Profiles 8, 12, 17, 30 MHz**
- **ADSL: ITU-T G.992.1/3/5 Annexes A, B, I, J, M, L**
- **ITU-T G.993.5 Vectoring**
- **ITU-T G.998.4 PHY Layer Re-Transmission profiles up to 30 MHz**

VDSL2-EFM Modem

- **Plug & Play VDSL2 module**
- **ADSL fallback (auto-detection)**
- **Intel® VRX220 transceiver**
- **Intel® I211 network interface**
- **Available for oPOTS and oISDN regions**
- **Supports full transparent access to Intel DSL software management interface**

LTE uCPE module\standalone box

- NM Form Factor – fits all Silicom uCPE modular Platforms
- LTE or WiFi Radio
- Certified on its own to allow easier homologation
- Two antennas
- Installation Options
  - uCPE module
  - Standalone box



uCPE Module Options

Front Panel I/O Module
Passthrough

Front Panel I/O Module
micro-BMC (µBMC)

Silicom's groundbreaking micro-BMC (µBMC) module is an optional ARM-based, open, royalty-free light management solution for uCPE products that provides secure remote management, software/firmware update, and phone home zero touch provisioning.

Micro BMC

Network Module NM0
(1G SFP, 1G RJ-45)

Network Module NM5
(NVMe or SATA SSDs)

Network Module NM1
(Switched 1G RJ-45)

Network Module NM5
(SSD & xDSL Modem)

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uCPE Module Options (continued)

Network Module NM6
(1G auto media detect)

Insert image here

Network Module NM8
(2x bypass pair, i211)

Network Module NM7
(1G RJ-45, 10G SFP+)

Insert image here

Network Module NM9
(2x bypass pair, i350)

Custom OEM module developments available

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RMN:
IA3101 1U
IA3001 Desktop

Feature:	
CPU	Intel® ATOM C3958/16C/2.0 GHz/TDP 31W Intel® ATOM C3758/8C/2.2 GHz/TDP 25W Intel® ATOM C3558/4C/2.2 GHz/TDP 16W Intel® ATOM C3338/2C/1.5 GHz/TDP 8.5W
BIOS	Coreboot, Blinkboot, or Insyde H2O
BIOS Flash	SPI – Dual redundant
OS	Linux
Memory	Two Channels, Memory Down, SODIMM, Up to 64GB, ECC Support, 2400 MTs
Storage	Soldered down eMMC (4GB to 256GB), M.2 M-Key SATA (supports for 2230/42/60/80), M.2 B-Key SATA or PCIe x1G3(HSIO config) / USB2 and USB3 (support for 2230/42/52/60/80) 1xSATA for 2.5” SSD/HDD 1xSATA DOM (SATA DOM supports +5V)
Ethernet ports	Up to 8 ports: 2 x1GbE RJ45 x via C3000/x553 through Marvell 88E1514P, 4x 1GbE RJ45 via i350AM4 (with optional +2x1GbE POE+), or 2x 1GbE RJ45 w/ i350AM2 no POE+. 2x 1GbE Combo (UTP or SFP), 2x via C3000/ x553 through Marvell 88E1543, SFP slots support 3W each. Supports for SR-IOV
Console	RS232 RJ45 (Cisco pinout) on front panel Default, 115200
USB 3.0	1x USB 3.0 on front panel
mPCIe	2x mini PCIe expansion slots

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RMN:
IA3101 1U
IA3001 Desktop

Feature:	
1U/ PCIe Expansion	Support for x8 Gen3 Card, 25W power budget (1U)
LTE	mini-PCIe Slot. PCIe x1G3 or USB 3.0 and USB 2.0. Externally accessible dual SIM slots M.2 LTE Slot (B-Key). USB 3.0 USB 2.0 Externally accessible dual SIM slots
WiFi	Support for 2x mini-PCIe slots which supports simultaneous dual-band Support for M.2 Wi-Fi card (Intel WAV654 802.11ax 2+2 Concurrent Dual-Band)
TPM	TPM 2.0
Dying Gasp (option)	The SOC supports a hold-up/warning circuit to allow a Dying Gasp packet
Redundant Power supply (option)	1U – external AC power supply + second DC (+12V) power supply Desktop – (2) units of DC (+12V) power supply
POE+ (option)	2x POE+ ports supported on 8 port SKU
Form Factor (WxDxH)	1U: 350x260x44mm Desktop: 222x241x44mm
Rack mount option for desktop	Enables (2) desktop unit installed in a 1U rack

