5G Rural Dorset WP6 Task 6: OpenRAN for NH: Product & Market Research

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Table of Contents

Table of Figures

Abbreviations

BBU	Baseband Unit
eCPRI	Enhanced Common Public Radio Interface
O-CU	O-RAN Central Unit
O-CU-CP	O-RAN Central Unit – Control Plane
O-CU-UP	O-RAN Central Unit – User Plane
O-DU	O-RAN Distributed Unit
O-RU	O-RAN Radio Unit
near-RT RIC	O-RAN near-real-time RAN Intelligent Controller
non-RT RIC	O-RAN non-real-time RAN Intelligent Controller
gNB	gNodeB
MORAN	Multi-operator radio access network
MOCN	Multi-operator Core Network
RIC	RAN Intelligent Controller
CAPex	Capital expenses
OPex	Operational Expenses
OSS/BSS	Operation Support/Business Support System
RRU	Remote Radiohead Unit
RRM	Radio Resource Management
RAN/vRAN	Radio Access Networks/virtualized RAN
RRC	Radio Resource Control
RLC	Radio Link Control
PDCP	Packet Data Convergence Control
xAPP	Near-RT RIC Applications
rApp	Non-RT RIC Applications
SMO	Service Management and Orchestration Network
NH	Neutral Host
MNO	Mobile Network Operator
MVNO	Mobile Virtual Network Operator
5GC	5G Core
SLA	Service Level Agreement
SDN	Software Defined Networking
QoS	Quality of Service
UP	User Plane
CP	Control Plane
AI	Artificial Intelligence

References

[1]	O-RAN Alliance https://www.o-ran.org/
[2]	https://www.airspan.com/open-architecture/
[3]	https://www.mavenir.com/
[4]	https://www.vilicom.com/solutions
[5]	https://www.parallelwireless.com/products/
[6]	https://accelleran.com/
[7]	https://www.5gcity.eu/
[8]	https://stlpartners.com/telco_cloud/10-ran-vendors/

Introduction

Satellite Applications Catapult is leading this work as part of Work Package (WP) 6, where it is responsible for the scope, delivery (design and build), validation and acceptance of Neutral Host (NH) deployment and testing. This report, as per the WP description, is closely related to the available market products targeting the virtualization of the RAN layer, so as to allow network operators to significantly reduce costs, promote healthy competition and accelerate the road to market through the utilization of open interfaces. The specifications of these interfaces are offered by the standards developed and established by the ORAN alliance.

Therefore, the analysis undertaken herein provides an overview of the most advanced commercially available ORAN compatible platforms, offered by UK and non-UK vendors. Furthermore, the comparison among these solutions and their suitability for NH deployments are discussed. More specifically the OpenRAN solutions provided by the following vendors are presented: Mavenir, AirSpan, Parallel Wireless and Acceleran.

AirSpan's OpenRAN Platform

Airspan is a 4G and 5G network densification equipment and software vendor, with a wide range of products ranging from RRUs and DUs, to integrated software platforms. The products exploit technologies including mmWave, Sub-6 GHz, Massive MIMO and Open vRAN architectures. Together, Airspan offers end-to-end flexible RAN solutions for projects including rural network deployment, indoor connectivity, fixed access, backhaul and IoT applications. Airspan offers its cloud-native open architecture solutions to internet service providers, carriers, and enterprises, which it claims will reduce CAPEx and OPEx significantly.

Airspan is a key player in the Open RAN environment. The company has recently partnered with Altiostar Networks, with hopes of leveraging their combined vRAN and intelligent radio solutions to accelerate the commercialisation of Open RAN 4G and 5G platforms. The partnership has seen recent success. In collaboration with Rakuten, the duo has managed to connect thousands of sites across Japan, to form the first commercial cloud-scale web-based virtualised network.

