WHITEPAPER

RIC and roll: how to unlock the true value of O-RAN

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Published by
MOBILE WORLD LIVE

Executive summary

The evolution of wireless networks to ever faster speeds and the shift to a world where everything that can be connected will be – from cars and coffee makers to cows and crops – is intersecting with concerns over a network supply chain that is under-competitive, proprietary, and subject to geopolitical pressures. The telecoms industry is meeting this challenge by opening the radio access network (RAN).

Open RAN also brings efficiencies and cost reductions by decoupling hardware and software. This enables service providers to adopt cloud-native computing, better harnessing the wealth of data from the RAN with AI-powered analytics tools and reduced power consumption to both control costs and meet carbon neutrality targets.

There are many players and many interests at stake, and no clear view of how it might turn out. But if history is anything to go by, opening the RAN may not go the way we expect. The telecoms sector has seen “open” revolutions come and go, and they tend to result in new technologies that vendors use to lock-in their customers even more tightly.

Complicating things further is the fact that while operators want openness, they don't want openness to the point of creating a chaotic, disorderly market. Telecoms networks are complex enough as it is, and there’s a real fear that Open RAN could result in even more complexity as well as lock-in to systems integrators (SI) or cloud platforms.

But it doesn't have to be that way – and the solution lies in focusing on using a well specified Open RAN variant, known as O-RAN, to build intelligent control into the RAN. The RAN Intelligent Controller (RIC) plays a crucial role in transforming the network and empowering operators to create and monetise distinctive service propositions.

In other words, it’s the RIC that can unlock the true value of the “open” proposition of O-RAN.

O-RAN reality check

Mobile operators have been pushing for the opening of the RAN for roughly two decades – primarily because they want a more competitive vendor landscape. A big reason for that is to bring prices down, an ambition which has been amplified by at least two recent developments:

1. The rise of 5G, which requires the installation of hundreds of thousands of small cells (as well as the associated backhaul and mobile edge computing infrastructure) in dense urban areas and the use of millimeter-wave bands to enable throughput speeds up to 10 Gb/s.

2. Recent geopolitical tensions between the US and China, which for a number of markets has taken Huawei and ZTE off the list of possible suppliers, leaving only Nokia and Ericsson as the primary options for one-stop shops.

Service providers are also keen to leverage lower-cost and more readily available cloud-native computing approaches, and to harness the wealth of data from the RAN and process it with modern AI tools – all of which require unprecedented openness. On a strategic level, some service providers also like the idea of taking advantage of cloud-native platforms to develop their own software to differentiate their offerings and improve customer loyalty.

At heart, O-RAN is a challenge to the status quo of network buildouts and promises to deliver the competitive market service providers want by breaking the vendor lock-in cycle and enabling them to put together a best-of-breed multivendor network. This in turn will spur innovation from plucky start-ups with fresh, out of the box ideas on what kinds of services an open network could enable.

Only we've heard this before with initiatives like the Open Base Station Architecture Initiative (OBSAI) and Common Protocol for Radio Interface (CPRI) – which kicked off their work in 2002 and had similar ambitions. In reality, OBSAI and CPRI fragmented the market and had limited impact because while the hardware interfaces were open, the operation and management (O&M) protocols were not.

O-RAN goes further than OBSAI and CPRI did by disaggregating hardware from software, allowing core RAN functions such as baseband processing, quality of service (QoS) management, handover control and load balancing to be virtualized, which allows them to run on any hardware that supports O-RAN standards.

Only that doesn't seem to be happening – at least not yet.

