MAVENIR™

BUILDING THE FUTURE OF NETWORKS – TODAY.

CLOUD-NATIVE. AI-ENABLED. GREEN BY DESIGN.

Pioneering Open vRAN
with Mavenir software and
4th Gen Intel® Xeon®
Scalable processors

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Senior Fellow
Chief Technology and Strategy
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Date: Mar 19, 2024
Time: 9AM PDT / 12PM EDT

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Mavenir Vision | Building the Future of Networks –Today. Cloud-Native. AI-Enabled. Green by Design.

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AI Across the Network

Single Multi-Cloud Platform for AI and 5G

Low Energy Footprint

ICT

SMART PLACES
Car Movements, Ride-Share Taxis, Utilities, Civic Cameras, Smart Agriculture

HEALTHCARE
Patient Data, Wearable Data, Remote Early Prognosis

MEDIA & ENTERTAINMENT
Content Personalization, Video Stream with Real-Time Input

RETAIL
E-banking, E-commerce, E-learning

TRANSPORT
Intelligent Connected Vehicles, Autonomous Driving, Self-Coordinated UAVs

INDUSTRIAL
Automation, Collaborative Robotics, Digital Twins, Smart Manufacturing

✓ Applications/Content moving to Cloud
✓ Industry 4.0 revolution
✓ AI based proactive networks
✓ Private Networks for different verticals

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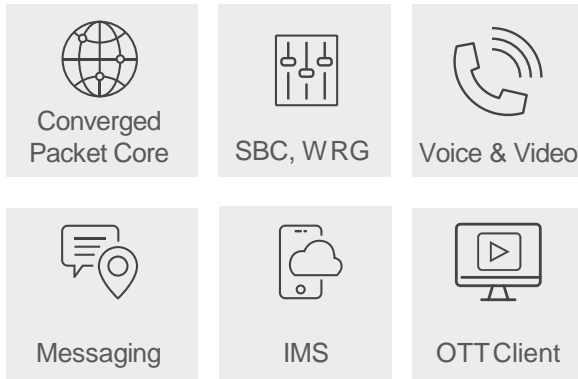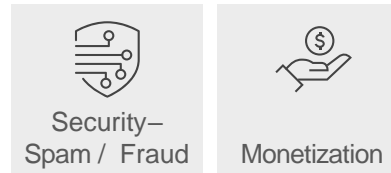
End-to-End Product Portfolio Across 5G Network Infrastructure

Digital Enablement

Network Slice Management and Orchestration

MAVcore
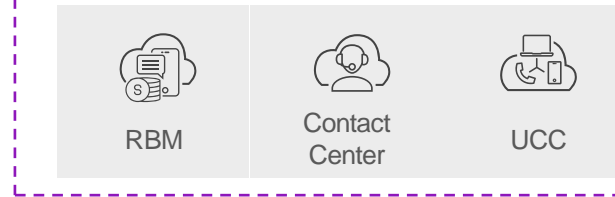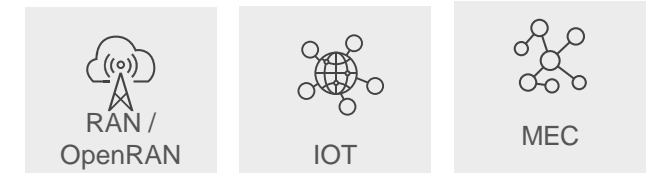
- Converged Packet Core
- SBC, WRG
- Voice & Video
- Messaging
- IMS
- OTT Client

MAVapps

- Security – Spam / Fraud
- Monetization

MAVbiz

- RBM
- Contact Center
- UCC
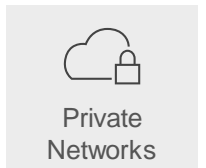
MAVair

- RAN / OpenRAN
- IOT
- MEC

MAVedge

- Private Networks

Mavenir Web-Scale Platform for Containers & NFV Deployment with integrated AI & Analytics

MAVscale

Mavenir Telco Cloud Integration Layer	
PaaS (Platform as a Service) **CLOUD NATIVE** COMPUTING FOUNDATION	VNF Manager
CaaS (Container as a Service) Kubernetes	**openstack**
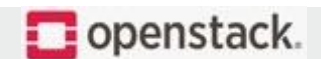
Mavenir - Only Industry End to End Network Software Provider

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5G Open-RAN Network

> The radio access network (RAN) is the bulk of a mobile network operator's (MNO's) network investment
> Its performance and functionality are critical to successful service delivery and innovation.
> BBU is disaggregated into distributed unit (DU)) centralized unit (CU)) with open interfaces between them.