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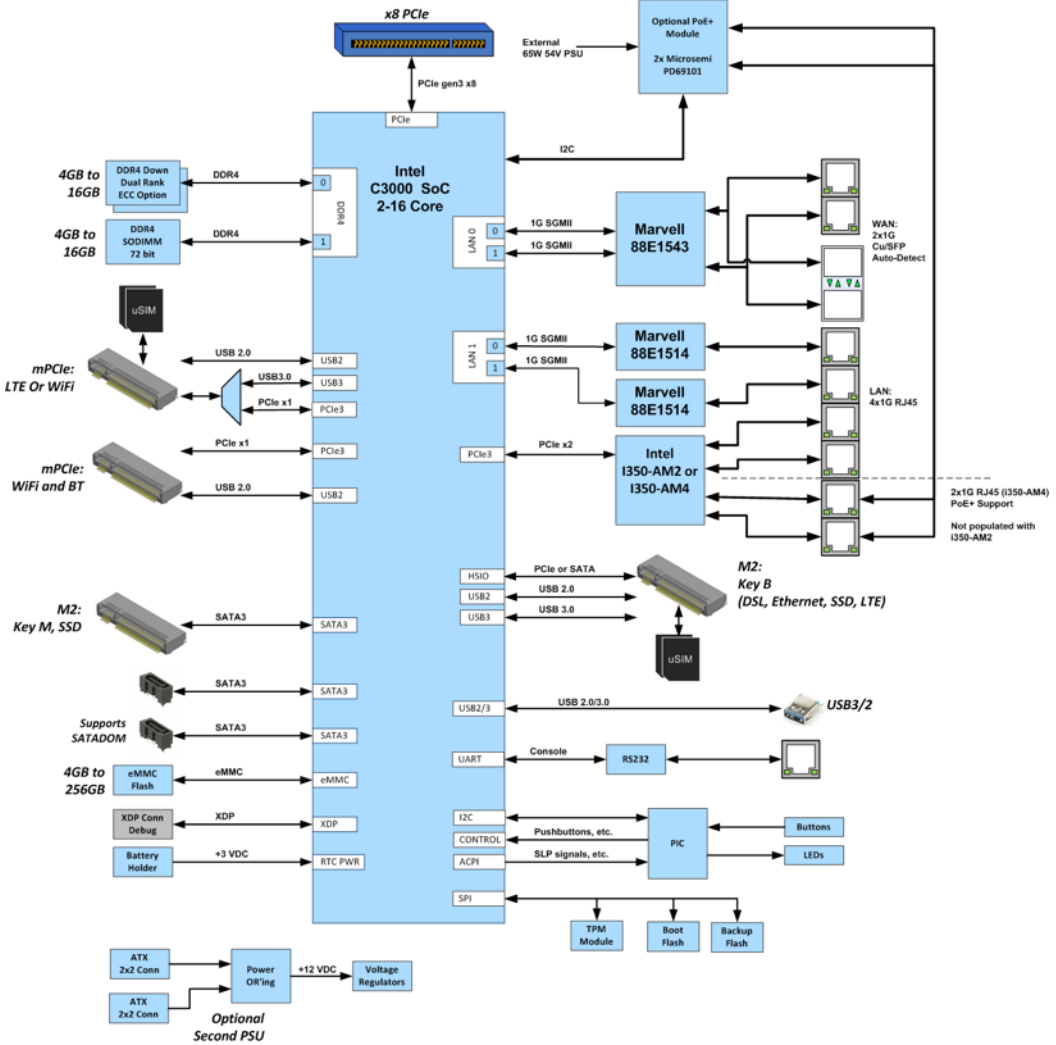
RMN:

IA3101 1U

IA3001 Desktop



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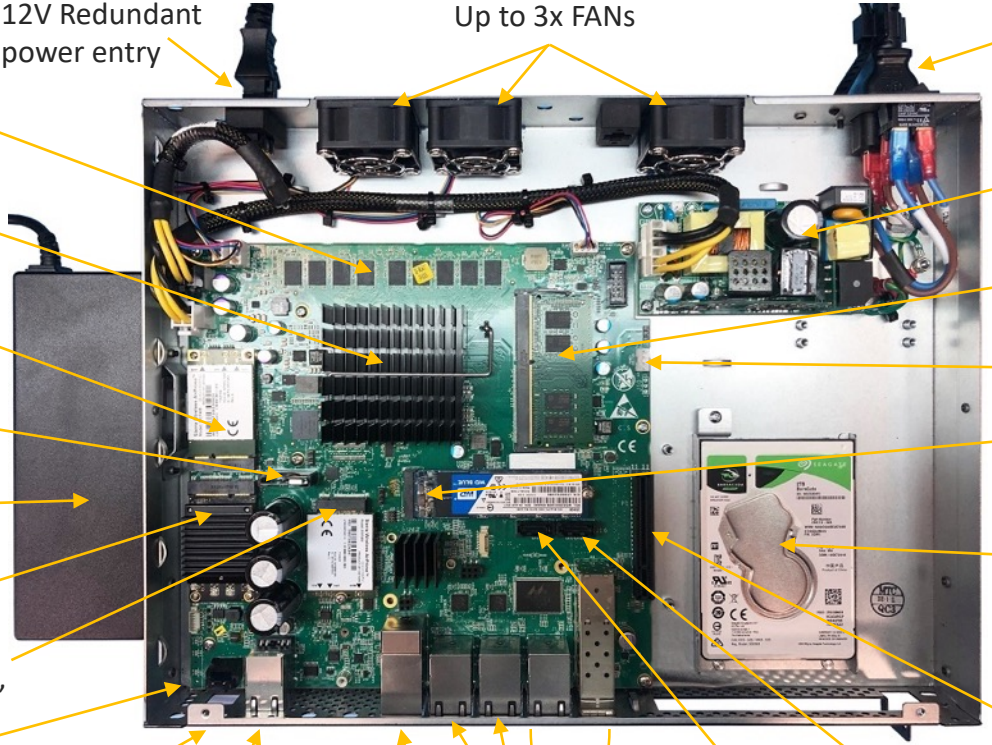
Madrid – 1U platform details



