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BUILDING THE FUTURE OF NETWORKS - TODAY.

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

The Open RAN transformation – USA view

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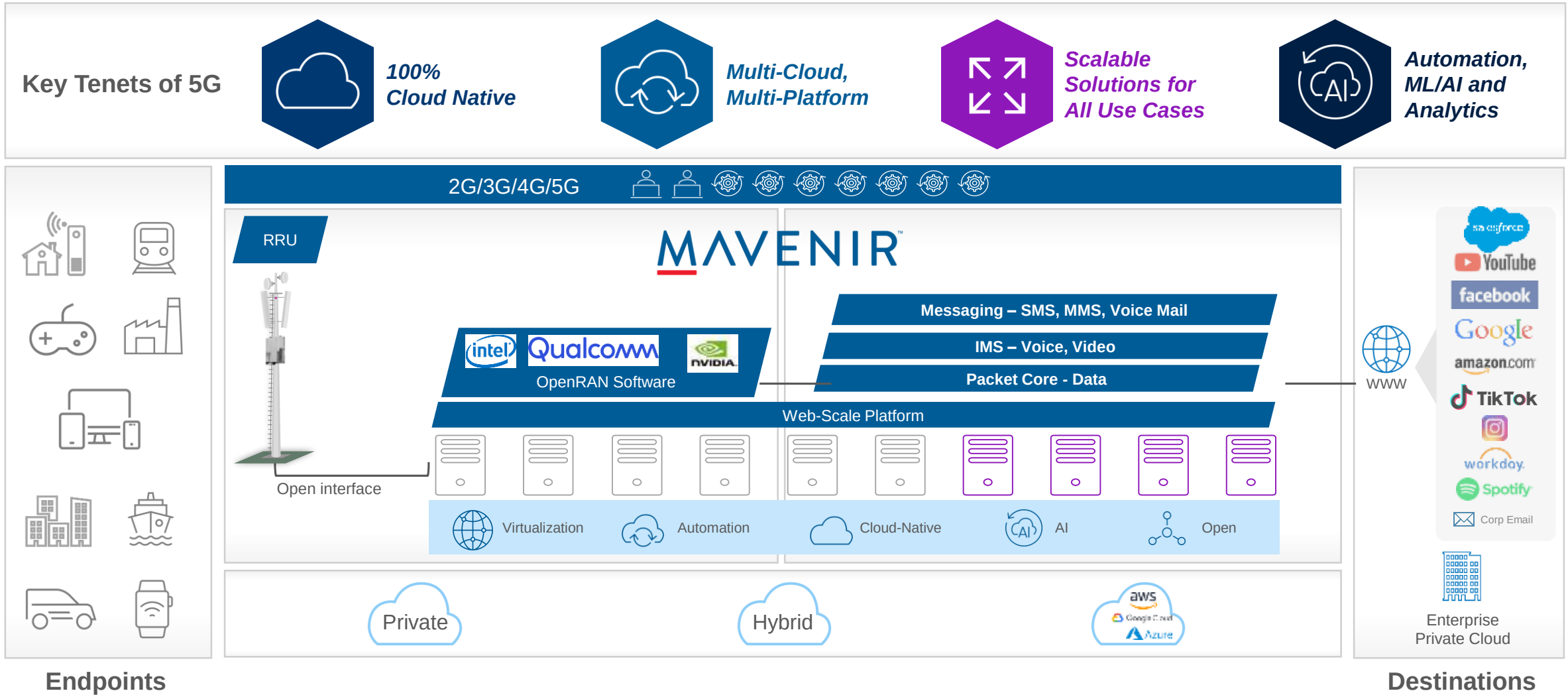
Open Software Platform Leading the 5G Disruption



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Why Open RAN?