Open FrontHaul

DU: COTS X86 server

CU: COTS X86 server

Packet Core

Base station 1

Base station 2

(*)

(*) Inter-DU interface – under ORAN alliance standardization study
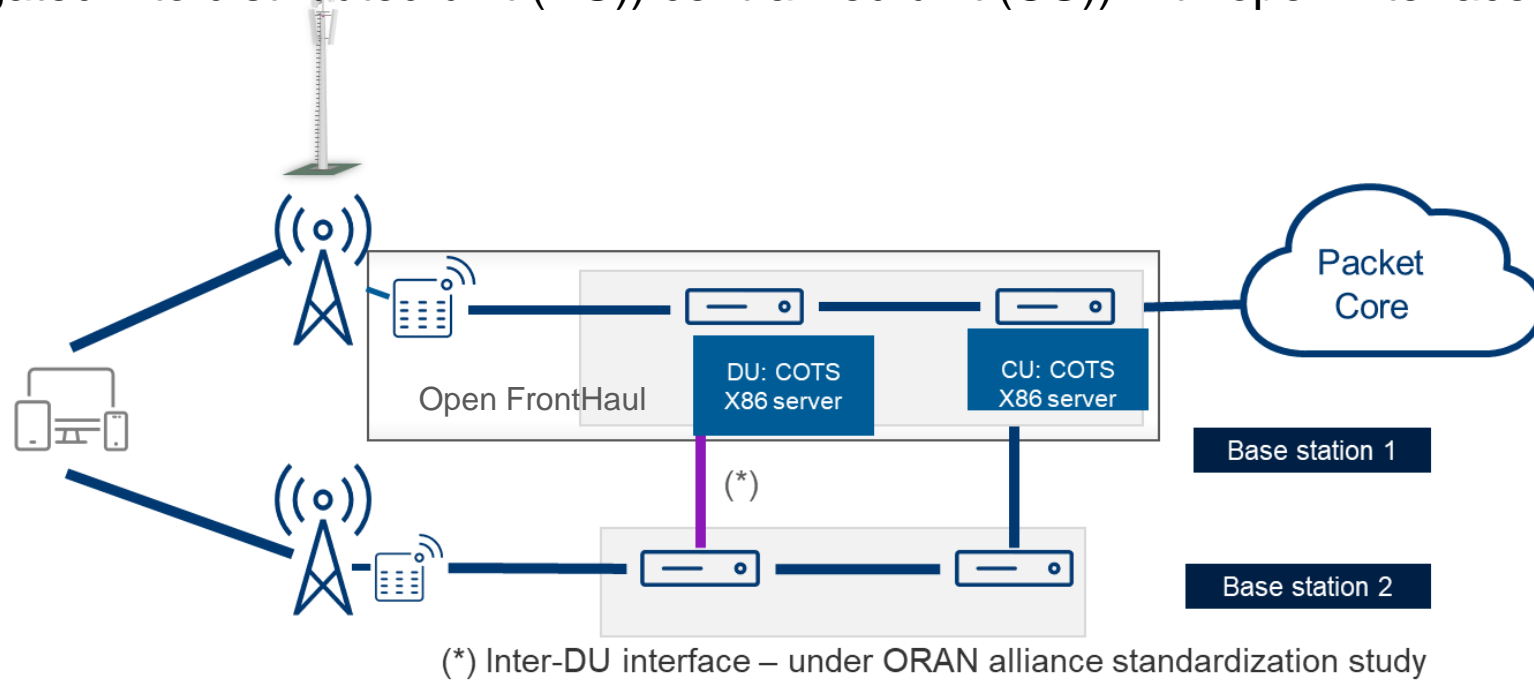
> Open RAN provides MNOs to build the network by replacing proprietary hardware with open Intel® architecture CPU-based servers and cloud native RAN software.

Open RAN Provides Substantial Cost, Technology and Operational Benefits for wireless SPs

A | No Vendor Lock-in — vendor diversity & localization flexibility
> Freedom to switch vendors or take bad vendors out without swapping everything; just new software
> Ability to localize feature set to specific regional requirements

B | Better Performance — No more proprietary HW Radios and HW DUs; commoditize the Radios and use COTS servers
> Upfront costs on ASIC development are avoided. ASIC have longer development cycles, and higher costs – thus, they are replaced much less frequently
> Higher performance via 3rd party innovation in software
> Ride Moore's law with COTS servers

C | Better intelligent orchestration with RIC, AI/ML
> Gain in velocity to add new SW or upgrade features