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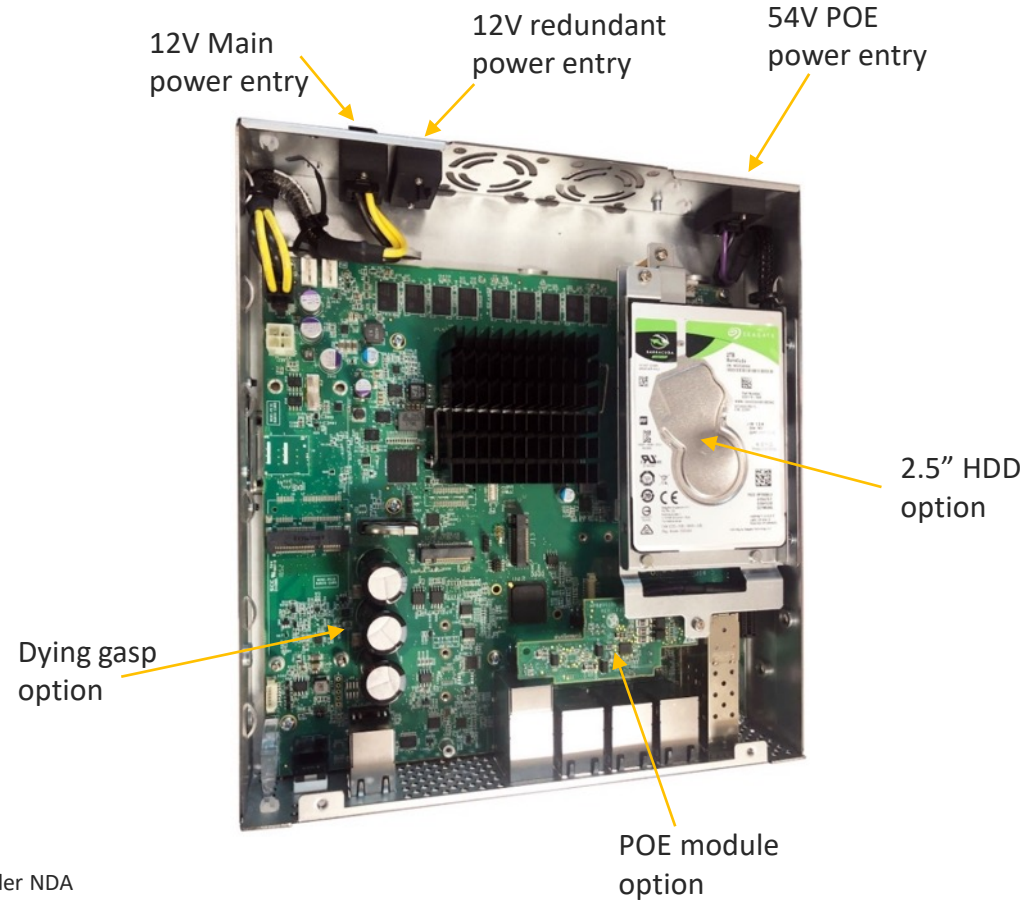
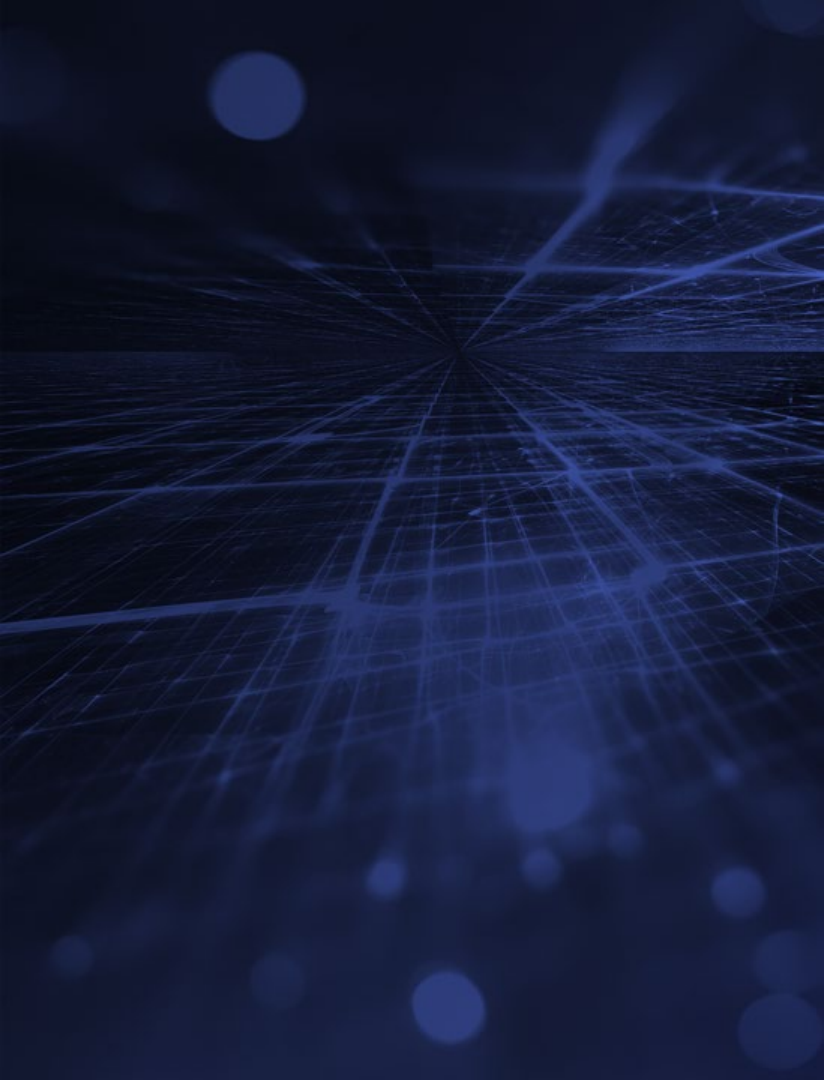
Madrid – Example of Desktop Configuration





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Accelerating Network Disaggregation