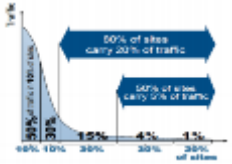
No Lock-ins w/ lower TCO

"Open Interface Applications"
on
"Open Market Hardware"
with feature, performance and cost benefits
40% TCO reduction

Flexible, fluid architectures for deployment

4G/5G, Macros, small cells, mmWave, massive MIMO, IoT, Private networks, various transport

The Cloud & COTS Effect



Pooling

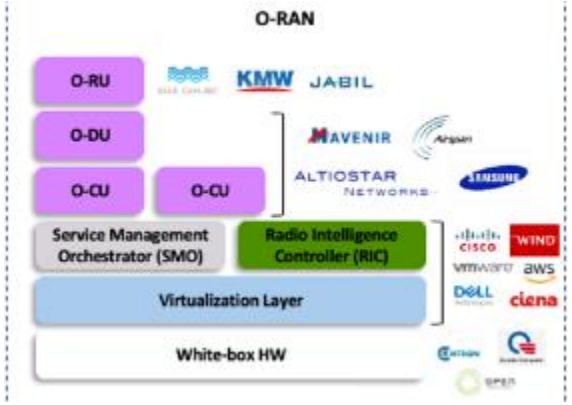
Public/Private clouds

XILINX intel NVIDIA

COTS: CPUs, GPUs, FPGAs

Scalability

Wider supply chain



The intelligent RAN – Data Lake & analytics

Automation & Management

State of art IT practices
CI/CD
Zero touch provisioning
Centralized software upgrades
Full network visibility & control
New features deployed (in days vs. months)
Cell sites activated (in minutes vs. days)
Fast customer activation (in minutes vs. hours)

A fluid elastic cloud-native multi-vendor vs. a rigid inflexible traditional single-vendor

Proven Open and Interoperable Open RAN ecosystem version 17

Promoting and Adopting Open Networks…

Governments
- Australia
- Brazil
- Canada
- India
- Japan
- Korea
- KSA
- Taiwan
- United Kingdom
- United States

Industry Alliances
O-RAN ALLIANCE; TELECOM INFRA PROJECT; Open RAN POLICY COALITION; 3GPP A GLOBAL INITIATIVE; ONF Open Networking Foundation; OPEN AIR INTERFACE

Operators
dish; Virgin Media O2; vodafone; docomo; Rakuten Mobile; airtel; axiata; Telefónica; 1&1; QUICKLINE .co.u; TURKCELL; du; TRIANGLE COMMUNICATIONS; orange; e&; stc; Mobily; zain; Batelco; Omantel; TELUS; TIM; MTN; verizon; paradise mobile; 中華電信 Chunghwa Telecom; 遠傳 FET; Taiwan Mobile; Türk Telekom

RAN SW & HW Components Providers…

Open Radios
MAVENIR; FUJITSU; JABIL; NEC; mu; SERMA TECHNOLOGIES; SERCOM; Comba; Azcom Technology; ZillnK; FOXCONN; Benetel; GXC; SOLiD; NewEdge Signal Solutions; Lions; ALPHA; arcadyan; Accton Making Partnership Work; LITEON; QCT; WNC; microamp SOLUTIONS; SUNWAVE; CableFree Wireless Excellence; PROSE Connect the Everyday; COMPAL

CU & DU SW
MAVENIR; JMA; Airspan; Capgemini; FUJITSU; Radisys; NEC; Parallel WIRELESS; SAMSUNG; Aelleran; is-wireless; Lions; CORNING; Rakuten Symphony; FOXCONN; ACCELERCOMM SUPERCHARGED WIRELESS; ALPHA; arcadyan; htc; SERCOM; wiwynn; PEGATRON; COMPAL; QCT; SynaXG; NOKIA

RAN Intelligent Controller & SMO
MAVENIR; VIAVI; vmware; Radisys; Parallel WIRELESS; Capgemini; NOKIA; is-wireless; FUJITSU; SAMSUNG; JUNIPER NETWORKS; Aelleran; Airspan; Rakuten Symphony; AARNA NETWORKS; NEC; vmware; ERICSSON

xApps/rApps
MAVENIR; JUNIPER NETWORKS; NOKIA; vmware; airhop communications; TIMEDO LABS; Airspan; SAMSUNG; cohere technologies; DEEPSIG; Rakuten Symphony; FUJITSU; AIVA; ERICSSON

Open RAN

RAN Infrastructure Component Providers …

COTS
DELL; Hewlett Packard Enterprise; QCT; MiTAC; ASUS; Lenovo; SUPERMICRO; ADVANTECH; Silicom Connectivity Solutions; kontron

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Cloud Infra
aws; vmware; Google; Red Hat; WNDRVR; Microsoft; Rakuten Symphony; SUSE