D | Energy savings   * over energy gains in closed systems
> As chipsets upgrade, more energy efficient features (e.g., deep sleep modes). Energy gains with Mavenir Open Beam next gen SoC RUs
> + AI methods leveraging the RIC (Radio Intelligent Controller)
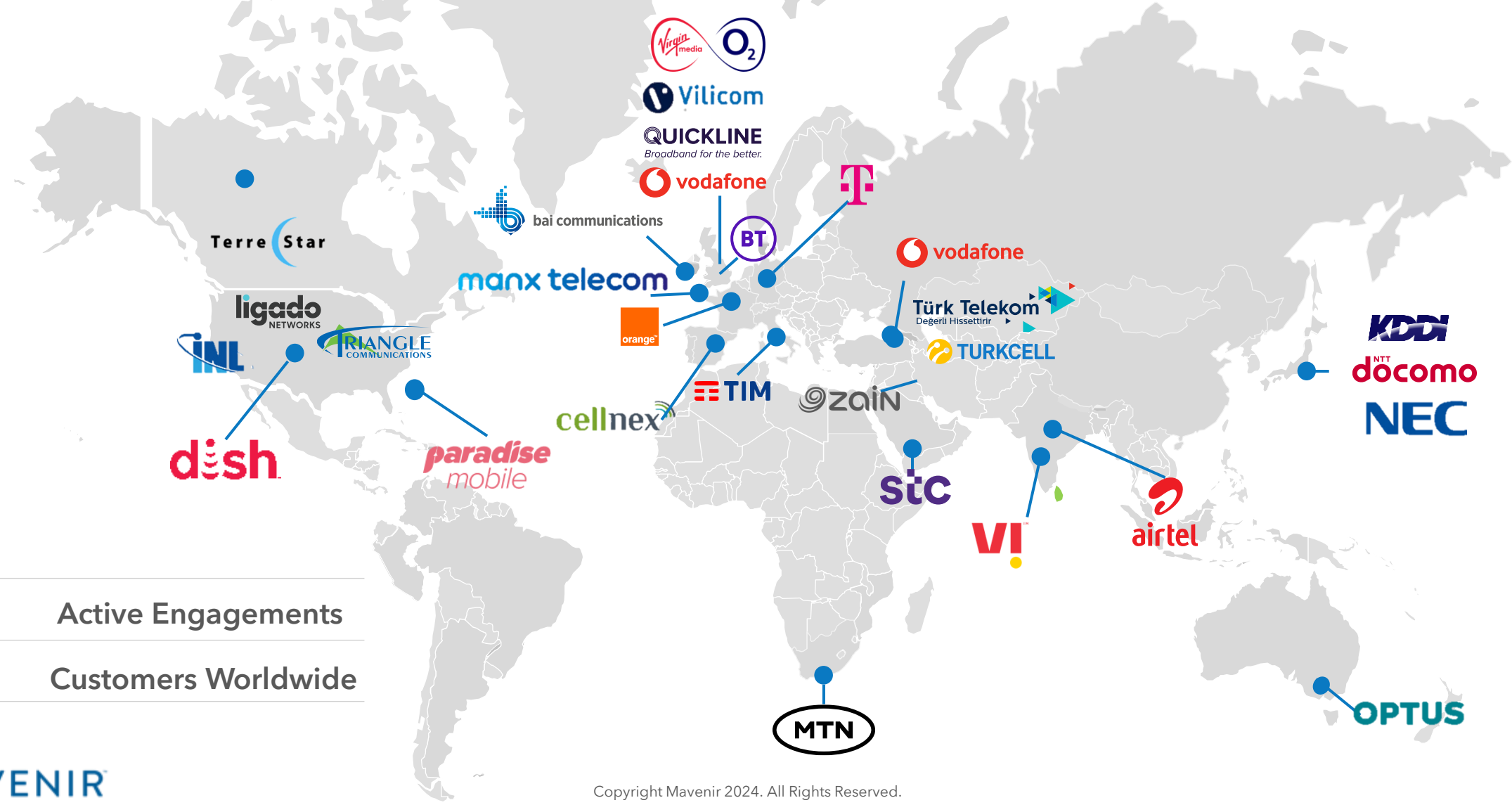
E | Future proof investment
> Software upgrade to 5G Advanced or 6G

Innovation leads to higher performance, Vendor diversity leads to Lower TCO

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Mavenir Open RAN Global Footprint

50+ Active Engagements

40+ Customers Worldwide

Proven Open and Interoperable Open RAN ecosystem version 19

Mavenir – Intel partnership with Open RAN

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Mavenir Open RAN – powered by Intel COTS servers

Analytics
- mCMS (Element Management)
- RAN Intelligent Controller (RIC)

- Non-Real Time
- Near-Real Time

Automation
Intel® Architecture

Centralized Unit (vCU)
Centralized Unit (vCU)
Centralized Unit (vCU)

Multiple CU instances allocated for many sites of:
- 5G
- 4G
- 2G

Radio Units (RUs)
- Macro, Micro
- mmWave
- mMIMO
- Small-Cell

Distributed Unit (vDU)
- 5G
- 4G
- 2G

Intel® Architecture

Fronthaul

Open RAN Multi-Standard:
- 4G/5G Split 7.2 (eCPRI)

Mid-haul

4G/5G 3GPP-F1
2G A-bis
3G Iub

Back-haul

Packet Core

Intel® Architecture

Cell-Site | Edge | Datacenter

COTS + Look aside accelerators

intel XEON D
+ FEC

> Very scalable model - CPU SKUs with various core counts
> Flexibility for feature additions over time
> Easy to maintain and debug

> Complete baseband unit (BBU) functionality
  – standard CU and DU CNFs
  – for public and private networks
  – O-RAN compliant solution
> Cloud-native Solution
  – fully containerized microservices
  – deploy easily on Intel® architecture
  – private, hybrid or public clouds
  – scale up by easily adding more CNFs.