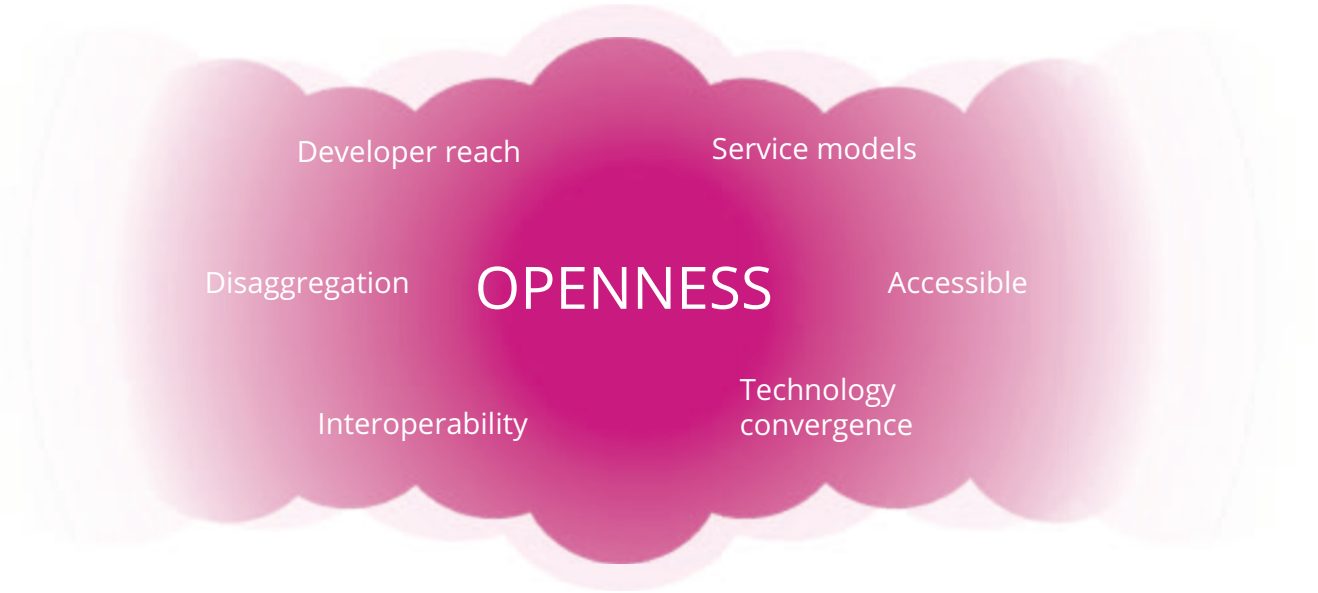


Figure 1 - Industry expectations on Open RAN

O-RAN promises much, but has a lot to prove. O-RAN can't just mean cheaper gear – it has to deliver equivalent or superior quality of experience (QoE) compared to existing vertical solutions. And it can't simply decouple software from hardware or open an individual interface – O-RAN must create a genuinely open and innovative software vendor ecosystem. No one wants an alternative ecosystem with the same shortcomings as the existing one.

Unfortunately, that's the current reality – for now, at least. O-RAN vendors are selling turnkey systems using virtualized platforms that amount to the same old vendor lock-in. The reasons are easy to understand – vendors are throwing a lot of R&D budget at this, and the only way to recoup that investment is to secure market share.

Ironically, service providers are partially complicit in this, because – as we will discuss in detail in the next section – the O-RAN paradigm is perhaps too disruptive. The economic and technological pressures that drive the need for openness are real, but they also bring disorder. For all its faults, the current RAN vendor landscape is easy to navigate and control. And there's comfort in pre-integrated solutions because performance is comparatively easy to predict, and there's only one number to call if something doesn't work. True Open RAN is a ticket to network entropy.

In this sense, service providers are caught in what looks like a Catch-22. They want a small number of vendors, simple points of control, predictable performance, and clarity of ownership – but they also want it at an affordable price. The catch, it seems, is that proprietary solutions and open solutions can offer one or the other but not both.

The thing is, it doesn't have to be this way. Service providers can have it both ways – and the key to this already exists in the O-RAN specifications.

O-RAN challenges

One key reason that service providers are pursuing the model of virtualized functionality and cloud-native platforms is because hyperscalers have already proven that it works.

