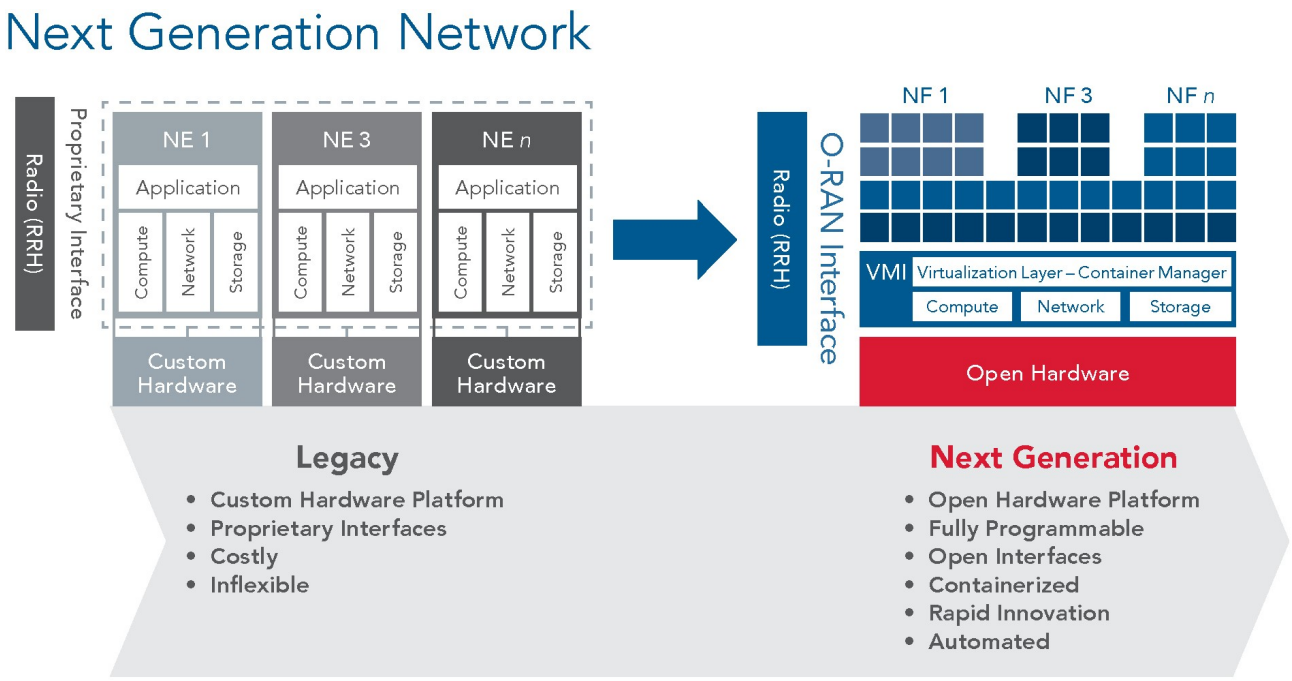
Without Automation, 5G Networks Will Not Achieve Profitability



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Next generation mobile networks will be unrecognizable from those of the 3G and 4G eras. Operators are laying the foundations for an unprecedented upheaval in their architectures and supporting organizational structures, as they move towards automated, cloud-native, programmable networks.

The scale of the migration towards the 'network of the future' requires very significant commercial justification. For many operators, learning lessons from the cloud industry will be a matter of survival as mobile data usage rises, but without a parallel rise in usage fees. In a survey of almost 80 mobile operators, conducted by Rethink Technology Research, two motivations dominated the return on investment case for migration to automated, open, cloud-based architectures – radical reduction in total cost of ownership (TCO), and high levels of adaptability, enabling them to adjust their network dynamically to address new services and revenue opportunities.

On average, operators in the survey are targeting TCO reduction of 35% over 6-7 years, plus the ability to address entirely new markets in enterprise and Internet of Things applications. The most important enabler, according to the survey, is end-to-end (E2E) automation, which is considered a top two critical success factor by 38% of operators.

However, the effects of automation will be maximized if other changes are also embraced in parallel. The most important, according to the respondents, are cloud-native architectures and multivendor interoperability, the latter enabled by open platforms such as OpenRAN, which can throw the mobile network supply chain wide open.

In the survey, almost 60% of respondents considered end-to-end open networks to be essential or desirable for the 5G era.