Evolution of Open vRAN with Intel Xeon Scalable processors

Processor Family	Max Core Count	Open RAN Capabilities
2nd Gen Xeon® Scalable Cascade Lake	28 cores; 56 threads	Intel FPGA PAC N3000 Supports narrowband
3rd Gen Xeon® Scalable Ice Lake	32 cores; 64 threads	Intel® AVX-512 Intel® vRAN Dedicated Accelerator ACC100 (discrete FEC accelerator Supports mMIMO Supports millimeter wave frequencies
4th Gen Xeon® Scalable Sapphire Rapids	32 cores; 64 threads, on-chip accelerators	Increased capacity vRAN Boost integrated FEC accelerator Intel® AVX-512 - FP16 Instruction Set Network slicing

> Open vRAN has become a mainstream consideration for 4G and 5G network build-outs.
> Mavenir is working with Intel to deliver new performance, functionality and management features.
> Intel's 4th Gen Xeon® Scalable processors are at the heart of Mavenir's Open vRAN solutions.
  – 32 high-performance cores plus on-chip accelerators, including the vRAN Boost integrated FEC accelerator.

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Benefits of Intel's 4th Gen Xeon® Scalable processors

32 high-performance cores plus on-chip accelerators including the vRAN Boost integrated FEC accelerator.

4th Gen Intel® Xeon® Scalable processors with Intel® vRAN Boost	Intel® vRAN Boost	Accelerating AI workloads with 4th Gen Intel® Xeon® scalable processor
Delivers **up to twice the capacity** and an additional ~20% compute power savings versus the previous generation processor	Offloads computationally heavy layer 1 tasks such as low-density parity check (LDPC) decoding and forward error correction (FEC). > The integrated accelerator reduces system complexity and consumes less power.	SPR-EE features integrated acceleration for AI inferencing (not training).

Processor Power Management modes for Energy Efficiency – C0-Cn states

Benefits of Mavenir Open vRAN powered by 4th Gen Intel® Xeon® Scalable processors

Greater vRAN Capacity

> Open RAN CUs/DUs enable greater RAN capacity, with software running on faster CPUs. Mavenir software can deliver more features and capabilities

> Mavenir Open vRAN software improves CPU processing density by supporting Intel® Advanced Vector Extensions (Intel® AVX) for vRAN
>> This instruction set leverages floating point 16 models to double the number of instructions processed per cycle.

Fully Integrated L1 Acceleration

Intel 4th Gen Xeon Scalable processor, w/Intel vRAN Boost

> Eliminate the need for an external acceleration card and delivers higher capacity for L1 processing

> This reduces the number of cores/servers needed per cell site compared to previous CPU generations.

> Paves the way for (MNOs) to support more cloud-native, energy efficient RAN services at a lower cost

Energy Savings

> Mavenir Open vRAN software opens up potential for energy savings in low-load traffic conditions by leveraging Intel architecture CPU-based advanced sleep cycles

> Tests conducted by Mavenir customers show meaningful energy savings across multiple workload types.

RAN Slice Assurance

> Powered by high performance CPUs, RAN Slice Assurance allows dynamic allocation of resources to meet service level agreements, needed for offering differentiated services.

> SLA Assurance with AI/ML: Utilizing AI /ML for network slice RRM, Mavenir Open RAN platform ensures that operators can maintain SLA efficiently to permit revenue-generating business models with optimal radio resource utilization.
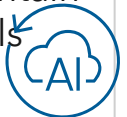
Ease of scaling of compute resources, Portability across CPU generations and maintainability

Mavenir utilizes Intel® FlexRAN™ reference software

Mavenir DU utilizes Intel® FlexRAN™

> FlexRAN™ reference software is used to efficiently implement wireless access workloads powered by Intel® Xeon® Scalable processors.

> FlexRAN™ reference software is comprised of modular, virtualized control functions with interfaces that allow flexible and programmable control of the layer 1 wireless infrastructure.

> Mavenir makes use of the Open Source Data Plane Development Kit (DPDK):

> especially the O-RAN standard AAL implementation of the Baseband Device (BBDEV) library to better integrate accelerators or FPGAs in PHY layer processing.