Indeed, it's somewhat ironic that the hyperscalers, who have successfully exploited network connectivity to create the OTT services that beat service providers to the online consumer services dollar, have also given them a demonstrably workable strategy to reduce costs. By shifting value from hardware to software and thus commoditizing hardware, hyperscalers have shown how cloud technologies have the potential to assist service providers to modernize their networks.

And not a moment too soon, as 5G has emerged with its high capex requirements in the form of things like small cells, massive MIMO antennas and power requirements.

Ever since the first 4G networks went live, mobile network operators (MNOs) and vendors alike have talked up the importance of network performance as a competitive differentiator in terms of QoS, which has now shifted to a focus on QoE. This will be even more the case with 5G – not just because of its faster throughputs and lower latencies, but also because of the advanced data-driven digital services that connectivity enables. Remember that 5G is rolling out at a time when more aspects of our daily lives are moving online, from streaming services to healthcare and more. 5G is merging with cloud, digital services and AI to create a digital economy that aims to mirror the real world as much as possible.

That's a data-intensive model. With new transformational opportunities such as Web 3.0, the metaverse and decentralized business emerging, network performance and resiliency will be more important than ever to deliver the QoE required to make the real world and its digital twin as seamless as possible

Drivers of chaos

The open-source community now has a serious opportunity to break open the existing oligopoly by leveraging the shift to virtualized

software and enabling specialist vendors to enter the ecosystem with specific microservice-based functionalities.

The problem for O-RAN players is that when you go into a market as a cheap alternative, your prices can only go down from there, which means profitability can only be achieved by scale. Emerging O-RAN vendors have attempted to address this by producing what are ostensibly locked-in vertical solutions similar to those in the existing ecosystem.

Open systems are distributed systems, and therefore complex systems, which raises issues of interoperability, orchestration and management that go above and beyond what traditional networks have to deal with. Service providers will either have to take responsibility for systems integration and hence the resulting QoE, or outsource this to an SI.

There are other complexity factors such as the complex makeup of the ecosystem itself. Early players like Samsung, Mavenir, Parallel, Altiostar, Affirmed Networks and Rakuten Symphony have different backgrounds and different business objectives. Hyperscalers have also entered the picture, leveraging their cloud infrastructure to offer high-level telecoms applications as a service to MNOs.

All of this adds up to increasing network entropy, a large and unruly ecosystem of suppliers competing with each other, and no prime integrator to take responsibility for it all. It also means being stuck in the current business model of overprovisioning capacity to meet performance requirements that dominate both telecoms and cloud ecosystems – which is cost-intensive and power-hungry, and thus unsustainable in the long run.

It's all about the RIC

The key component that can address these challenges is the RAN Intelligent Controller (RIC), a software-defined component of the O-RAN architecture that's responsible for controlling and optimizing the RAN.

The RIC can serve as a vendor-agnostic prime virtual SI, harmonising and integrating resource management across the O-RAN components to allow for a holistic and simplified RAN network management. The RIC has access to data from across and outside of the network and applications, and together with OAM systems and service assurance, use that data to enable insights and thus automate management of the RAN that has not been possible before.

RIC and roll

To better understand the importance of the RIC in the O-RAN, it's helpful to start by looking at its components. The RIC is equipped with the facilities and means to provide the common functions and resources that support applications, and also allow all participants in the business model to cooperate through interfaces and data.

The RIC is part of the O-RAN architecture, and includes network automation tools called xApps and rApps that maximize the radio network's operational efficiency.

The RIC sits in two different places in the architecture – a non-real-time RIC sits at the orchestration and automation layer to handle the rApps which look at trends and overall performance, while a near-real-time RIC sits at the application layer to handle the xApps and work with policy and decision making.

The RIC doesn't just enable intelligent control of the RAN – it also enables the creation and operation of new applications and businesses around the RAN. This means it's possible to build a strategy around the RIC's capabilities that's similar to strategies for digital platforms.