Network Disaggregation at the WAN Edge with Open SD-Edge platform

Open and Secure WAN Edge Connectivity

Agenda

- Market Trends
- Open SD-Edge Platform
- Target Use Cases
- Open Ecosystem

IP Infusion Solves the uCPE Challenge for MSPs

SD-WAN/SASE

Dominating the Enterprise…

BUT, too proprietary

Managed Services

Dominating the delivery

BUT, too expensive, too complex, and not agile

Disaggregation

Driving down costs

BUT, requires integration and support

Openness

Tailor uCPE platform and services to the needs of the environment

Future Ready - Software-Defined Agility

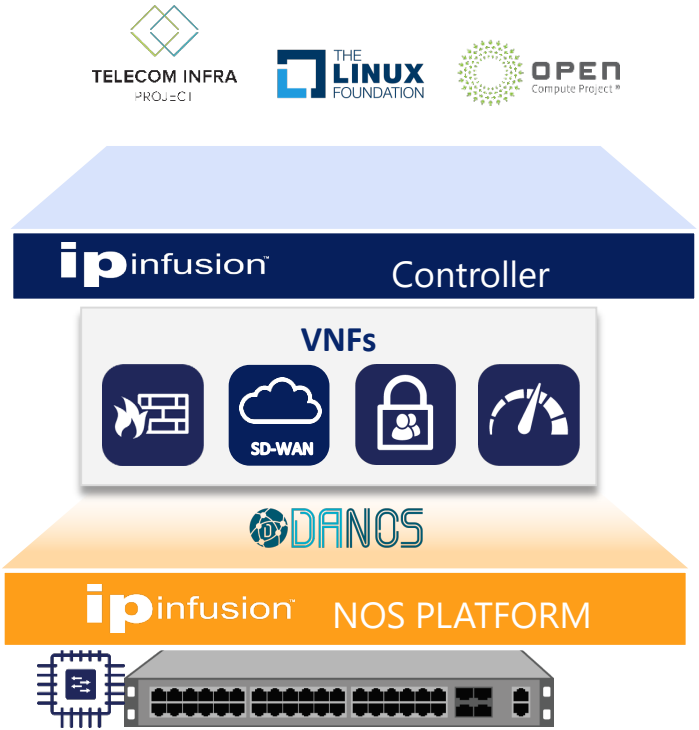
Readily onboard SD-WAN or SASE solutions with virtualized services

Carrier Grade Support

7/24 product support with expert professional advice

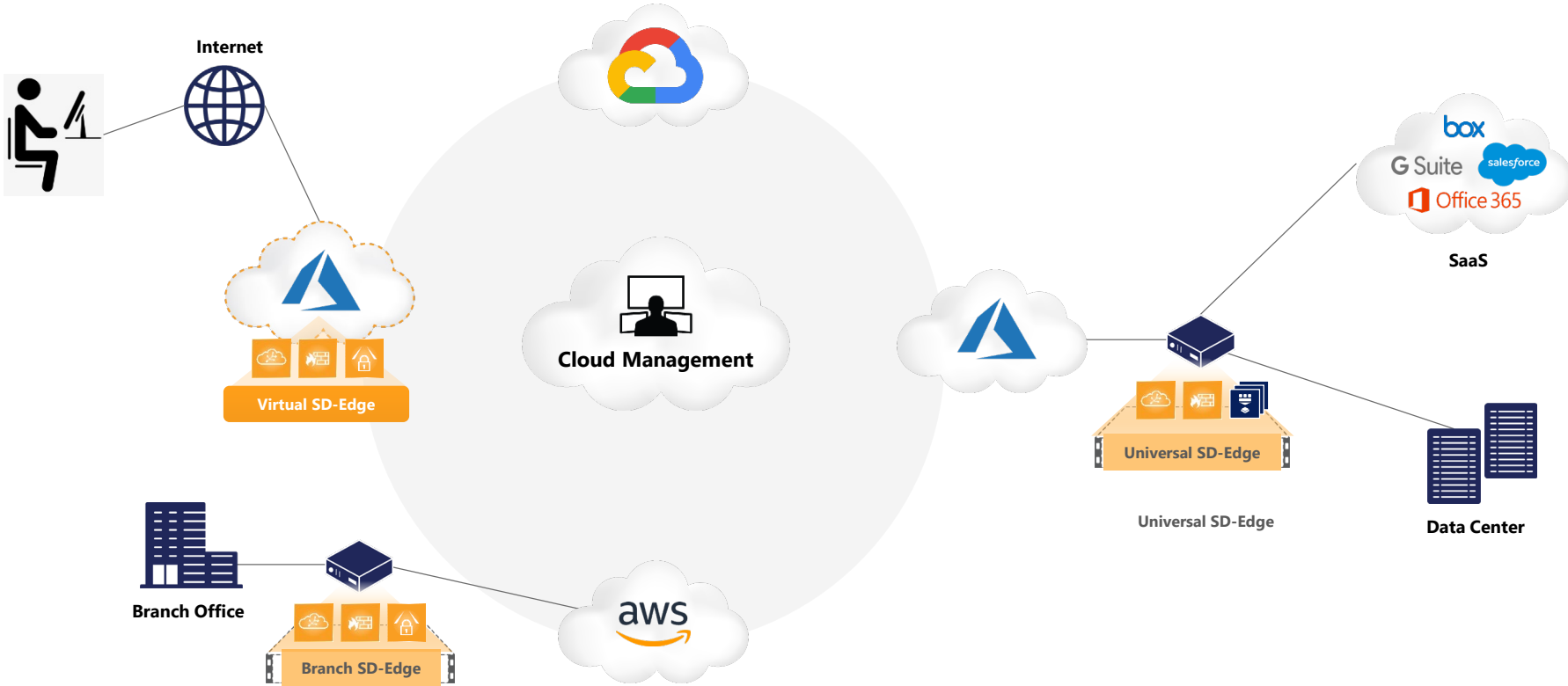
Open SD-Edge Platform

Powered by DANOS-Vyatta edition



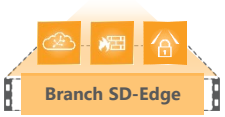
- DANOS-Vyatta edition (DVe) supports an optimized software forwarding plane and switching silicon integration
- DVe: Widely deployed by AT&T for multiple use cases
- Open SD-Edge platform is optimized for cloud and WAN edge services
- Best-in-Class, validated VNFs for service agility
- Lower TCO
- Carrier-grade commercial support