AirSpan is a member of the ORAN alliance [1]. In terms of featuring NH into their system, and after having discussion with their management team, the main obstacle is that AirSpan does not include a network share gNB. In consequence of, although they have an available OpenRAN product, multiple RRUs required to host multiple Core networks, and this can be reflected at a cost and complexity increase, making it not the optimum solution for utilizing neutral hosting. A high-level architecture of the AirSpan de-centralized platform option is depicted in Figure 1:

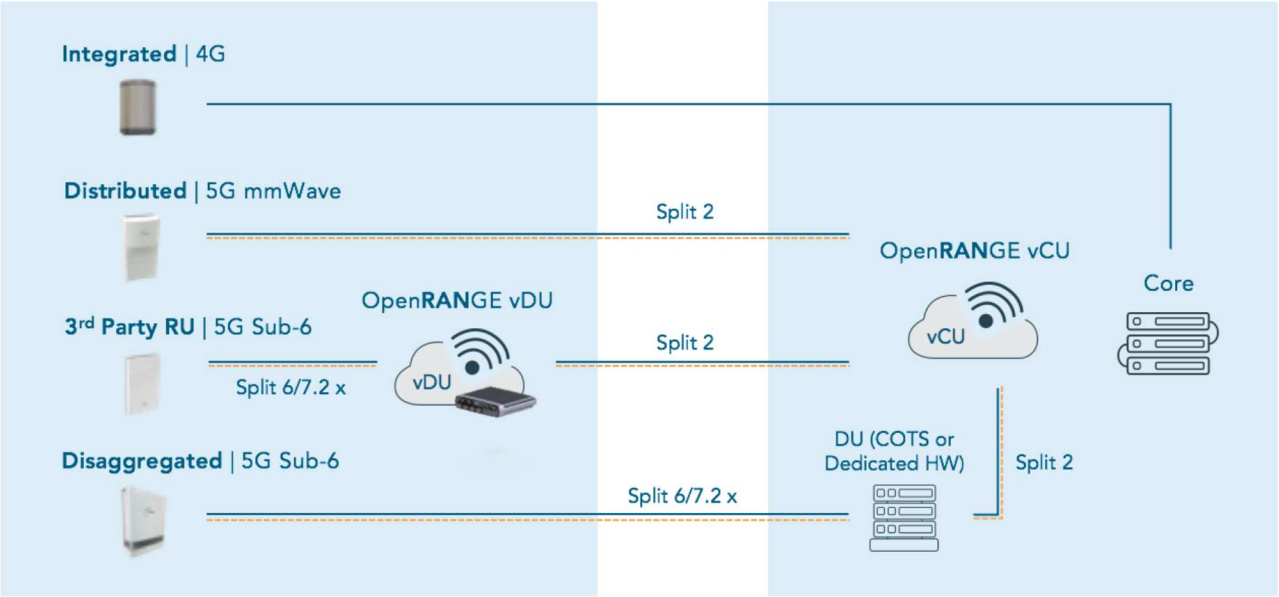

Figure 1. AirSpan ORAN based split architectures (source: [2])

To the best of our knowledge and through interactions and discussions with AirSpan management, the disaggregated solution is available only with dedicated hardware

(proprietary), adding thus an extra burden in the openness of their system, making the system more of a Virtualized RAN (vRAN) solution. A more explanatory view of AirSpan solution for NH based on splitting points is illustrated in Figure 2.