RIC commercial platform strategies

On the commercial side, the RIC brings together providers and consumers. The consumers in this case are the service providers' customers, with the network serving as a proxy. The providers are the applications providers and the applications themselves. In this model, the purpose of the RIC platform is to act as a pivot point and (if all goes well) achieve the 'network effect' – more customers are attracted to the network because of the benefits from the attractive apps from the RIC, while more app providers are attracted by the rising numbers of customers using the network.

For this to succeed, the benefits of the two sided model have to be observable to the customer. In other words the customer has to notice the difference in QoE enabled by the ingenuity of the app providers for the network effect to kick in. The more apparent the impact then the more powerful the network effect.

One of the most promising aspects of opening up the RAN is the ability to invite software innovation not only from outside the operator, but outside the mobile industry entirely. A consistent 5G axiom has been that – like 4G before it – the 'killer apps' will likely be things no one is thinking about today, and will likely come from non-telecoms companies

Important components of the RIC platform include:

- **Virtualized infrastructure**
- **Interfaces** – in particular, the E2 interface which connects the near-real-time RIC to the RAN and over which large amounts of network telemetry data will be made available to the applications
- **Data and information management** – a data mesh that manages structured and unstructured data, and provides the data that will power the AI-based algorithms
- **APIs** – allow application developers to efficiently write applications for the RIC, and the SDKs to support offline development
- **Application run time environment** – for cloud-native techniques to build micro service-based apps and run in Kubernetes containers, as well as algorithms for AI-based applications
- **Tools and diagnostics**

O-RAN testbed used AI to accurately predict user perception

Cambridge Consultants has developed an O-RAN testbed to help its clients conduct R&D into the many opportunities for the RIC, including the exploration of novel use cases and custom 5G features through AI.

The testbed consists of a virtualized 5G standalone network that has been implemented with open-source components, such as open-air interface, to provide a system that can be modified, configured and upgraded. The testbed follows a standard O-RAN architecture and has a virtualised UE and simulated RF, enabling a variety of network conditions.

To explore potential applications of the RIC, Cambridge Consultants developed an xApp on the testbed that predicts the QoE of a video streaming application at the user equipment (UE) only using data available from the RAN centralized unit (CU) and distributed unit (DU). The aim is to expose the user perception of the performance of the application to other xApps which can optimise network performance KPIs.

The xApp leverages various control loops in the normal operation of the RAN, such as HARQ and Channel Quality Indication. The xApp makes predictions of the QoE at the UE in real-time, without direct information from the UE. This has many advantages:

- The video app is unchanged - there is no need to publish QoE data
- The RAN makes predictions from data it already has
- There are no additional control loops over the air