Open SD-Edge Target Use Cases



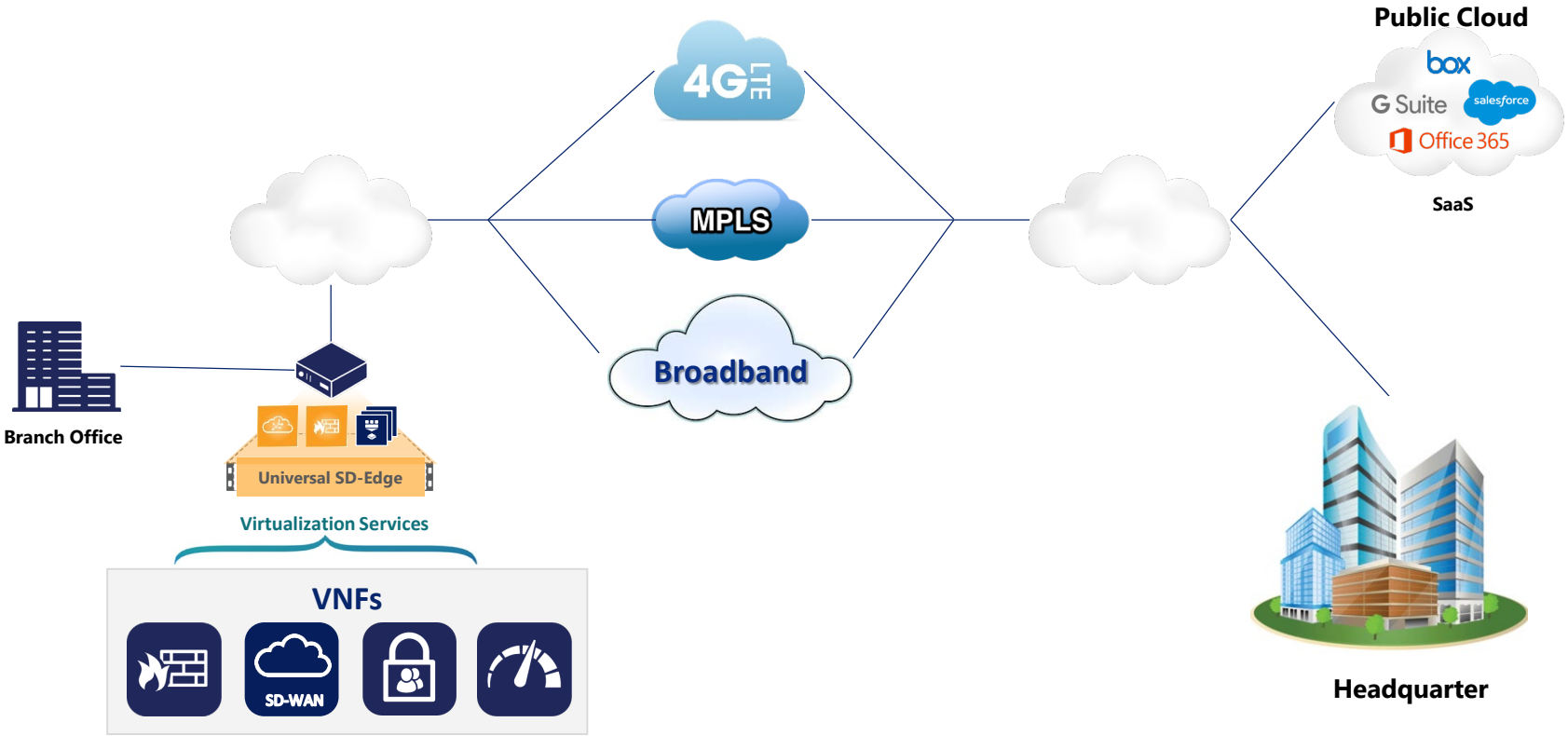
IP Infusion Open SD-Edge Solutions

Virtual SD-Edge	Universal SD-Edge Branch SD-Edge
Secure, robust connectivity to the cloud ▪ Available for hosting in the public cloud marketplace or private cloud/server ▪ Includes: vRouter, VPN, vFirewall,	Secure branch office connectivity and cloud migration ▪ VM or White Box form factor (multi-platform) ▪ vRouter, VPN, vFirewall ▪ 3rd party VNFs for on-demand services ▪ 1G or 10G interfaces



Universal SD-Edge

Next Generation uCPE Solution for Open and Secure WAN Connectivity



Open Platforms – Lowest Cost per Bit

VNFs

Built-in switch for guaranteed throughput
Up to 10G interfaces
POE support
BMC for management

Open SD-Edge:
Extra Small

Open SD-Edge:
Small

Open SD-Edge:
Medium

Open SD-Edge:
Large

Silicom uCPE models

Universal SD-Edge Differentiators

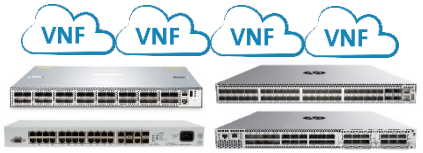
DANOS-Vyatta edition Virtualization Platform