Mavenir-Intel Collaboration

A new level of performance, scalability, and flexibility for virtualized RAN

Mavenir and Intel, continue to innovate with latest Intel® architecture CPUs

Mavenir's Open vRAN solution, powered by Intel® 4th Gen Xeon Scalable processors

- Optimized, scalable FlexRAN ™ reference software for vRAN
- Eliminating the need for external acceleration with **Intel vRAN Boost**.
- More processing power with higher capacity, reduces number of cores or servers needed per cell site
- Fully integrated cloud-native, energy-efficient and AI-driven RAN solutions at a lower cost.
- Driving Open RAN momentum through three generations of Intel® Xeon® Scalable processors.
- Delivering enhanced performance, functionality, and integrated AI/ML applications for next-generation 4G/5G networks

Mavenir RAN vDU Software

COTS Server

4th Gen Intel® Xeon® Scalable Processors with Intel® vRAN Boost

intel. xeon 4th Gen Intel Xeon Scalable Processor

Distributed Unit (O-DU)
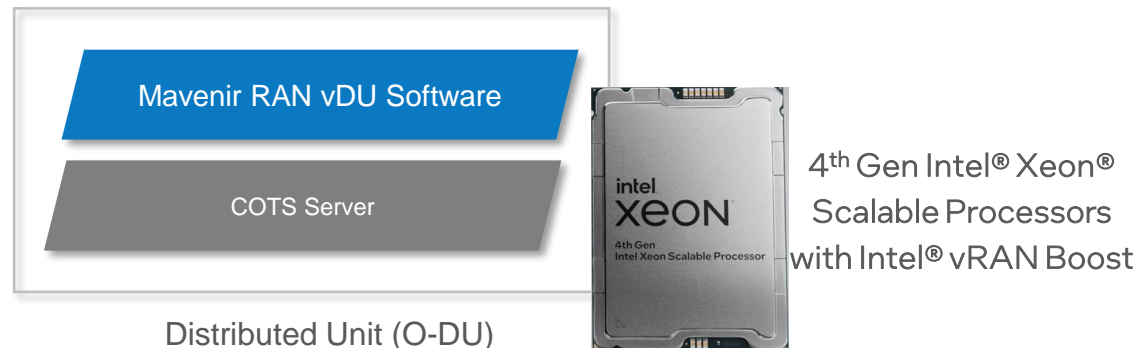
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Mavenir's Web-Scale Platform Enables Seamless Cloud Deployment