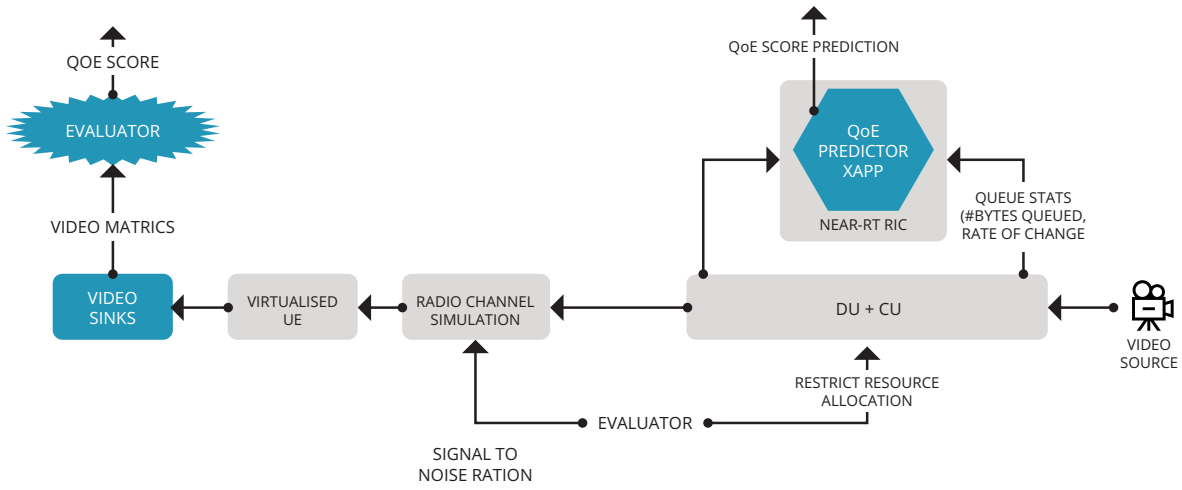


Figure 2 – Cambridge Consultants' O-RAN testbed UE quality of experience prediction

who find their own uses for 5G's core capabilities, from automotive, finance and entertainment firms to some kid in a garage who thinks up something totally outside the box.

Data analytics

Like with other application platforms, the "secret sauce" that gives the RIC its true value is data. RANs generate a lot of data, including hardware telemetry data, performance data, QoE data and application data. Base stations use that data to configure usage over their coverage area, optimize the aggregate performance over the coverage area, and optimize network planning. The RIC uses powerful analytics to harness data generated by current operations, historical performance data, data generated by xApps and rApps including both their meta data as well as the data generated by their results to improve network performance and QoE. In the next section, we'll show you how.

RIC benefits

Optimization and insights

The RIC can boost optimization and insights for O-RANs in a number of areas. The non-real-time RIC can interface with a wide range of services that are not available within the RAN, while the real-time RIC has access to the detail of a UE. For example, service providers often provide overcoverage of an area, either because the area is difficult to cover, or just poor planning (which is particularly true for private cellular networks). In these scenarios, the real-time RIC resolves issues of intercell interference by selecting which radio is used.

The RIC can also play a role in optimizing MIMO beamforming via an xApp reacting to data coming from the RAN. The decisions that have to be made in MIMO beamforming, such as direction and intensity, can be impacted by other information outside of the RAN data itself. An open RIC allows the building of a composite app that brings RAN data and external data together to influence those decisions.

For example, if beamforming is used to connect a drone in flight, in addition to the internal RAN and network data, the RIC could also incorporate external flight planning, mapping and weather information that would inform and direct the operation. In cases where beamforming is being conducted to achieve energy management for energy sustainability goals, data that informs consumption targets can also be used.

A further use case for the RIC's analytics capabilities is in predictive maintenance. Analytics of network telemetry data enable informed judgements on when corrective maintenance action is needed. The xApp provides feedback and makes recommendations to be applied to the real-world network.

Intent-based QoE

As the telecoms sector migrates towards intent-based networking – an automated AI-based approach to achieving prediction-based outcomes in the network – it's difficult to overstate the importance of the RIC in improving QoE. Going forward QoE is going to be perhaps the key differentiator for operators offering 5G-based services, potentially even giving the option to monetise the quality of data.

The RAN xApp analyses measurements from different parts of the network and in turn provides the input feed into the intent-based algorithms, which then provide feedback on the optimizations necessary to achieve the desired QoE KPIs.