Built-in routing, security functions, and a common abstraction to support hardware offloads and software data plane to enable operators to quickly ramp up new services and revenue

Universal SD-Edge Completely Open Architecture

Open source-based software and best-of-breed Open Hardware (White box uCPE) can deliver line rate throughput and lower MSPs' total cost of ownership

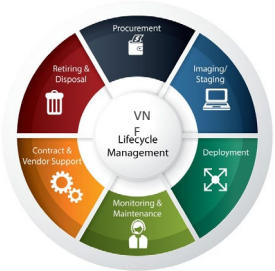
Fully managed NFV Infrastructure Platform



Offering choice of uCPE hardware & best-in-class VNFs.

Complete VNF life cycle management solves operator pain points to deploy new on-demand services.

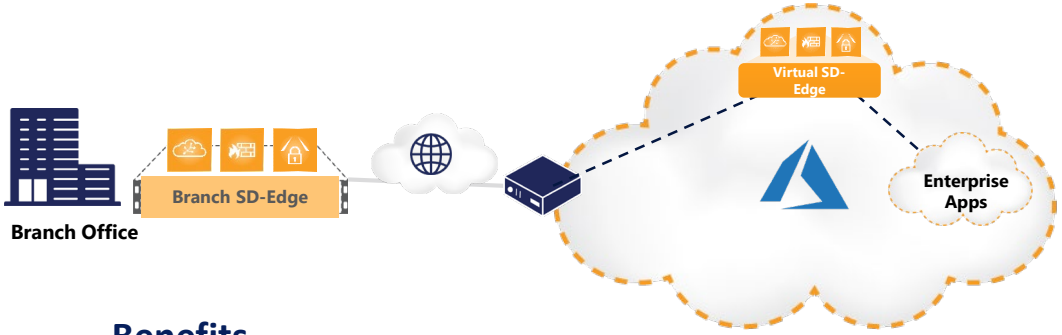
MSPs and Enterprises can dynamically add new services thereby increasing agility and lowering the operational costs



Branch SD-Edge - Secure Branch Router

Overview:

- Secure WAN connectivity to enterprise resources in the public cloud



Key Features:

- Extend VPN tunnels into the cloud
- Comprehensive IPSec support
- Enterprise-class firewall
- Ready for upgrade as a VNF platform for on-demand services

Benefits

- Network reliability: Carrier-grade, single networking function for all networking needs
- Multi-cloud interoperability
- Future-proof deployment – upgradable to the Universal SD-Edge uCPE
- Pay-as-you-grow: Best-of-breed white box (uCPE and x86 server) options available for quick service deployment
- Network management

Virtual SD-Edge – Open, Multi-cloud, Secure Routing

Overview:

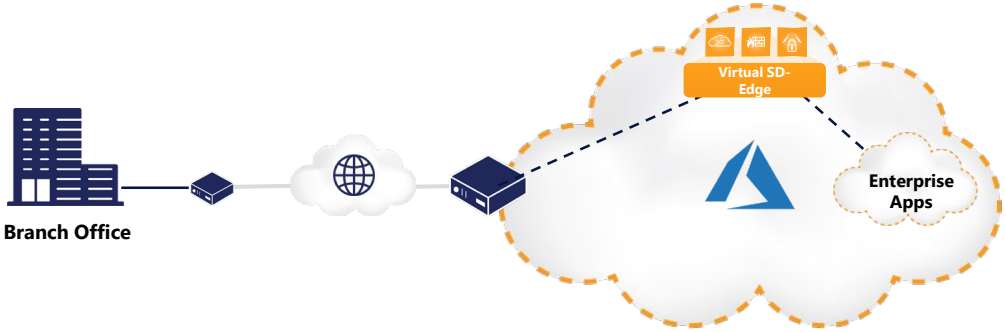
- Virtual router, VPN, and vFirewall

Target customer segments

- CSP/MSP
- Enterprise
- Cloud Operators

Availability:

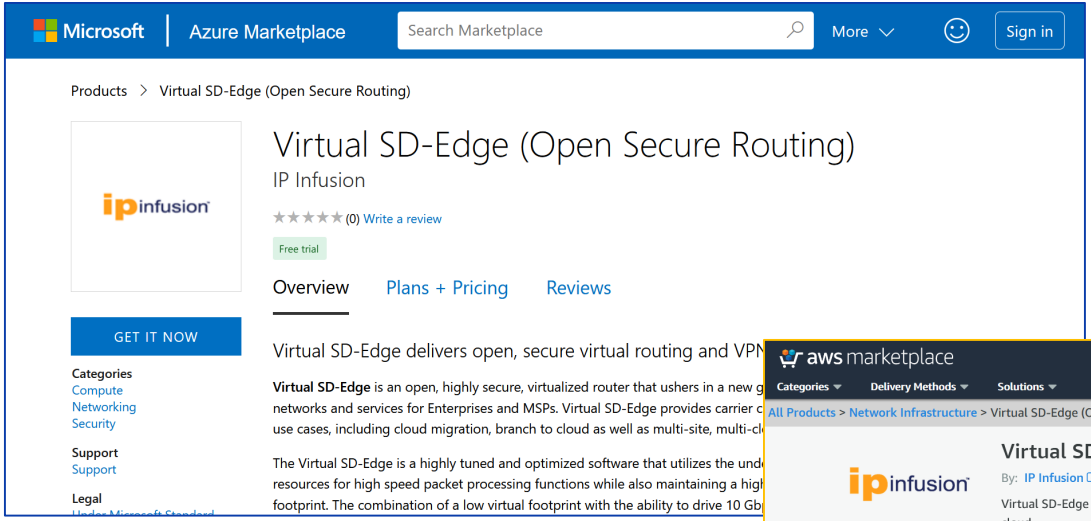
- VM on Azure or AWS public cloud
- VNF for private cloud/white box