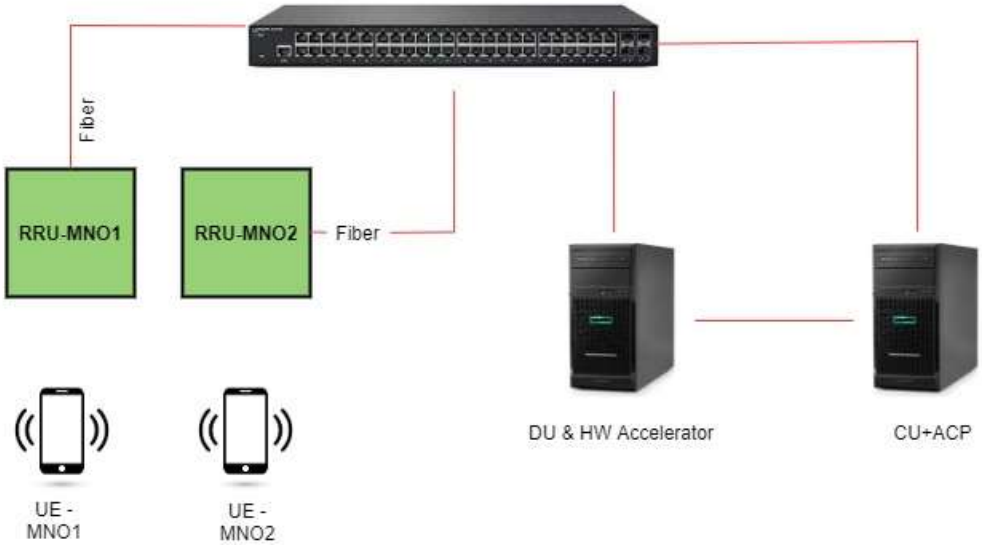

Figure 2. AirSpan v/OpenRAN based NH solution

As shown in the figure above two radio remote units required for different MNOs , and although not shown in the figure there is an one to one correspondence between serving MNOs and DUs. Although Airspan utilizes splitting points and disaggregation, there is no reference to the intelligence units of the OpenRAN architecture such as Radio Intelligent Unit (RIC) where third xApps can be developed and deployed through API constructs provided by the vendor. Therefore, their solutions still lacks some of the important elements of OpenRAN ecosystem.

The Airspan Control Platform (ACP) provides a rich suite of features that delivers management and network orchestration applicable to any customer deployment, including network operators, private networks, and enterprises. With ACP, customers have flexibility to allow them to span and control single or multiple technologies, provide full management and control, integrate into existing OSS/BSS stacks, and automate network orchestration and management. It is also worth mentioning that Virtual Network Functions (VNFs) management and orchestration is based on Kubernetes (K8s) container management platform.

Due to NDA agreements signed between Catapult and AirSpan, we are not able to provide detailed component description and functionality of the platform, however the schematics above capture the important features of the solution provided.

Mavenir's OpenRAN Platform

Mavenir's OpenRAN solution is a fully containerized, virtualized OpenRAN Split 7.2 architecture. It leverages open interfaces, virtualization, and web-scale containerization to support various deployment scenarios – including private, hybrid cloud, and public cloud solutions.

The evolved OpenRAN architecture, designed with cloud-native virtualization techniques, enables the RAN to adapt based on usage and coverage. Cloud computing shifts network functions from dedicated hardware platforms into virtualized software components that can be implemented on hardware, which can be pooled in centralized data centres [3]. In addition, and in contrast to AirSpan, Mavenir features a developed intelligent AI/ML based intelligent platform that controls efficiently the OpenRAN platform. However, Mavenir lacks OpenRAN-based 5G support at the moment and the prediction is that this will be available by the second quarter of 2022.

Mavenir's RAN Intelligent Controller (RIC) manage multi-vendor RAN components and enables management of network resources targeting processes automation, mitigation of service degradation and high quality experience for the service subscribers. The non-Real Time (non-RT) RIC is a containerized application that uses advanced machine learning algorithms to optimize network performance and train machine learning models using long-term RAN data for dynamic and adaptive policy and control. The near RT RIC application hosts trained AI/ML applications to control O-RAN elements in near-real time and supports functions such as traffic steering, slice Service Level Agreement (SLA) management, massive MIMO Beam forming optimization, and other industry specific use cases. However, it is unclear if Mavenir is offering an API to integrate third party xApps and rApps in their platform. Definitely if not still available this will be a feature to be incorporated in the near future. Mavenir's OpenRAN diagram is illustrated in Figure 3.