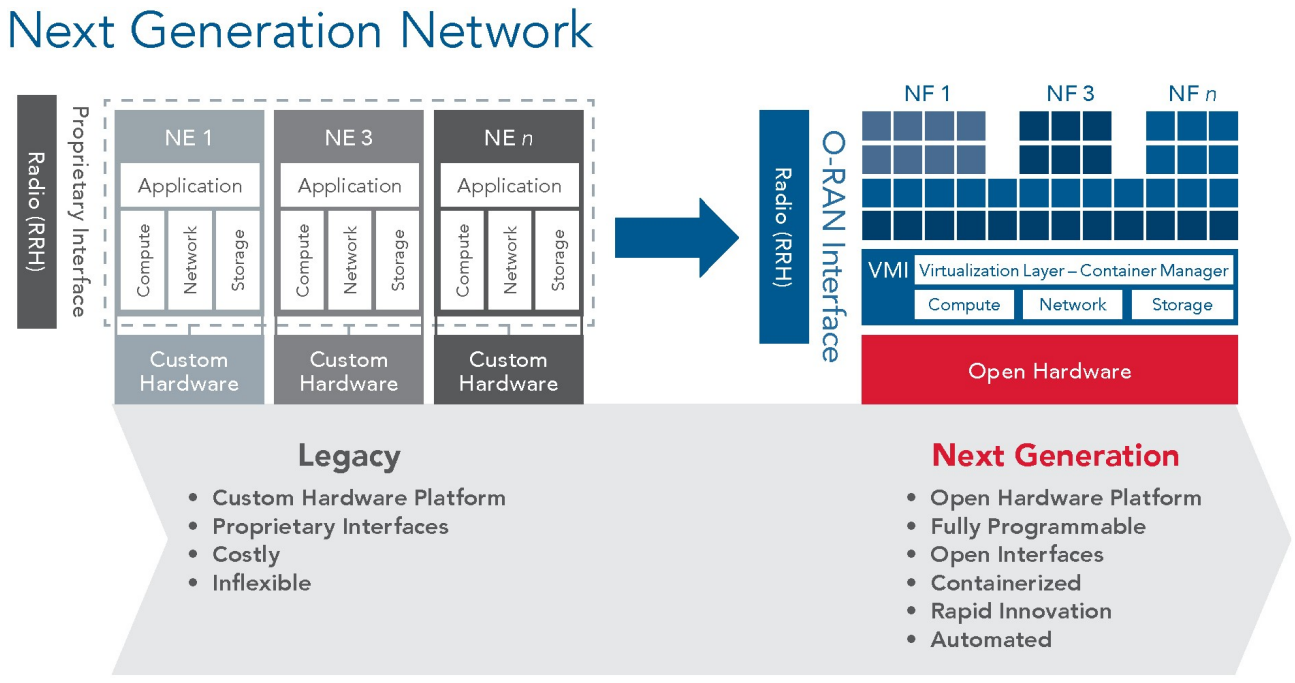
A key enabler of these open, automated networks – especially as operators deploy ever-larger numbers of cells and virtual network functions – will be machine learning. This will lend intelligence to the cloud platform's ability to scale resources up and down rapidly and automatically in response to changing requirements. The operators

surveyed for this white paper regarded AI/ML as second only to open interfaces as a key enabler of a fully automated network.

These drivers mean that operators are starting to plan their roadmaps towards future networks, which will be open, automated and virtualized (see below).

Of course, there are perceived risks in migrating towards these new open platforms, many relating to the organization upheaval that automation will entail, or to the immature nature of new cloud-native architectures. But operators increasingly recognize that the biggest risk lies in excessive caution, which would limit the impact of 5G on their services and costs and open the door to being overtaken by more agile competitors.

Figure 1.
The progression from traditional networks to the open, virtualized, multivendor network of the future



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Introduction

With this opportunity to cut costs by one-third and double the number of services supported, it is urgent for MNOs to start to initiate clear, step-by-step plans for automation, with clear timelines, now.

If 5G networks are to fulfil their promises and deliver a new set of network economics, they will have to be built and run very differently from previous ones. By the early 2020s, networks will be rolling out that are almost unrecognizable from current platforms. The Next Generation Networks (see Figure 1) are starting to emerge and they will be cloud-native, software-defined, highly programmable, automated and sliceable.

Those architectures are designed to transform the mobile business model in a host of ways. Most of these relate to two fundamentals – adaptability and cost transformation. The former will allow operators to deliver a huge variety of services, and tailor the user experience and the connectivity dynamically to each use case and even each user. The latter will enable them to deliver very high capacity for high bandwidth/ throughput, and support thousands of applications with very different network requirements, while transforming their total cost of ownership (TCO).

This is nothing less than a life or death situation for some operators. They face intense pressure on their traditional sources of revenue (mobile voice and broadband data), at the same time as an accelerated roadmap looks to invest in next generation networks. The economics will be unsustainable if current approaches remain unchanged, and this is already highlighted by the rising debt burdens of many large operators.

No surprise, then, that they are looking to the example of the webscale industry, to learn from the transformation of the enterprise based on cloud economics, virtualization and accompanying new business processes. Examples abound – across major enterprise categories, typical data center TCO savings have been over 55% in a three-year period

(Source: Gartner), which can deliver up to 20% reduction in total IT budget, while speed to deliver new processes can been accelerated by more than 75% (Source: KPMG/GE).