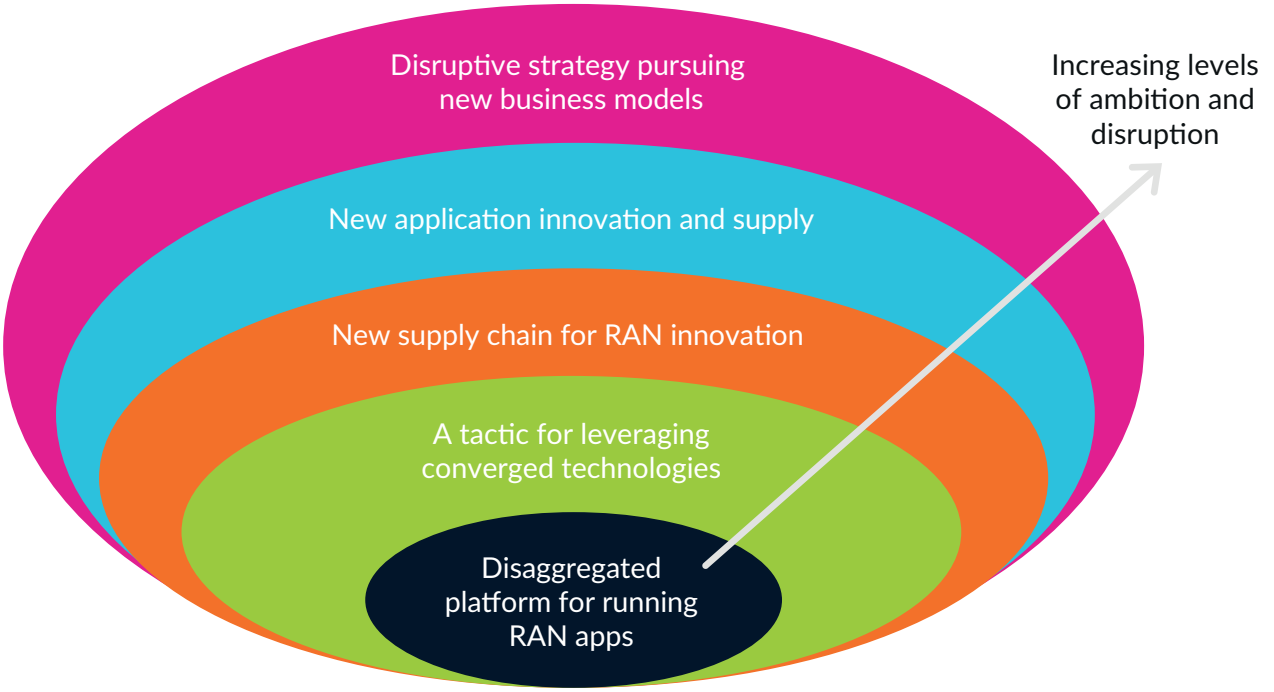
An easy yet important example is video services. Delivering maximum QoE for video requires minimal buffering at maximum available resolution. The challenge for the operator is to efficiently provide consistent service to the maximum number of users.

Currently the operator's best bet is to rely on fat data pipes to overcome the uncertainties of best-effort packet delivery – which might work for a limited number of users, but it's an inefficient way to do it.

The data that operators need to deliver maximum QoE for video is right there in the form of low-level network KPIs – these contain the information needed to determine what QoE each user is seeing on their video stream. The data can be extracted and processed to control what the data pipe does via the real-time RIC so that each user is using only the bandwidth they need.

Streaming video and livestreamed gaming are current examples where video QoE matters. The same principles will apply as AR/VR apps and services start to leverage 5G networks, especially as they are incorporated into the vision of the metaverse. QoE will be crucial to delivering the metaverse in whatever

Figure 3 - The RIC is at the heart of an evolving business ecosystem



form it eventually takes, and the RIC will be essential to that goal.

Security

The RIC can also play a role in improving network security – which is ironic, since one challenge to the O-RAN paradigm is that it makes security harder.

When the new interfaces and nodes that O-RAN adds to the network are combined with the additional complexity that comes from allowing applications from multiple vendors the potential for attack increases significantly. Meanwhile, the disaggregation of hardware and software reduces the integrity of hardware root of trust.

The open-source software environment will allow for rapid response to new threats as they arise. Furthermore, the RIC can identify individual devices in real-time and, together with external data (such as access policy, device type and location) it can detect anomalous behaviour and prevent devices accessing the network in unexpected ways. This can help reduce the threat from distributed IOT devices which represent one of the biggest attack surfaces in networks.