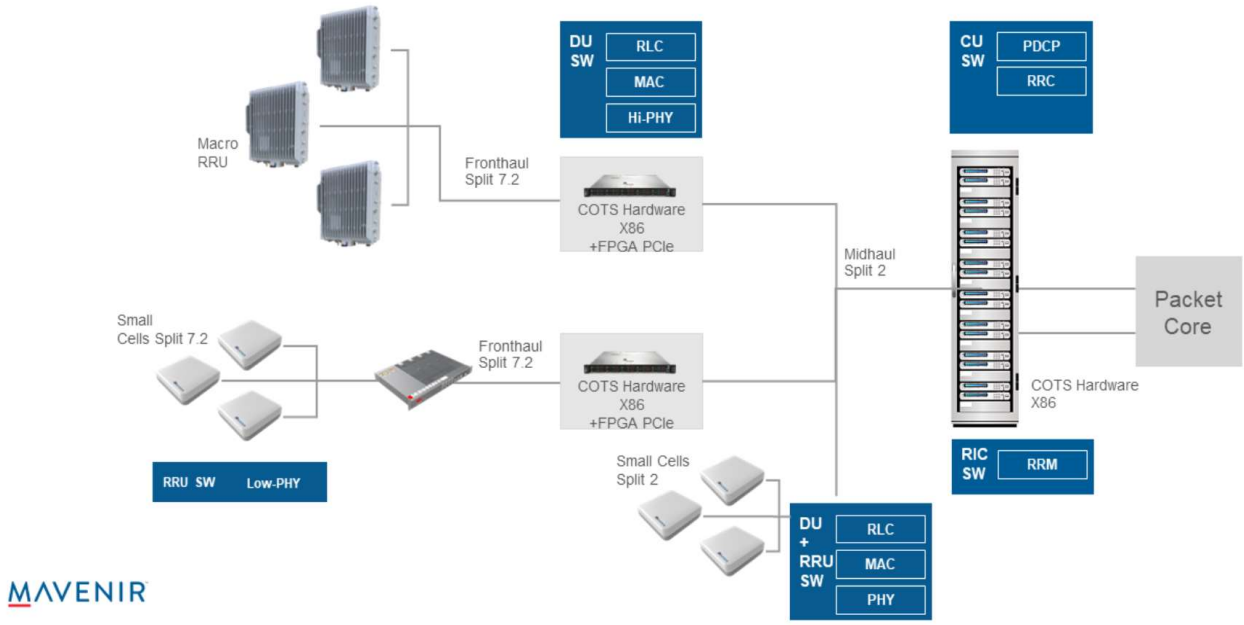

Figure 3. Mavenir's OpenRAN system architecture (source: [3])

The enhancements offered by the presented OpenRAN platform are the following:

- Open Fronthaul interface between the DU and RRU (eCPRI),
- ORAN compatible E2 interface and A1 interface between Service management and orchestration (SMO) layer containing non RT RIC and RIC near RT function.
- Programmable, hardware accelerators, real time processing, light weight virtualization technologies
- Software Defined Radio (SDN) to decouple the control plane (CP) & user plane (UP) into RAN to embed intelligence.
- Enhanced traditional Radio Resource Management (RRM) functions through the hierarchical (Non-RT and Near RT) RAN RIC

In terms of featuring NH into their system, and after having discussion with their management team, Mavenir does hold a multi-operator radio access network (MORAN) configuration and their Radio Resource Control (RRC)

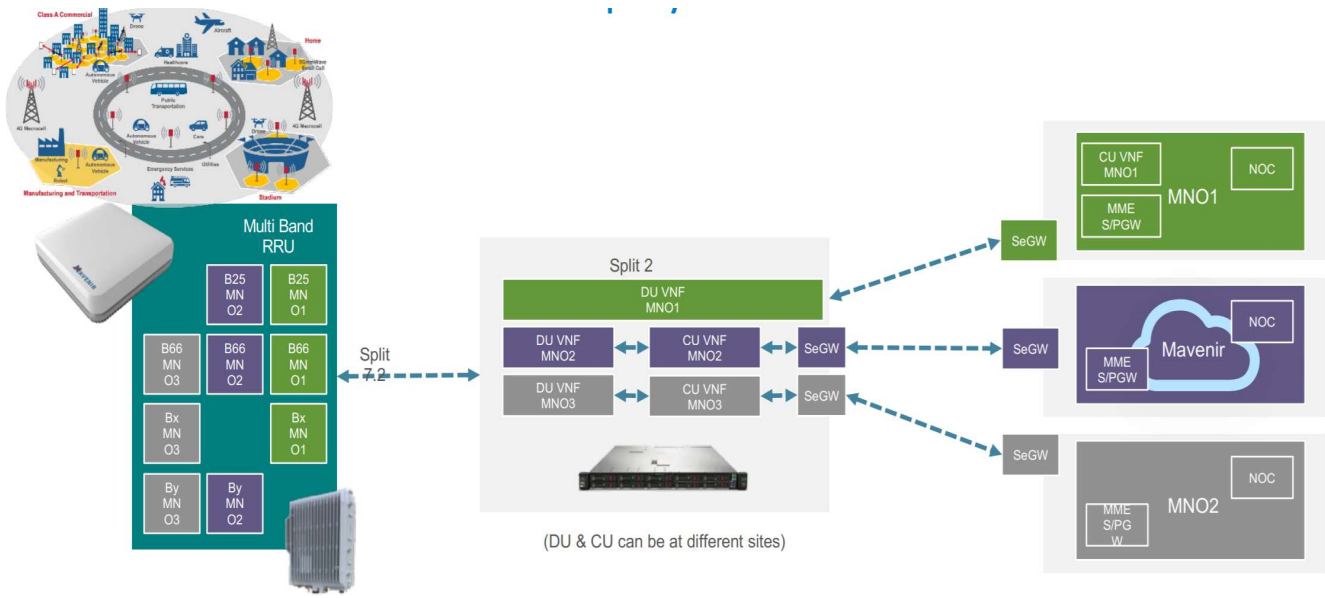

Figure 4. Mavenir's NH end to end architecture based on MORAN.

