ORAN, The Future Of Wireless Architectures

A Technical Paper prepared for SCTE by

Bill Beesley, Principal Solutions Architect, Fujitsu
2801 Telecom Parkway
Richardson, TX 75082
bill.beesley@fujitsu.com
972.479.2098

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1. Abstract

As MSOs continue to transform their networks to be more wireless centric, many are considering the architectural map provided by the Telecom Infrastructure Project's Open Radio Access Network or ORAN project. ORAN has defined a set of open interface specifications that allow vendor neutral disaggregation of the radio access network software and hardware that delivers increased flexibility, via best of breed vendor options and eliminates the issues of vendor lock in that currently burden the wireless infrastructure ecosystem. This paper will outline what ORAN is and how it can be implemented in an operationally sustainable fashion sharing examples from existing operator implementations. The paper will provide how MSOs can and should use an ORAN architecture to increase flexibility in vendor selection, take advantage of virtualization and containerization of software, provide innovation via adoption of new technologies and maximize supply chain diversity

2. Introduction

When Alexander Graham Bell (or Elisha Gray depending on which side of the historical fence you stand) created the first telephone in 1876, it took another 75 years for the telephone to reach 50 million users. Television, which started broadcasting in 1929 took 33 years to reach 50 million users. The World Wide Web took only 4 years, and the popular app Pokemon Go only took 19 days to reach 50 million users. What we've seen happen over the last 100 years is that the pace at which people adopt technologies has accelerated astronomically. Much of this increased pace is arguably because of the Internet, which hit 50 million users in 7 years, itself a technology evolved on the telephone lines created by Bell. It is hard to imagine what Bell would think of what his invention has evolved into and even harder to imagine he would have believed that most of that evolution has happened in the last ten years.

Transport networks have also had to evolve to keep up with the expectations of users. Network function virtualization has increased the agility of networks, made them more programable and adaptable, and ultimately made them less expensive to own and operate. Open optics, open line systems, open ROADM, DOCSIS, and other open standards work has further allowed innovations in networks. Globally, ORAN is beginning to bring these same evolutions to the wireless mobility ecosystem. ORAN is allowing operators to evolve their networks to be more flexible, capable and agile. But here in the US, there is still much skepticism on the viability of ORAN, even among operators who are currently creating greenfield networks and are not constrained with having to own and operate an existing closed ecosystem.

3. What is ORAN

Generally speaking, ORAN represents efforts to standardize the radio access network by disaggregating the hardware from the control software and defining standard interfaces to allow a multi-vendor network ecosystem. For the purposes of this paper, the author is intentionally conflating the work being led by two groups into a single term, "ORAN. The first is the O-RAN Alliance and the Telecom Infrastructure Project's OpenRAN working group. O-RAN with the hyphen is an alliance founded in 2018 by AT&T, China Mobile, Deutsche Telekom, NTT DOCOMO, and Orange with a mission to reshape the RAN industry towards more open and competitive ecosystem. Next is TIP's OpenRAN program comprised of both suppliers and operators who collaborate to create open, multi-vendor interoperable products. Traditionally, radio access networks or RANs were closed ecosystems, often with all the necessary equipment and management and control software coming from a single vendor.

The most recent version O-RAN architecture specifications divide the RAN into the radio side, and the management side. On the management side, there is the service management and orchestration components as well as the Non-Real time RAN Intelligent Controller (RIC) which is primarily responsible for high level intent-based control and optimization of RAN resources. The non-real time RIC is analogous to a traditional element management system providing element visibility, high level management and reporting. On the radio side, the near-real time RIC is responsible for supporting more granular control and data, generally via microapps delivering functions such as anomaly detection and mitigation The radio side also defines the radio unit (RU) providing RF interfaces and protocols, the centralized unit (CU) supporting higher layers of the stack (eg SDAP, PDCP, and RRC) and the distributed unit (DU) supporting the lower layers (eg RLC, MAC, and PHY). These abstracted elements can be delivered by either a single supplier or the operator can select to obtain these from multiple suppliers.