Transmission
cisco; ciena; JUNIPER NETWORKS; ADVA; ip infusion; TrifSpace; Infinera; FUJITSU; FOXCONN; QCT; ALPHA; TAILYN; wistron; 達運光電 twoway group; Edge-corE NETWORKS; DZS; FibroLAN FIBEROPTIC NETWORKING; CERAGON

Computing & Acceleration
intel; AMD; Qualcomm; NVIDIA AHEAD OF WHAT'S POSSIBLE; ANALOG DEVICES; picocom Empowering Wireless; TEXAS INSTRUMENTS; MaxLinear; MARVELL; LeapFrog Semiconductor; SynaXG; COMPAL; arm

Ensuring Interoperability and Reliability…

System Integrators
MAVENIR; Capgemini; NEC; IBM; HCLTech; NTT DATA; Radisys; Tech Mahindra; amdocs; EANTC; REPLY NET; FUJITSU; Inventec; OpenValley Transforming Networks; 中華電信 Chunghwa Telecom; COILER; Hwacom; KCCTech; Wave; AARNA NETWORKS; MESHLINK; Rakuten Symphony; accenture; KCCTech; wipro

Test & Measurement
KEYSIGHT TECHNOLOGIES; VIAVI; MAVENIR; Ospirent; Anritsu; XENA NETWORKS; SIMNOVUS; Calnex Insight and Innovation; ROHDE&SCHWARZ; QUALITEST; TELSASOFT; AUKUA SYSTEMS; SIEMENS

Open Testing and Integration
- ✓ European OTIC in Berlin
- ✓ European OTIC in Torino
- ✓ Auray OTIC and Security lab
- ✓ European OTIC in Paris
- ✓ European OTIC in Madrid
- ✓ Asia & Pacific OTIC in PRC
- ✓ Korea OTIC, TTA
- ✓ Kyrio O-RAN Test and Integration Lab
- ✓ North American OTIC in NYC Metro Area/East (COSMOS)
- ✓ Asia & Pacific OTIC by ritt7layers
- ✓ Asia & Pacific OTIC in Singapore
- ✓ North American OTIC in Salt Lake City (POWDER)
- ✓ DELL OTEL
- ✓ North American OTIC in Boston Area (Northeastern Univ)
- ✓ ITRI 5G Open Network Lab
- ✓ SONIC Lab. UK
- ✓ I14ylab Germany
- ✓ North American OTIC in Central Iowa(ARA)
- ✓ North American OTIC in Washington, DC
- ✓ North American OTIC , MITRE

US Eco-system building around Open RAN

From: closed 1-2 vendor eco-systems to commercially deployed vibrant and open eco-systems

US Government

- NTIA
- ORPC
- ATIS 6G Alliance
- MITRE

- $1.5B for open RAN over 10 years

US Operators

- Dish
- AT&T
- Paradise Mobile
- Triangle FWA

- 16000+ sites in Dish today
- $14B investment by AT&T over 5 years

Cloud providers and hyperscalers

- AWS
- Microsoft
- Google
- RedHat
- VMWare/Broadcom

Vendors

- Software: Mavenir, JMA Wireless
- Servers: Dell, HP
- Accelerators: NVIDIA, Marvell, Qualcomm
- Silicon: Intel, AMD, ADI

Test equipment & Labs

- Keysight
- Viavi
- CableLabs

Universities

- NEU
- Univ of Utah
- Virginia Tech
- Rutgers
- Iowa State
- Rice

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Challenges solved during Open RAN transformation

Challenge	Status
No traditional vendor support: too complex, will not work, poor performance, not secure	All traditional vendors (except Huawei) today claim support
Fronthaul eCPRI standardization	Standardized. E.g. Mavenir has integrated 16+ radio vendors
Management	Hybrid / Hierarchical modes supported for options in managing radios
Virtualization, Orchestration	Many open RAN vendors provide containerized products on COTS hardware. Platform vendors such as Redhat provide orchestration support.
Innovation	Network intelligence supported with SMO, AI/ML and RIC
Security	E2E security and zero trust options supported in Open RAN
Acceleration / Dimensioning	L1 accelerators supported with in-line and lookaside options for capacity
Performance enhancements – mMIMO	Performance enhancements for mMIMO developed in O-RAN
Energy savings	Energy savings a key focus in Open RAN across operators
6G evolution	Architecture being designed and evaluated to be 6G ready