Assuming a connection takes place from a UE subscribed to MNO-1, the UP/CP is transferred from the RRU to the corresponding distributed unit, through eCPRI that is an open fronthaul interface, compatible to the requirements of ORAN alliance.

Split 7.2x implies FFT/IFFT, Cyclix Prefix insertion/removal, pre-coding and digital beamforming, modulation and demodulation or parts of it, are performed at the DU.

The link from DU to CU (Midhaul) is based on a split 2, splitting Radio Link Control (RLC) and Packet Data Convergence Control **(PDCP)**. PDCP and **RRC** (Radio Resource Layer) are then logically located in the CU. This split corresponds to F1 interface in 3GPP Release 15. Finally, through a secure gateway, the communication is established to the core network of the respective operator.

Although Mavenir does not offer a 5G OpenRAN solution yet, it can provide a system that include major OpenRAN features such as A1, E2, F1 interfaces, RT/non-RT RIC and neutral hosting.

Satellite Applications Catapult is investigating among other solutions, a possible purchase of Mavenir's solution in the form of a Lab as a Service (LaaS) from Vilicom [4]. Vilicom is an system integrator and Catapult has signed NDA for the exchange of information related to the platform. If negotiations move forward then the 5G version of the system will be included in the agreement as part of a software add-on due to Q2, 2022.

Parallel Wireless' Solution

Parallel Wireless' OpenRAN solutions offer a virtualised network deployment solution that combines software-defined software architecture, allowing mobile operators to replace legacy 2G, 3G or 4G systems with an integrated fully virtualised OpenRAN system. This system is centrally monitored through Parallel Wireless' network software. This enables capabilities ranging from network intelligence including network orchestration, analytics, and optimisation for faster time-to-market deployments via the platform's OpenRAN controller.

Parallel Wireless has been active in the OpenRAN space, where collaborations now exist with major mobile operators including Vodafone, and Telefonica. Utilizing this OpenRAN solution, the company claims to facilitate the converging of all 2G,3G,4G and 5G into one unified software platform, removing the need to maintain legacy networks dedicated to a single technology. Similarly, the company has been selected by Orange to aid in a multi-country program to extend existing coverage across the Central African Republic.

By disaggregating hardware and software, the Parallel Wireless's software platform helps mobile operators expand and modernize their legacy networks to support subscribers across all G technologies. Parallel Wireless OpenRAN solution consists of COTS vBBU, OpenRAN-based RRU, and OpenRAN Controller and network software suite [5]