Key Considerations Driving Cloud Architecture

Latency / Location

Cloud Content

Edge

Differentiation

Pricing

Mavenir Web-Scale Platform

Web-Scale Platform

Common platform that abstracts applications from underlying infrastructure

Hybrid

aws

Google Cloud

Azure

Private
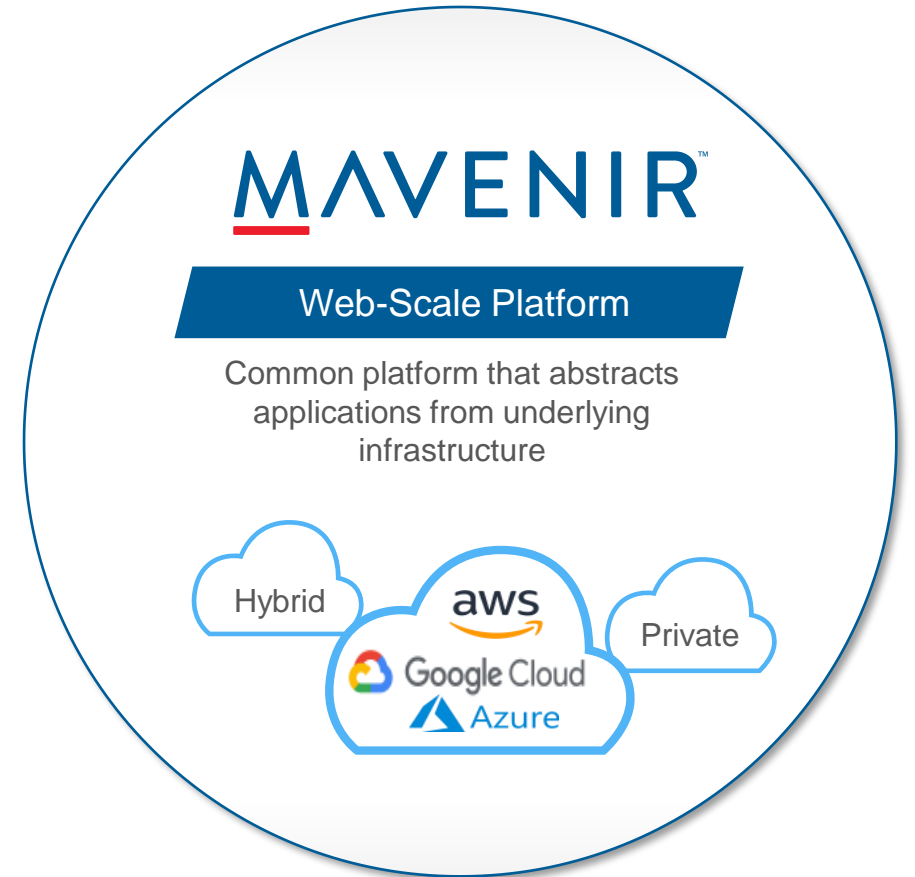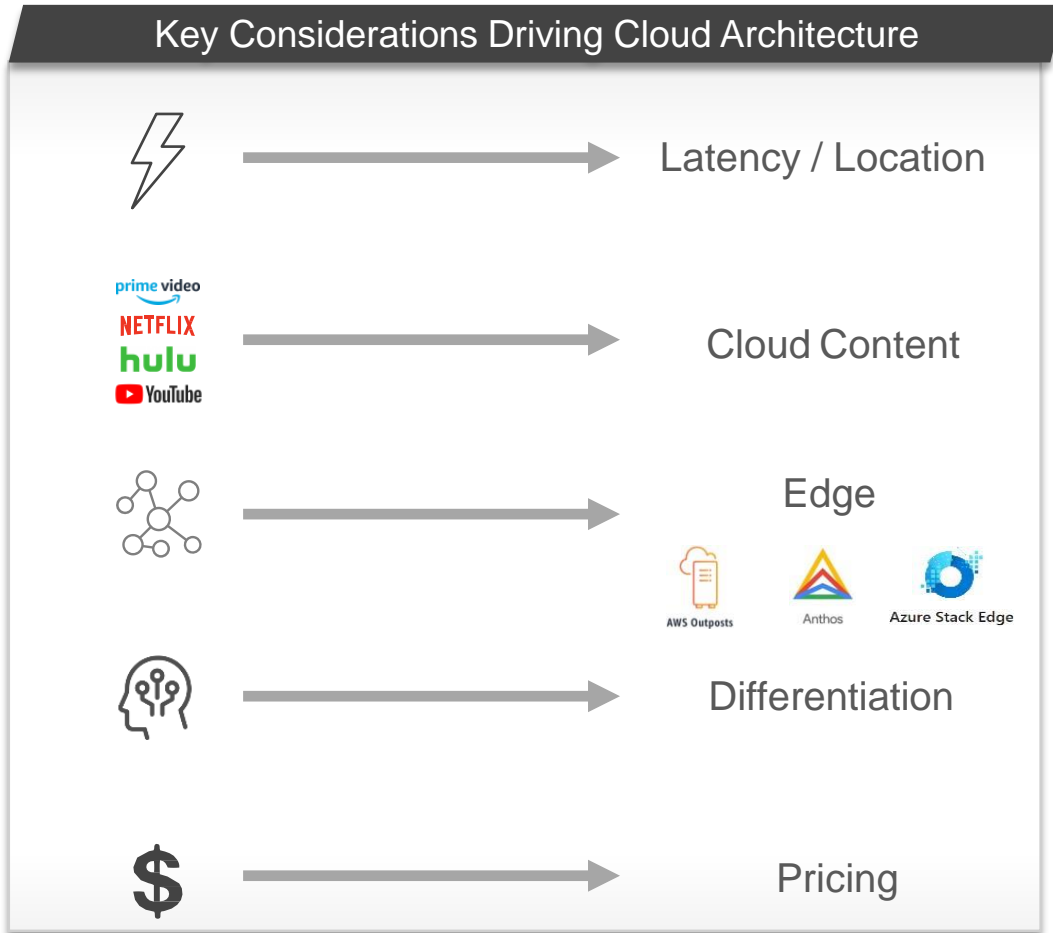
Mavenir Webscale Platform (MWP) includes K8s based CaaS, PaaS and MTCIL (Telecom PaaS layer) along with a management layer that includes full FCAPS, analytics, slice management and service orchestration.