Benefits:

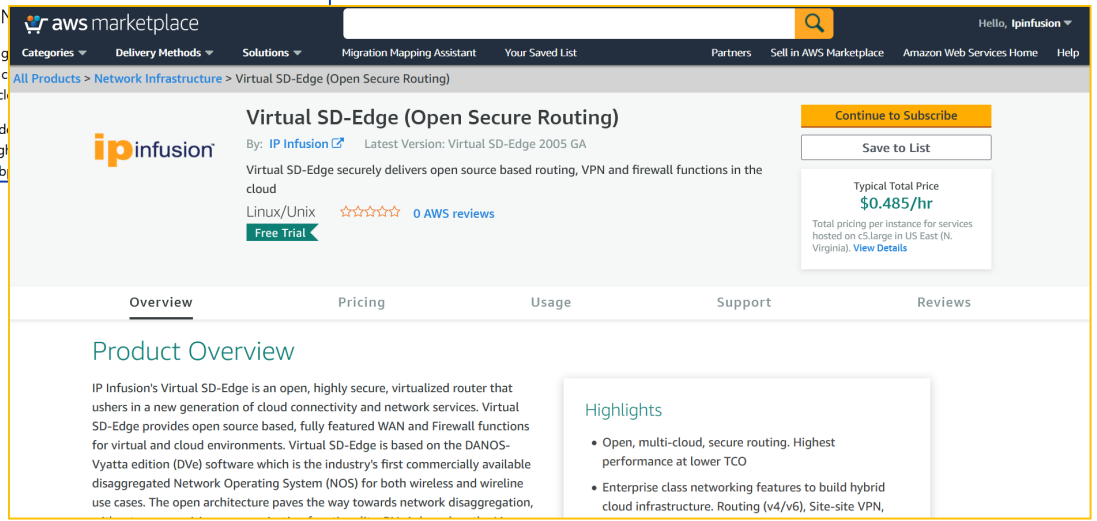
- Highest performance at lower TCO
- Open Architecture
- Pre-integrated package
- Simplified (per vCPU) licensing
- Full-featured control plane supports diverse use cases
- Easy to deploy and manage
- High-Availability and Carrier Grade support