Unlocking the RIC's innovation potential

The RIC creates many opportunities for better optimization and efficiencies for both the network and the services that run on it, but perhaps the most interesting and exciting applications for the RIC – and O-RAN in general – are the ones we don't even know about yet.

The vision of O-RAN isn't just to make RANs cheaper by bringing in a little more competition – O-RAN also serves as a new source of inspiration by bringing new people, new business models and new tools into the RAN ecosystem.

The O-RAN model allows operators to apply advanced analytics such as AI to RAN data (and relevant external data) via the RIC. Operators can interrogate the data using AI and the associated algorithms, tools and skills to find new answers to both existing and new questions. The question might be a classic RAN question such as: what's the optimum point to conduct handover between nodes for a fast-moving vehicle? But it might also be a new question such as: how can I ensure the signal coverage map inside a hospital?

Meanwhile, new people outside the traditional telecoms space, such as cloud-native apps developers, will be able to write applications to control RAN behaviour. They will bring different perspectives and different client requirements that will bring new applications, be it a premium experience for eSports players, a VR app for the metaverse or a connected robot performing remote surgery.

Where to start

Greenfield and private networks

O-RAN is a relatively easy proposition for greenfield network deployments. Rakuten famously built its 4G network with Open RAN technology from day one. In India, Reliance Jio is waiting for 5G to introduce Open RAN, but having started at 4G, Jio may have a relatively easier time introducing Open RAN into the equation than any of its older competitors.

The other greenfield opportunity lies in private networks, which is a new twist on the cellular network paradigm. 5G vendors and operators alike see enterprises as a new customer segment as they tout 5G as an alternative to Wi-Fi in campus and industrial settings like factories, ports and hospitals.

That said, private networks have their own challenges, the most prominent one being that the "operator" has little or no telecoms-related expertise – this matters because deploying a Wi-Fi network isn't the same as deploying a cellular network.

Private O-RAN networks will need to be much simpler to plan, install and operate than is currently the case with cellular networks. Based on the cloud native principles familiar to enterprise IT departments the RIC could be helpful by providing functions such as site planning and location.

Enterprise environments are challenging from a cellular coverage and deployment perspective as they can include manufacturing floors, complex office buildings, shopping malls and underground environments. Data from the network can be exposed to the RIC and could help private operators predict coverage and traffic growth patterns, help select the best cell site locations to improve coverage planning and ensure improved performance and QoE. The RIC can also help predict traffic growth to ensure sufficient capacity planning for the future.

Brownfield deployments

For brownfield scenarios, O-RAN faces all kinds of challenges, not the least of which is a well-entrenched incumbent vendor(s) supporting legacy 3G and 4G equipment.

Incumbent vendors are hard to oust for a number of reasons: their gear has unique features the operator uses, sophisticated support organisations and complex business models such as managed services and capacity. Operators plan their equipment purchase cycles based on a depreciation period of up to 10 or 15 years, which means if they aren't buying O-RAN solutions today, they won't be buying any for quite some time.

So breaking into brownfield networks can be tricky, but it's not impossible. Opportunities include vendor underperformance, end of life of hardware platforms, end of depreciation lifetime, new architectures such as small cells, private networks or non-terrestrial networks, and of course new cellular technology generations… like 5G, say.

Most service providers have addressed these challenges by deploying more than one vendor in their networks in order to maintain at least a modicum of competition.

The immediate opportunities for O-RAN vendors in brownfield scenarios include overlay networks of new technologies, or a hardware replacement combined with the introduction of new technology.

Mindset shift

Whatever your starting point with O-RAN, an absolute, non-negotiable prerequisite is going to be a holistic transformation of the service provider.

This is the very essence of the digital transformation that many telecoms operators are either undergoing now or will be undergoing soon – the breaking down of silos, the resulting liberation of data, the streamlining and automation of processes across the organization, a DevOps approach (a combination of software development and IT operations to shorten development life cycles and improve quality), and ultimately intent-based networking that supports the planning and operations of networks as far as possible on the back of intelligent functionality.