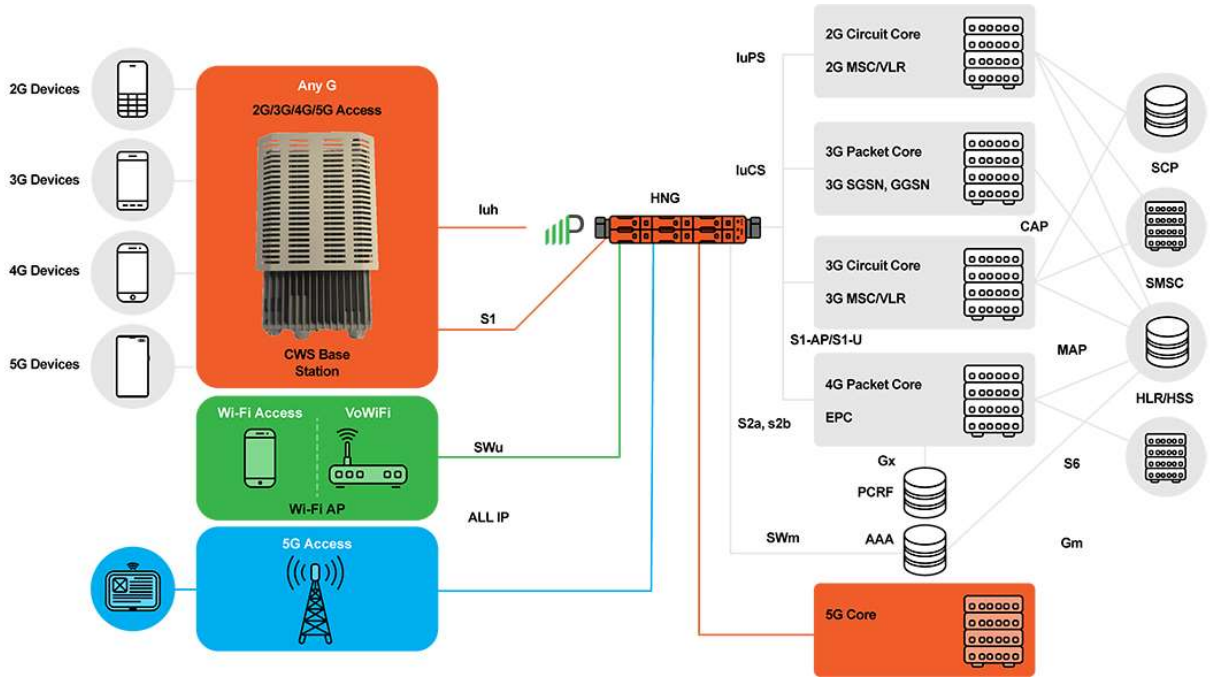

Figure 5. Parallel Wireless OpenRAN platform (source [5]).

The vBBU is running on COTS servers, thus bringing the future-proof architecture of a Distributed Unit (DU) and a Central Unit (CU), deployed at the network's edge. The vBBU resources can be shared among multiple RRUs on-site.

The HetNet Gateway **(HNG)** software combines RAN and core functions (vBSC for 2G, vRNC for 3G, small cell and core gateways for 4G) to lower the cost of RAN via simplification and automation of all- G networks. The OpenRAN Controller and Network Software Suite enables

a unified architecture through abstraction of traditional RAN and core network functions on a COTS server. The software enables an open network architecture by using standards-based and open interfaces between network components.

With respect to neutral hosting, the Parallel Wireless solution quite easily enables MOCN and MORAN by having the ability to interrogate the traffic and route to the proper core for 4G, 3G or 2G traffic. This then allows RAN sharing to happen without complication to any of the home networks, where the software platform simply requires connections to each core and handles the heavy lifting of routing of the traffic properly. In turn, each core network manages their users as if they are on the home network. The OpenRAN Controller and network software act as a router for different operator core networks connecting subscribers. Routing criteria includes PLMN, and SIM Id per user based.

Parallel Wireless' solution is mature in terms of radio disaggregation, (DU CU separation) and multi G technology aggregation. However, to our understanding there is not a RIC, non-RT RIC development currently available, that allows deployment of third party xApps/rApps. Further, the 5G OpenRAN platform is not yet available however they claim that a software upgrade can incorporate 5G networks as well.

Acceleran's OpenRAN Platform

Accelleran [6] provides open and containerised RAN Software solutions that support an economically viable alternative to the traditional mobile telecom approach. Accelleran's software architecture, encompasses software-defined networks and network virtualisation to serve private, public and neutral Host networks. The platform is targeting the four cornerstones of OpenRAN ecosystem:

- Cloud Native techniques that bring flexibility and scalability to Radio Access Networks as well as hardware independence
- Open architecture
- Artificial Intelligence to drive innovation and RAN automation through the building and deployment of x/r Apps
- System integration since integrating the individual components into a working solution remains a challenging task for the successful deployment of OpenRAN platforms.

The above solutions are provided through the available solutions that are incorporated within Acceleran's products. More specifically, these products are:

1) The dRAX, which is a Cloud-native openRAN software. dRAX includes a RAN Intelligent Controller (RIC) and Service Management and Orchestration (SMO) platform, a Central Unit (CU) and an xApps framework and xApp library. The dRAX-RIC involves a framework that provides all the necessary functions for onboarding and life cycle management of xApps. It supports the deployment of containerized xApps and provides them with a number of services:
    - xApps onboarding and lifecycle management
    - access to real-time RAN measurements and events
    - configuration of RAN components
    - real-time commands to direct RAN behaviour (e.g. force a handover, sub-band masking)
    - real-time state database
    - Inter xApps communication
    - API-driven xApps configuration and policy management

    Acceleran claims that dRAX-RIC can be used as production-ready development for third party platform to leverage real-time RAN data and control hooks to create their own AI-based xApps and enhance RAN intelligence and automation. dRAX SMO tool also includes the non-RT RIC unit as well as a Kubernetes-based orchestration capabilities that can dynamically instantiate RAN microservices when and where they are needed. Finally, dRAX also provides a fully standards-compliant, Cloud-Native implementation of the CU-UP and CU-CP as defined by 3GPP.