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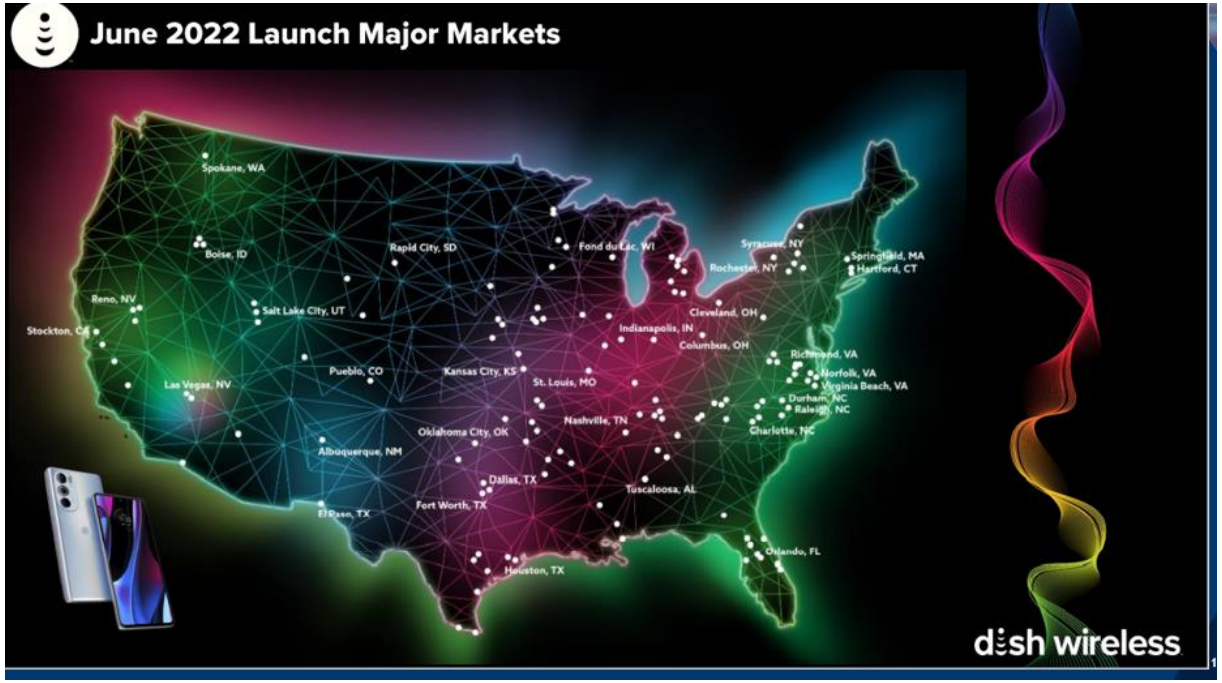
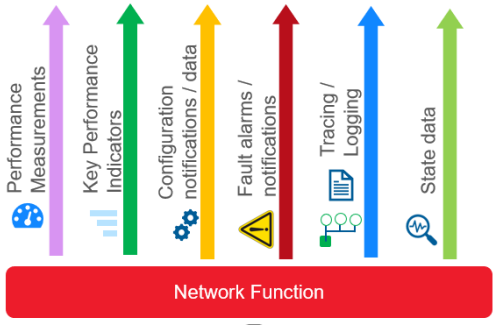
Launched Open RAN 5G SA service in Las Vegas – June 2022

- Mavenir & Samsung DUs and CUs
- Running on VmWare and AWS (Kubernetes)
- Fujitsu & Samsung Radios
- Nokia 5G SA Core
- Dish's other ecosystem partners– Oracle, IBM, Amazon, Samsung, Cisco, Dell, BluePlanet
- Roaming agreements with TMO and AT&T
- 70% of US covered in 2023
- Over 10,000 sites powered by Mavenir Open RAN software