Open RAN Cloud Native-ness lends to Opex Reduction via Automation

Deployment at Scale – 400 sites/day

Configuration Generation Automation

Upgrade at Scale – 1K+ sites/day

Consistency & Error checks
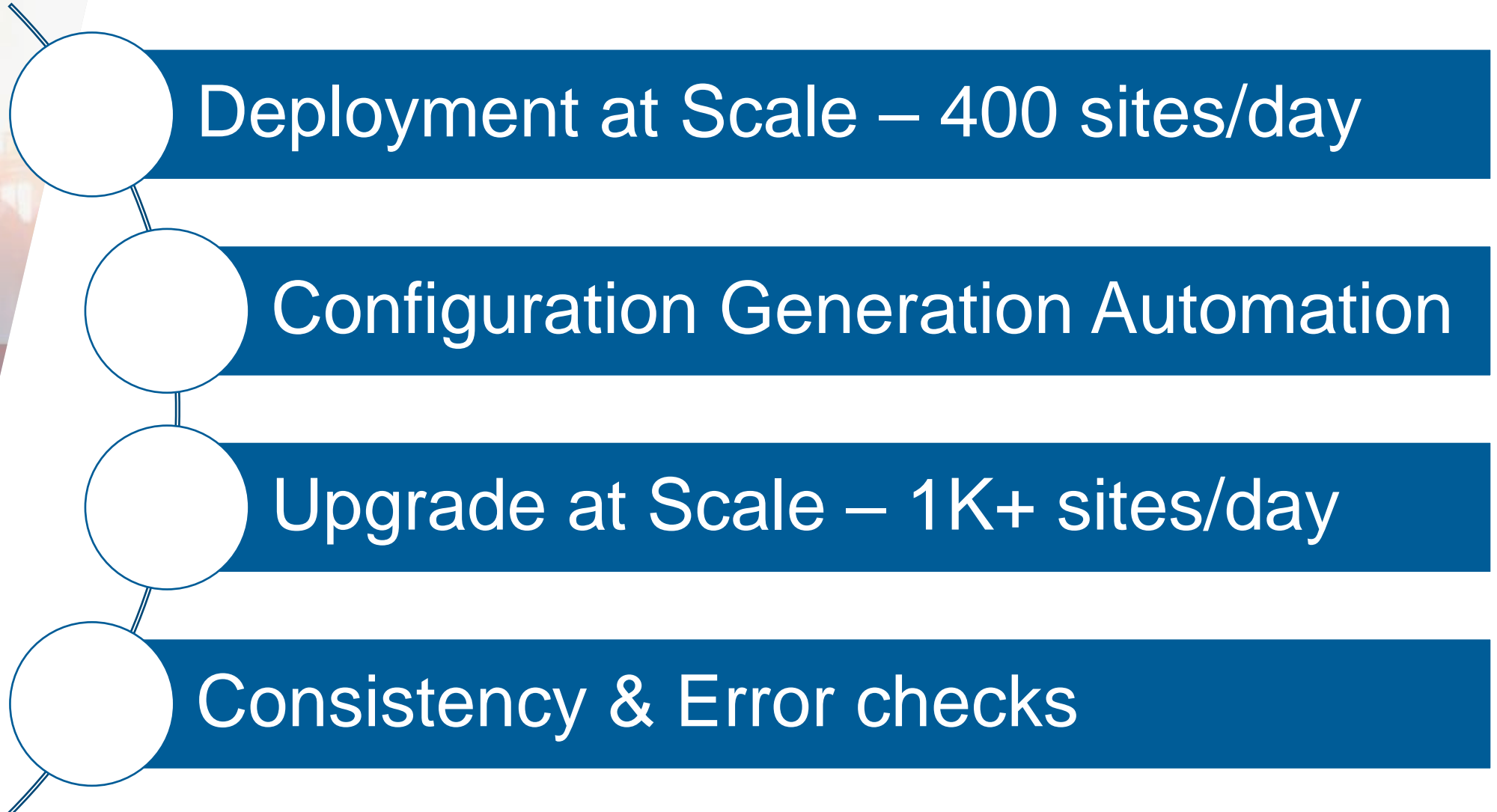
Flexible Deployments - Open RAN supports flexible deployments ranging from Extreme Far Edge to Central Cloud

Open RAN architecture will enable built-in computing and data services, enable a large-scale, distributed cloud in a heterogenous and ubiquitous computing environment, and the incorporation of device information.

Applications

Wide area cloud

Compute/communicate/data functions and services

Cloud computing

Edge computing

UE compute

RAN, CN node compute

Cloud server compute

Open RAN supports flexible deployments ranging from Extreme Far Edge to Central Cloud