This means that traditional ways of working in the telecoms industry with hard and fast processes for test, acceptance and preliminary deployment in which everything is approved and finalized before the software is finally rolled out will no longer be viable. This isn't how the digital world works – digital native apps developers have run circles around telcos, driving a huge new industry precisely because they don't wait for the app to be perfect.

Operators need to go the same way. To get the most out of O-RAN, they will have to embrace a DevOps and agile culture that streamlines software development and deploys software on a sprint-by-sprint basis, perhaps to a staging area initially for performance evaluation before being exposed to the wider network.

Conclusion

O-RAN heralds a paradigm shift that goes well beyond the actual RAN technology and the open architecture. O-RAN introduces a new and more innovative supply route into the telecoms ecosystem as 5G takes hold (including the private network opportunity).

While O-RAN is faced with the challenge of meeting the baseline requirements of cellular technology and offering a solution that performs as well, or better than, existing integrated solutions at a competitive cost, it has to offer value beyond the usual performance metrics to tackle the challenges of new applications, sustainability and more. And it has to do all of that without becoming a new iteration of the same vendor lock-in problem.

As we've seen, the RIC is the key that provides a unique opportunity for O-RAN to achieve these ambitions. It enables increased levels of innovation, simplifies the entry of a large number of small innovative specialist vendors and reduces the possibility of simply being locked into a new supplier.

The RIC can achieve this via the application of improved analytics to the wide range of data generated by networks. Meanwhile, basic O-RAN functionality will quickly become commoditized, which means the value and the higher level functionality will migrate to the RIC. As a focal point for data analytics, the RIC will be able to make the most of new technology areas such as AI/ML in order to extract the most value from network telemetry and other data available to it.

But again, it's not just a tech issue. The transition from a traditional vertically-integrated RAN ecosystem to an open O-RAN ecosystem will be (and indeed must be) accompanied by a transition from a siloed, single development organization to an agile DevOps ecosystem in which vendors can specialize on specific parts of the overall solution.

App developers will aim to maximise their addressable market – and thus their ability to gain operational experience – by working with several platform vendors to create a vibrant app marketplace. Meanwhile, platform vendors will have to cultivate ecosystems of app developers to provide them with innovative functionality.

That's a tall order – most disruptive paradigm shifts are. That means service providers are unlikely to let go of the rigid processes for product introduction that they have built up over the years. Service providers understand that they need to encourage a more dynamic DevOps culture that they may have to trade-off with lower service reliability, at least in the short term. On the other hand, if service providers do not release their reassuringly tight grip, O-RAN may not take off unless a middle way can be found that enables both innovation and quality.

Something has to give, because the status quo is unsustainable. With the right strategy and a little nerve, service providers have the opportunity to evolve with the times into something much different from today's operators. The networks of tomorrow may well be widely distributed networks of small edge data centre with a constantly evolving software platform extending and improving network performance and QoE. And it all starts with the RIC.

This paper was written in collaboration with Dr Derek Long, Head of Telecommunications (derek.long@cambridgeconsultants.com), and Martin Cookson, Director for Service Innovation (martin.cookson@cambridgeconsultants.com), Cambridge Consultants.

Continue the conversation

Cambridge Consultants has a proven record of strategic consultancy and technology development services in high performance wireless-based applications.

We have recently developed a virtualized 5G standalone O-RAN testbed, including AI-powered near-real-time and non-real-time RICs. Through this, we are helping clients develop the network infrastructure and applications for the next generation of digital services.

Our expertise in O-RAN is coupled with a deep understanding of the requirements across diverse industries and we hold direct experience of working on the next generation of terrestrial networks, satellite connectivity and high-altitude platforms.

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To continue the conversation, contact Derek Long, Head of Telecoms and Mobile, Cambridge Consultants
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