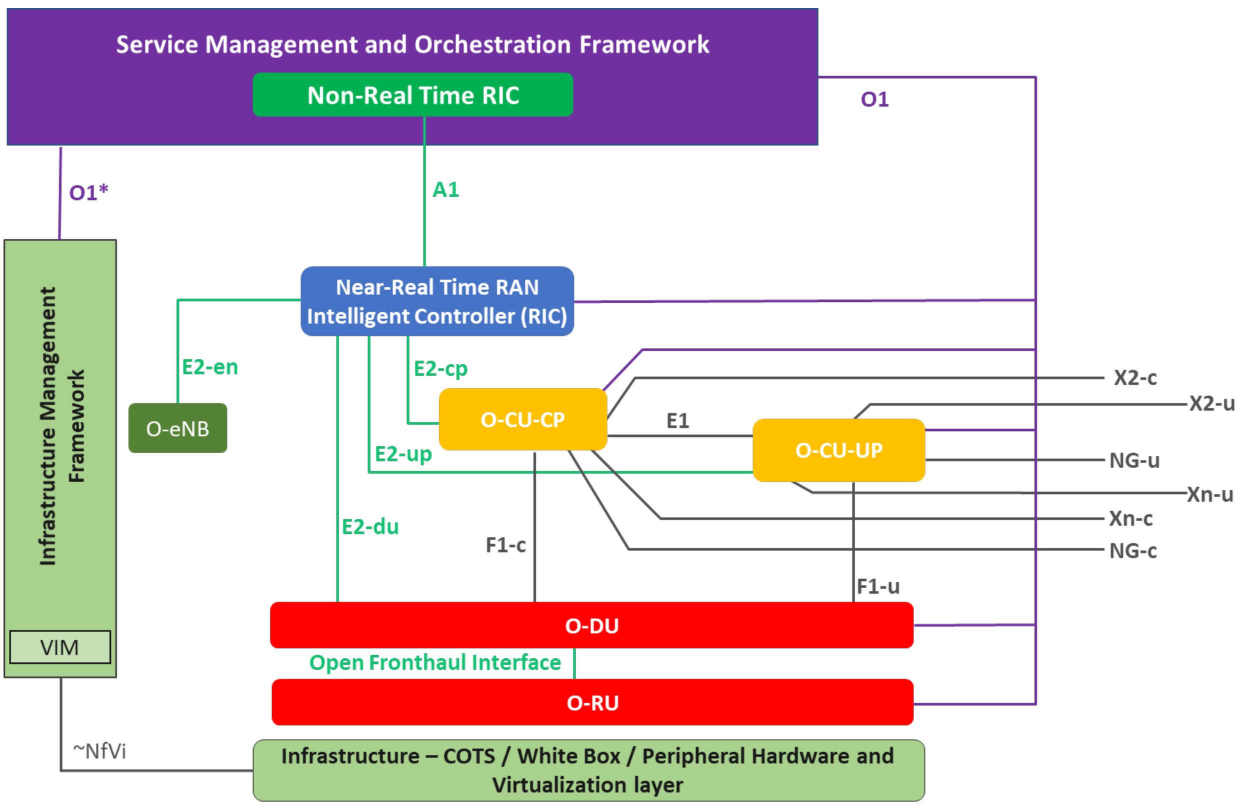

Figure 1 - O-RAN Alliance Logical Architecture

4. Arguments against ORAN

Historically, open systems such as the original IBM PC, DOCSIS, Open ROADM, and others have driven down costs to own and operate their respective technologies, but more importantly they spurred innovations in those industries that allowed the original use cases to grow. So, why would anyone be resistant to ORAN? Frankly, there are very valid concerns about how ORAN changes how wireless networks are built and operated. The current 4G and 5G technology that allows us to have near ubiquitous access to communications and information are very complex systems with a lot of moving parts that must operate in a consistent and coordinated manner. Operators who are skeptical of ORAN generally have two reasons as to why they are resistant to the new paradigm. The first is supply chain simplicity. We often hear this phrased as "one throat to choke". By having a single vendor ecosystem, there are fewer components to manage in the network. There is one company to call on for support, technicians have fewer systems to be trained for, and warehousing of equipment for deployments or spares is simpler. The second argument builds upon the first, closed ecosystems are more fully integrated whereas ORAN aside from TIPs interop lab work has little integration. There is a valid concern among operators that they will be left with total responsibility to integrate systems from multiple vendors and if problems arise, will be left in between suppliers who are pointing their fingers at each other. There is also the obvious concern that integration in a network does not happen just one time. Over the life of the network, as elements are updated and patched, this integration may have to happen multiple times. Thus, they take what is perceived as the less risky approach of selecting a vendor to supply most if not all the components necessary to build their radio network on the premise that vendor will be the "only throat to choke" to ensure systems are fully integrated, secure and operate as envisioned. Most of these operators are taking a "wait and see" attitude towards ORAN and opting to continue deploying traditional closed ecosystem networks. Recognizing the very valid concerns of operators who must manage and maintain networks at scale, the remainder of this paper will show how these concerns can be managed as well as a number of reasons why the risk in moving to the new paradigm is worth the benefits gained.