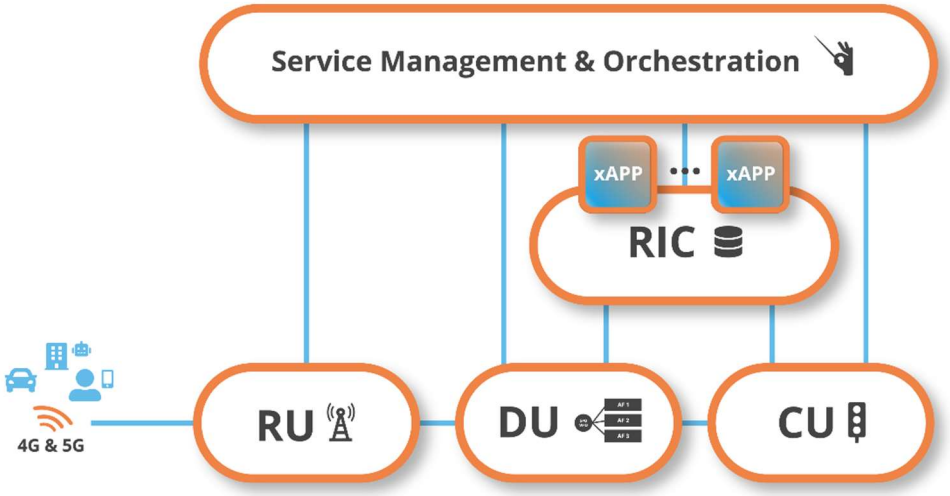

Figure 6. Acceleran's OpenRAN platform (dRAX).

2) dRU are Open RAN interoperable radio units. dRU include pre-integrated third-party RUs that can deliver an easy access towards a multi-sourced Radio Access Network. Acceleran is continuously working with our partners to ensure proper functionality as products evolve and have partnerships in place to build bespoke RUs for specific applications.
3) dLAB is the integration of the various OpenRAN components. This includes hardware and software network functions, from radio units over distributed and central through the RIC, providing an effective path towards a fully operable and integrated RAN.

In relation to NH development, Acceleran has shown that the CU can be used to accommodate multi-tenant deployments in projects such as the EU project 5GCity [7]. However, not many details are included in their commercial advertisements, therefore, we have initiated several technical calls with Acceleran's team to gather more information and move forward with the purchase of their platform, as long as this is covering the technical requirements we have posed with respect to NH and intelligent network deployment.

Platform Capability Comparison

This section provides a comparison among the solutions presented above through a capability and features table:

Vendor	5G enabled	Multi-RAT aggregation	RT RIC module	non-RT RIC	RIC API readiness	SMO	NH-enabled	DU on COTS x86	CU on COTS x86
Mavenir	✗	✓	✓	✗	✗	✓	✓	✓	✓
Airspan	✗	✗	✗	✗	✗	✓	✗	✗	✗
Parallel Wireless	✗	✓	✓	✗	✗	✓	✓	✓	✓
Acceleran	✓	✓	✓	✗	✓	✓	✓	✗	✓

Table 1. Capabilities and Features Table for selected OpenRAN platform vendors

From the analysis undertaken in the previous sections and the features highlighted in the table above, the following conclusions can be derived:

- Acceleran is the only vendor that holds a 5G enabled platform, ready to be deployed on premises
- Acceleran provides a documented API for third party xApps deployment and a complete and easy to function RIC platform
- Parallel wireless provides the most sophisticated system in terms on multi-RAT integration. This is based on their aggregator software and HetNet gateway. Acceleran and Mavenir clam that they provide this functionality, however, a statement of work would be critical on understanding better the level of the platform capability in terms of multi-RAT aggregation
- In terms of SMO, Acceleran and Vilicom provides the most suitable platforms offering both CLI and GUI interfaces to configure the various radio parameters(i.e. PLMN, bearer selection, RIC, DU,CU, Power levels)
- Acceleran does not provide its own DU, but they are closely engaged with third party solutions, which can be adapted easily as a plug-n-play software module

Based, on the above analysis, and considering cost is not a major barrier, we propose the procurement of the solution offered by Acceleran, as long as they map the platform features sufficiently, in the SoW that will be shortly circulated. This platform can directly target the requirements of this project and can be easily scaled based on the needs of future projects related to the use of OpenRAN in 5G and beyond.