Virtual SD-Edge in Public Cloud

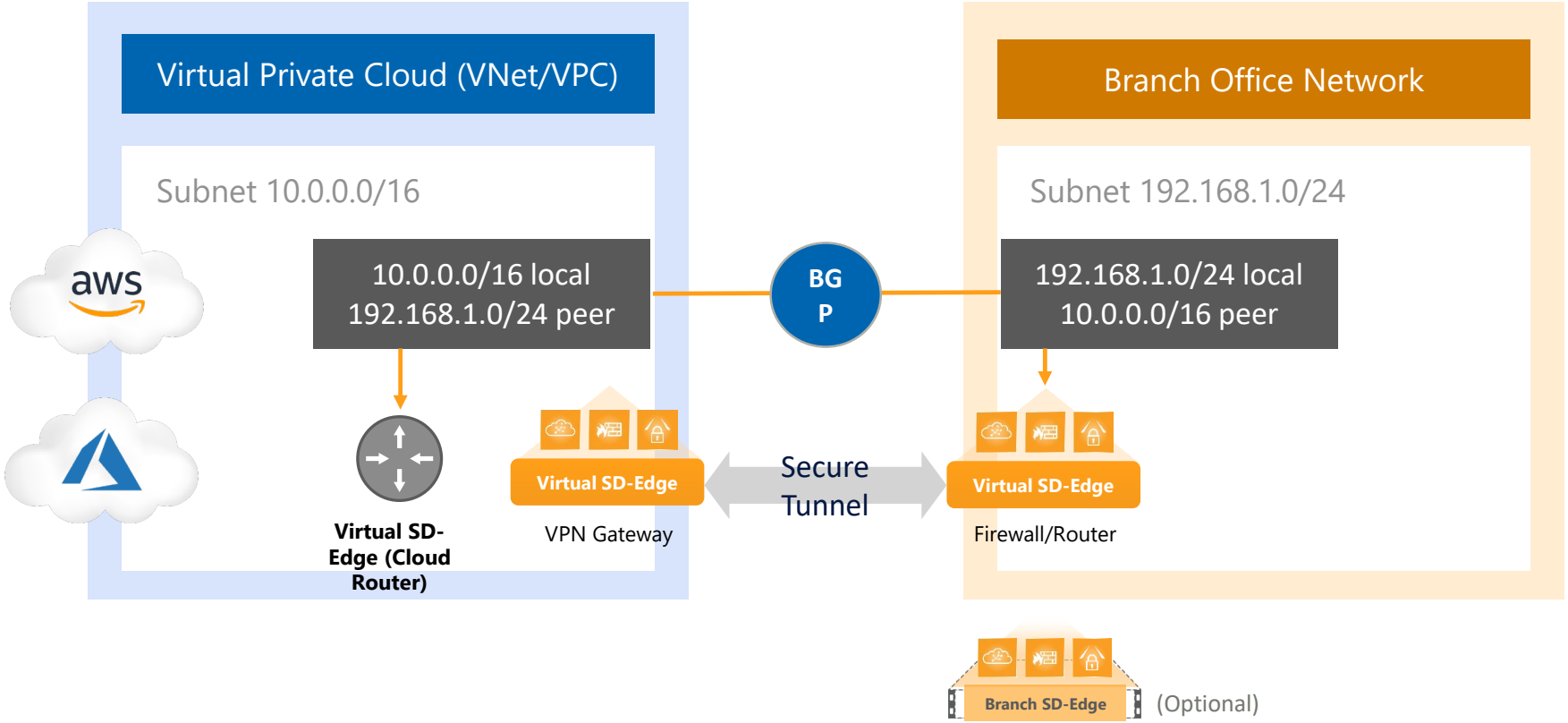


Azure Marketplace

AWS Marketplace

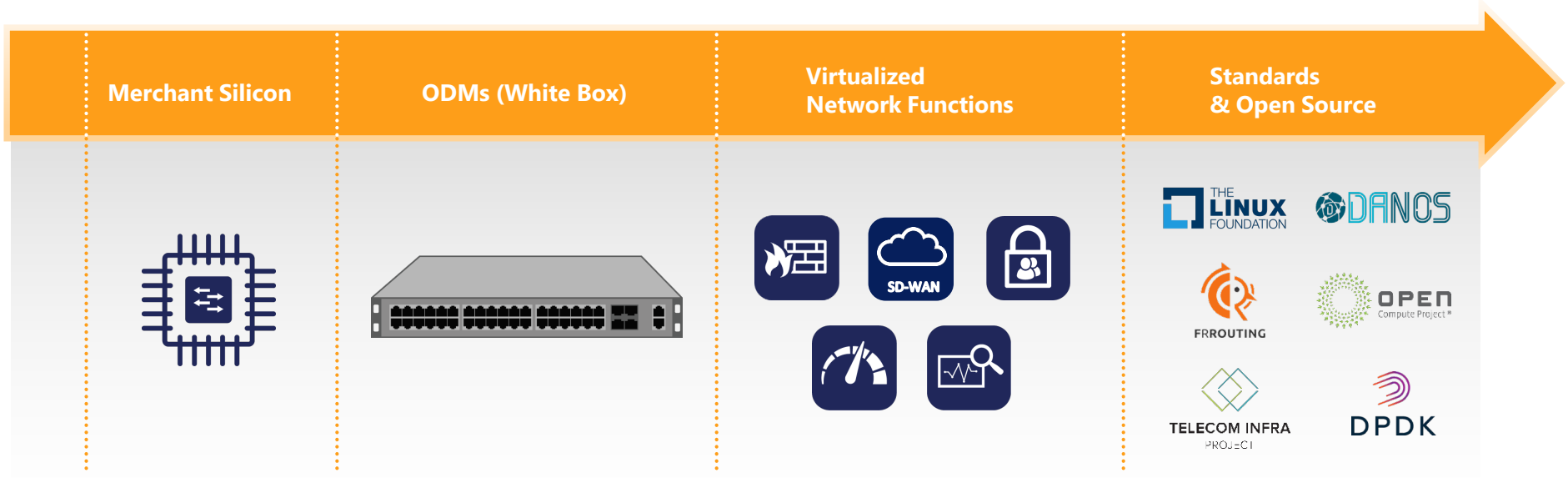


Virtual SD-Edge – Secure VPN and Routing in the Cloud



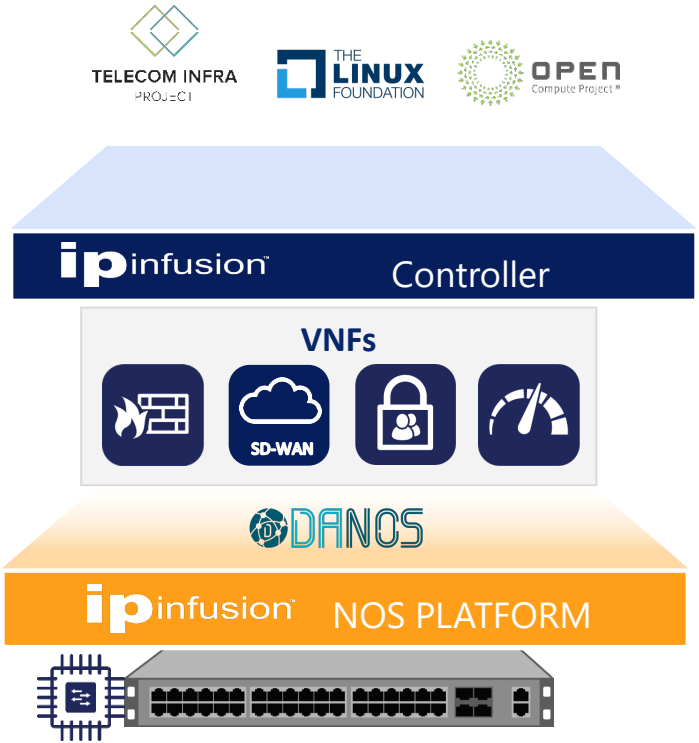
Announcing Open SD-Edge VNF Ecosystem

Join our growing VNF Ecosystem



Contact ipisales@ipinfusion.com to join the ecosystem of validated VNFs

Summary



- Open platform for WAN Edge solutions targeted for MSPs/CSPs
- DVe has built-in routing and security functions with a highly optimized software data plane
- On-demand services from a validated catalog of virtual functions (VNFs)
- DVe: Widely deployed by AT&T
- Lower TCO, Carrier-grade support

For more details, visit: https://www.ipinfusion.com/ucpe/