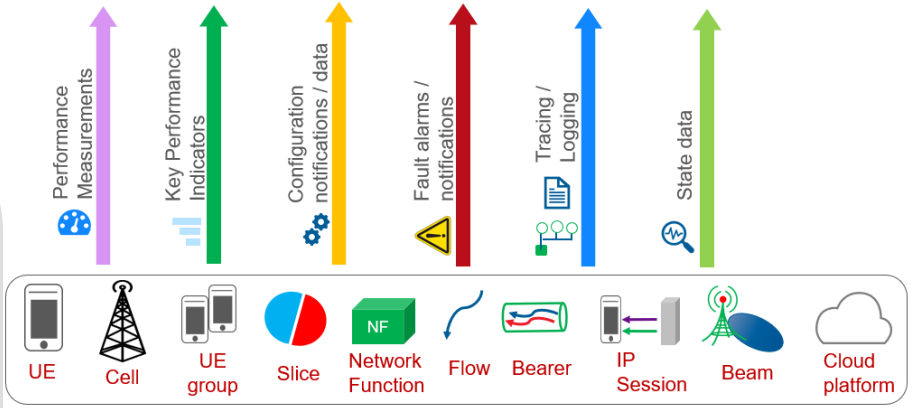


Network management with open and cloud-native data flows

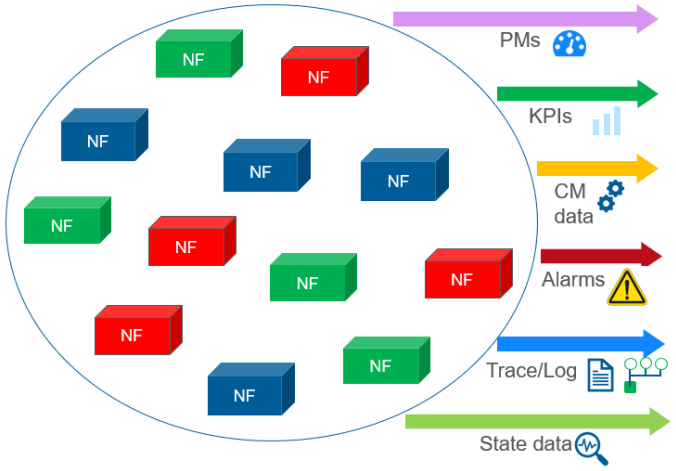


Different Data Types

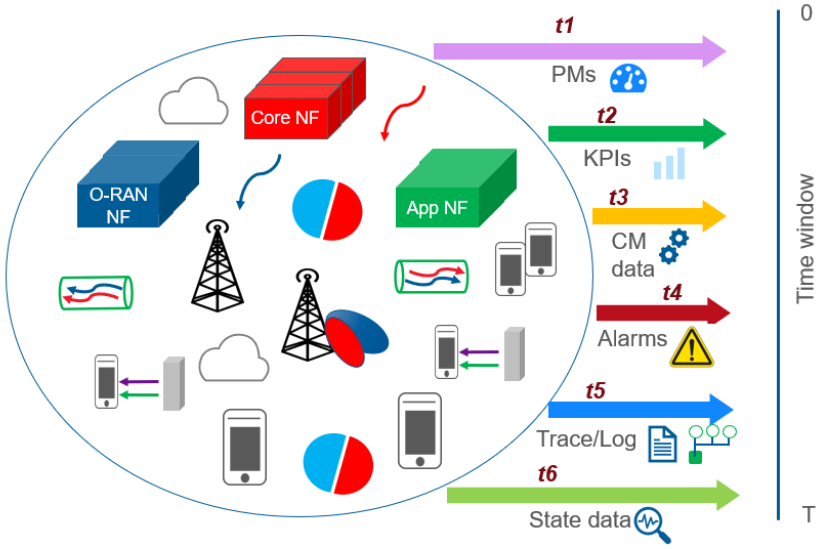
- **Multiple consumers**
  - Different data needs (RIC, SMO etc)
  - Frequency
  - Latency requirements
- Need to manage data **from thousands of nodes**
- **Efficient use** of CPU, networking and storage
- **Resiliency**…protect against loss of data
- **Security** – can see what is going on