5. Supply chain advantages

The counter argument to the supply chain simplicity argument is one of supply chain integrity. Diversity of suppliers lowers the risk to your operations and gives you more flexibility. The current pandemic has brought us far too many stories of multiple supply chain disruptions. Historically events like natural disasters, disease, and even industrial accidents have caused supply disruptions of one kind or another. The telecommunications industry is currently experiencing supply shortages that are creating component lead times that may have traditionally been days or weeks to currently running into years. To mitigate this and ensure their networks can continue to grow and maintain the pace of demand mentioned earlier in this paper, operators are having to risk buy equipment that they won't receive until months or a year or more later or risk disrupting business growth. ORAN allows for vendor diversity that de-risks supply chain disruptions by allowing the operator to select alternate vendors should their primary supplier not be able to deliver.

Selecting a single vendor for your network also constrains your ability to deliver new features or capabilities as they become available in the market. With a single supplier you are limited by their roadmap and their view of what technologies are important to bring to market and when. With an open ecosystem of suppliers, you are not locked into a single vendor's vision of the network. When innovations become available, if another supplier brings them to market first you can take advantage of the innovation because you are not locked in. Open systems allow innovations to come to market and begin delivering value to your network and your customers faster.

Lastly, it is very difficult to imagine that any single vendor is going to be the best at everything that makes up a network as complex as the modern RAN. Having an open ecosystem allows you to select best of breed suppliers and make fewer compromises in your network.

6. Systems integration

While it is generally true that ORAN presents new integration challenges, it is not entirely true to suggest that if an operator elects to go with an open network, they are forced to take on all the integration challenges themselves. First, there is nothing stopping an operator from deploying an open ecosystem in partnership with a single supplier who takes on all the integration responsibilities. This is a bit like the old adage, eating your cake and having it too. By having a single supplier responsible for the final solution, the operator takes on less effort and risk themselves while still allowing them to add in alternative technologies and products in the future should they decide to shift. Having the flexibility to pivot at some point in the future in this way is extremely difficult with vendor specific systems.

Operators can also take advantage of the work that TIP has been doing to create the OpenRAN Exchange which is designed to accelerate the creation of an ORAN ecosystem. The marketplace has a wide list of suppliers of RU, CU/DU, transport, software, consulting services and other components that have been demonstrated to provide best of breed technology and interoperability that is the promise of ORAN. More information can be found on their website listed in the references at the end of this paper.

Much of the concern of solutions integration for ORAN are essentially based on the fear of the unknown and operators are apprehensive about being able to not just deploy a service once, but ensuring the ability to consistently deliver a service in a repeatable manner thousands of times. Fortunately, wide industry support for deploying ORAN is available and growing daily.

7. ORAN and Security

There is a lot of back and forth over whether closed or open ecosystems are more or less secure. Generally speaking, the most adopted and popular systems, closed or open will tend to get the most attention of bad actors attempting to exploit flaws and gain access. It is also important to remember that if you are depending on a closed system being more secure because the internals are less widely known, there is an old adage that obscurity is not security. The advantage that open systems have over closed is the sharing of information about faults and exploits is much faster and much more transparent. Issues tend to be identified and brought to community awareness more quickly. There is also much more flexibility in developing workarounds more quickly and the operator often does not need to wait for one to be delivered as they have the option of implementing their own. Lastly, bugs and other security issues tend to get resolved faster in open systems because there are more developers contributing. A community of five thousand developers can outpace a company who may have as few as five developers working on a project.

8. Network Agility

As mentioned earlier in the paper, modern telecommunication networks must consistently evolve to meet the ever-increasing demands users bring. What Bell started as a communications network has evolved to become an information and content delivery system that even just a few short years ago was unimaginable. Emerging use cases for the RAN such as Industry 4.0, IoT, gaming, autonomous vehicles, AI/ML, augmented reality and others require not only increased bandwidth and lower latency, they also require networks that are adaptable and agile. The modern radio network will need to be envisioned as software that can be automated and programmable.

In addition to this, to achieve the latency and bandwidth promises of 5G, orders of magnitude more radios will need to be deployed so that the serving groups can have smaller numbers of users. Much like fiber deep technologies like Remote PHY are delivering making more bandwidth available per subscriber, highly distributed antenna architectures will soon become the norm. One major MSO has publicly shared at trade conferences a vision of a radio network that is not the traditional large macro cell towers but thousands upon thousands of small strand-mounted radios deployed deep into the neighborhoods.

While closed ecosystem networks can support all of the above 5G features, having the most flexible, agile network will become a competitive necessity to support them. Open systems are much more adaptable, agile and flexible.