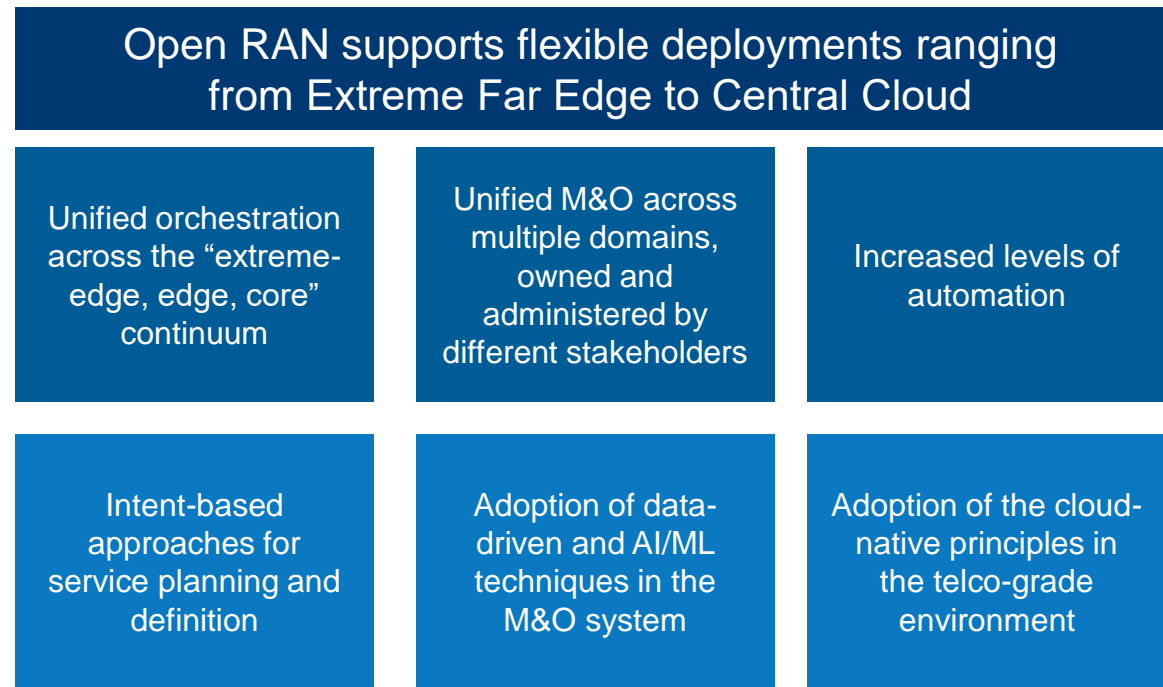|		
Unified orchestration across the "extreme-edge, edge, core" continuum	Unified M&O across multiple domains, owned and administered by different stakeholders	Increased levels of automation
Intent-based approaches for service planning and definition	Adoption of data-driven and AI/ML techniques in the M&O system	Adoption of the cloud-native principles in the telco-grade environment

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Management and Orchestration enabled by Open-RAN non-RT RIC and near-RT RIC

Enablers for intelligent network:
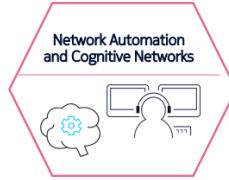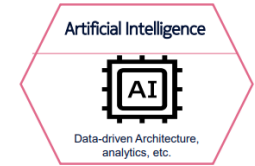
> Network Automation
>> – Reducing human errors in network management and operations

Network Automation and Cognitive Networks

AI/ML

> A new AI-enabled architecture aims to support distributed AI services, needed for supporting AI as close as possible to the application

Artificial Intelligence
AI
Data-driven Architecture, analytics, etc.

E2E integration - managing the infrastructure as a common pool of resources.

1) Device-edge-cloud continuum M&O processes

2) Network Slices Orchestration automation.

3) Optimized placement of NFs

4) Dynamic self-optimization of network slices

5) AI/ML-driven orchestration processes

Near RT RIC processes enables network programmability with AI/ML

1) Intent-based means for expressing application/service requirements using AI/ML

2) Enhanced service description models and profiling.

3) Assurance Subsystems should provide Automated Diagnostics processes

4) Programmable network enablers for reasoning.

Mavenir Comprehensive Open RAN Solution

Diversified Radio Portfolio	Disaggregating software from hardware	Enabling Network Intelligence

Diversified Radio Portfolio:
- 64T64R
- Massive-MIMO
- mmWave
- 8T8R
- Macro, Beamforming
- Mid-Band
- 4T4R
- Small-Cell
- Low-Band

Disaggregating software from hardware:
- vCU
- vDU
- ✓ **3GPP Complaint**
- ✓ **O-RAN Complaint**

Enabling Network Intelligence:
- RU — Open RAN
- AI/ML
- Element Manager
- Orchestrator

> Coverage:
  - Rural, Urban, Dense-Urban, Indoor
> Energy-Efficient Design

> Fully Automated, Cloud-native RAN
> Containerized RAN Workloads

> Real & Non-Real Time RAN Applications
> AI/ML-based Intelligent Algorithms
> Optimization for specific target KPIs

intel network builders partner
networkbuilders.intel.com

Cloud-native, fully-containerized Open RAN End-to-End Solution offering

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Mavenir and Intel Deliver the Future of Open RAN

Open RAN is a mainstream consideration for Operators who are expanding their 5G networks

Mavenir's Open RAN is powered by three generations of Intel® Xeon® Scalable processors

Next-generation Mavenir Open RAN solution with Intel Sapphire Rapids offers increased capacity, reduced latency, and optimized resource utilization

Mavenir and Intel collaboration sets the stage for further advances in next-generation O-RANs - energy savings, AI/ML powered SLAs, higher RAN capacity & more optimized functionality splits

Thank You