Additional OpenRAN Platforms

AirSpan, Mavenir, Parallel Wireless and Acceleran are the main OpenRAN platforms that are thoroughly investigated in terms of extensive technical discussions with their respective technical, management and sales teams. The scope of these discussions is the purchase of the most suitable system, bound to the needs of the projects and with a vision in extending this project into a state-of-the-art OpenRAN based neutral host platform, that can act as one of the most complete OpenRAN platforms in the UK, focusing onto the exploitation of future NH deployments.

Except from these platforms, there are vendors that have developed or currently developing solutions that can complement or even compete the aforementioned platforms. Amongst all, the following vendors have an existing semi-complete or complete OpenRAN solution:

Altiostar: Altiostar offers 4G and 5G open virtualised RAN software solutions that supports open interfaces and disaggregated hardware, facilitating a multi-vendor web-scale network. Altiostar is a partner to deliver its cloud native O-RAN compliant nationwide 5G network – the first of its kind in the United States. A large focus also has been in facilitating greater network utilisation and orchestration capabilities Incorporating AI and machine learning into their platform

Nokia & Intel: Nokia is a major contributor in several partnerships including the O-RAN Alliance. More recently, Nokia has partnered with AT&T (in the US) to co-create the RAN Intelligent Controller (RIC) based on O-RAN architecture and publishing in open source. Nokia has partnered with Intel to successfully trial the delivery of the first over-the-air data session in a fully virtualised RAN trial environment. Utilising Nokia's AirScale all-in-cloud base station, and subsequently, virtual baseband processing, with Intel's processor-based platforms, the trial represents a significant step forward in developing scalable 5G network solutions [8]

Radisys: Radisys has been active in the OpenRAN space. More recently, Radisys has successfully demonstrated a RAN slicing showcase involving different traffic streams with different latency requirements on a single RU connected to multiple CUs/DUs in a disaggregated network topology. The technology will become a key enabler in applications that require high data speeds and throughput, yet maintaining low latency, for use cases such as augmented reality, IoT driven connectivity and critical services.

Samsung: Samsung is an active member of the Open RAN community, participating in large-scale deployment tests, conferences and most recently, commercialising a new carrier-grade, fully virtualised 5G RAN solution. Samsung has recently announced a successful collaboration with AT&T to demonstrate an open-interface approach to delivering 5G deployments. The solution leverages on the enhanced Common Public Radio Interface (eCPRI), which is the fronthaul protocol being exploited by the O-RAN alliance.

Conclusions

Empowered by the principles of intelligence and openness, the OpenRAN ecosystem is the foundation for building the virtualized RAN on open hardware and software, with embedded AI-powered radio control. Inspired by the O-RAN alliance, the OpenRAN infrastructure combined with increasing RAN virtualization and data-driven intelligence, will allow complexity reduction, faster innovation and significant reduction on deployment and operational cost.
This report details the OpenRAN platforms available on the market from various vendors, highlighting their advantageous features alongside with their missing elements and weaknesses. Furthermore, the association to the Neutral Host paradigm is also presented in terms of the platform ability to provide NH deployments in a flexible and efficient manner.

The report begins by emphasizing the importance of OpenRAN platforms aligned to ORAN alliance features, especially when it comes to end to end NH deployments. Thereafter, OpenRAN platforms from companies such as AirSpan, Mavenir, Parallel Wireless and Acceleran are described in detail. More specifically the focus relates to the disaggregation, AI and RIC, service management orchestration and multi-PLMN NH capabilities of each platform.

Next, additional vendors related to radio virtualization and intelligence are presented such as Intel, Nokia, Samsung, Radisys and Altiostar. The ultimate scope of this analysis is the selection of the most suitable platform that will be utilized in the current project as well as at a possible continuation of the existing project, targeting integration of OpenRAN and NH and moving towards 5G and beyond as well as 6G technologies.

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