9. Opportunities for new revenue

Admittedly, the concerns raised over migrating to an ORAN architecture are valid even if they use appeal to possibility or fear of the unknown as their basis. We can't blame operations executives and their teams for being hesitant to dive into the unknown, especially when they are the ones held accountable should the network or systems not operate in a consistent and reliable manner. As a NOC expert friend of mine used to quip, "there are no optimists in Operations".

But the industry has successfully implemented open architectures in other areas of the network – DOCSIS is one example that comes to mind – and these implementations not only saved the industry both expense in purchasing the network and operating it, they drover further innovations that created new revenue streams.

Ultimately this is where ORAN will provide the biggest benefit to our industry. It supports an open and agile network that allows for innovations to bring new revenue opportunities to the network more quickly.

One of the most intriguing new service offerings that operators are expressing interest in is E5G or enterprise 5G. This is the delivery of private 5G networks, primarily to large enterprise and heavy industry to support use cases such as deterministic band for IoT and sensors in manufacturing, deterministic low latency/high bandwidth networks to support autonomous vehicles for industries such as mining, and the ability to slice out private networks so that mobility devices can access local network resources in a secure and reliable manner. Again, as stated 5G deployments can be accomplished with closed ecosystem networks but to provide competitive offerings that take advantage of 5G technologies such as network slicing, function virtualization and programmability, ORAN provides a clear differentiator. To be competitive in the emerging E5G space, operators will need to offer highly flexible and tailored offerings as no two enterprise networks have the same internal requirements. By selecting an open architecture, operators will be able to create offerings that appeal to the small to medium enterprise sweet spot that makes up 92% of the businesses in the United States and where the MSOs have been wildly successful in the past. ORAN will allow the operator to create highly adaptable offerings while minimizing capital and operating costs, especially for the edge radio and EPC functions as there will be more down-scalable products that minimize the cost to deploy.

Finally, it seems appropriate to give a mention to another upcoming open specification known as SCTE GAP. GAP is a working group that has created a standard set of mechanical specifications for outdoor equipment that allows for component reuse and the creation of a supplier ecosystem that will drive down costs and increase innovation much like the IBM PC standard did. As of the time of the writing of this paper, the final draft of the GAP spec is undergoing the final voting and comment process at the SCTE and should be finalized by the time this paper is published. What is innovative about GAP is that the service delivery modules can be mixed and matched to support multiple use cases at the edge. This means a GAP deployment could contain a cable modem module for transport, a CBRS small cell module and a compute module to push virtualized compute resources right to the subscriber edge. This opens up a number of use cases such as the aforementioned E5G. IoT for smart cities, edge gaming, or even offering real-time access to the radio network through slicing and virtualization. This would allow the MSOs to offer access to highly distributed radio and compute resources to provide something similar to an MVNO offering but with a much higher degree of granularity and flexibility. It is not hard to imagine that given enough time to deploy thousands and thousands of distributed radios in the MSO network, which already has space, power and transport to the edge, that at some point in the future a cable operator could become a dominant wireless provider in the areas they serve. But using legacy closed systems won't create the next generation network that can support this vision.

10. Conclusions

As previously stated, ORAN doesn't mean that the operator has to become the wireless system integrator managing multiple supplier relationships and taking on all the risk for issues that arise. MSOs can select single suppliers to either provide a fully integrated ORAN solution or they can work with ecosystem suppliers that are emerging via working bodies such as TIP to build, deploy and maintain their infrastructure. What is important to remember is that ORAN means flexibility. Flexibility in defining what capabilities you want to have in your network. Flexibility to select best of breed suppliers, whether now or at some point in the future. And ultimately, ORAN provides the type of agile and programmable network that will be a competitive differentiator in our 5G IoT world

11. Abbreviations and Definitions

11.1. Abbreviations

5G	Fifth generation
AI/ML	Artificial intelligence/machine learning
CU	Central unit
DOCSIS	Data over cable service interface specifications
DU	Distributed unit
E5G	Enterprise 5G
GAP	Generic Access Platform
IoT	Internet of things
MSO	Multi service operator
MVNO	Mobile virtual network operator
NOC	Network operations center
ORAN	Open Radio Access Network
PC	Personal computer
PHY	Physical layer
RAN	Radio access network
ROADM	Reconfigurable optical add drop multiplexer
RU	Radio unit
SCTE	Society of Cable Telecommunications Engineers
TIP	Telecom Infrastructure Project
US	United States

11.2. Definitions

Network slicing	A network architecture that enables the multiplexing of virtualized and independent logical networks on the same physical network infrastructure
5G	Fifth generation network technology standard for broadband cellular networks
Industry 4.0	Fourth industrial revolution
Open line system	Optical line system allowing vendor interoperability
Open ROADM	Interoperability specifications for ROADMs
O-RAN Alliance	Alliance between wireless operators to shape open RAN standards

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