Different Data Levels



Different Network Functions



Different Times

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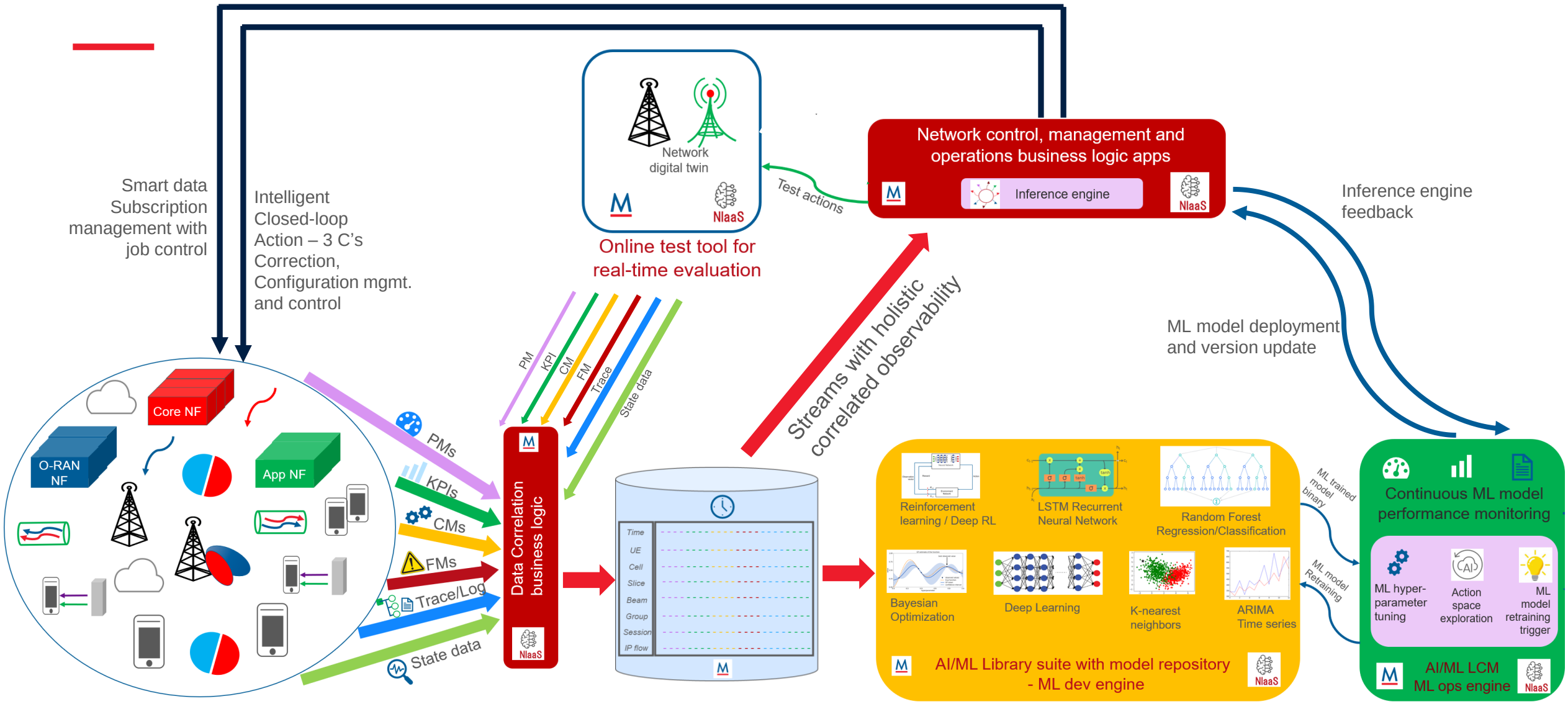
Need Right Data, Right Place, Right Time, at the Right Cost

Network Intelligence as a Service (NIaaS) supported by Open RAN



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Summary

Open RAN has enabled a vibrant eco-system in the US with a wide variety of hardware, software vendors, cloud hyperscalers, platform vendors, test equipment manufacturers.

US Operators are increasingly evaluating and adopting open RAN in their networks

- Dish Networks: 10000+ sites
- AT&T: $14B investment over 5 years

US government encouragement and funding for open RAN

- $1.5B over 10 years

Open RAN enables innovation and competitiveness in networks

- Do not need E2E delivery from single vendor
- Enables smaller vendors to contribute and be successful – opening up eco-system and sourcing options
- Network intelligence and optimization supported in cloud-native manner
- Designs being evaluated and extended for 6G

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