In a global survey of 78 Tier 1 mobile network operators (MNOs), conducted in October 2019, three objectives emerged as the dominant commercial goals for a 5G deployment. These were:

- Radical total cost of ownership (TCO) reduction. On average, operators in the survey were targeting TCO reduction of 11% in the first three years of a commercial 5G deployment, compared to the first three years of LTE. And with the introduction of the next phase of architectural changes - the 5G core, virtualized RAN and the sliceable network – they will target even greater TCO cuts, up to 35% over 6-7 years.

> WITH THE INTRODUCTION OF THE 5G CORE, VIRTUALIZED RAN AND THE SLICEABLE NETWORK, MNOS WILL TARGET EVEN GREATER TCO CUTS, UP TO 35% IN 6-7 YEARS.

- A transformed user experience for new and existing applications. This includes higher quality of service for challenging applications, such as virtual reality, for existing user bases; as well as the ability to support new user experiences related to new user groups, such as low latency response for emergency services.

- A fully flexible service platform to deliver a wide variety of use cases on-demand. Mobile broadband (MBB) will no longer suffice, for many operators, as the only core service. They will need to support large numbers of use cases for multiple industries, which may have very different requirements of coverage, latency, availability and power efficiency, compared to MBB. MBB is a minimum basic requirement. These use cases have the potential to support new revenue streams, in many cases with higher margins than consumer services, because these services may be business-critical. However, each use case, and each customer, will require connectivity that is optimized for their specific needs.

To deliver these goals, the two critical enablers, rated higher than any others by operators, are end-to-end automation, and open disaggregated platforms. In many scenarios, these two critical enablers will go hand-in-hand, working together to amplify the overall impact on the mobile business case.

Figure 2 shows the key strategies that the MNOs believe they will need to adopt, in order to achieve their goals.

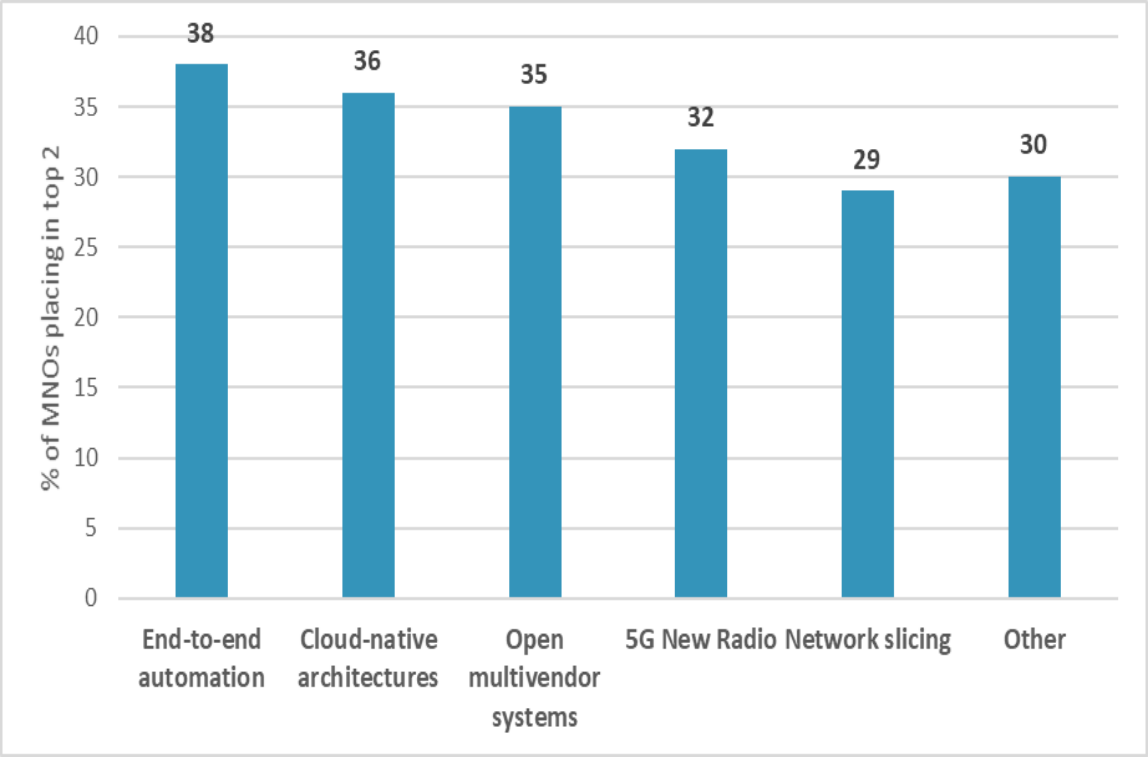
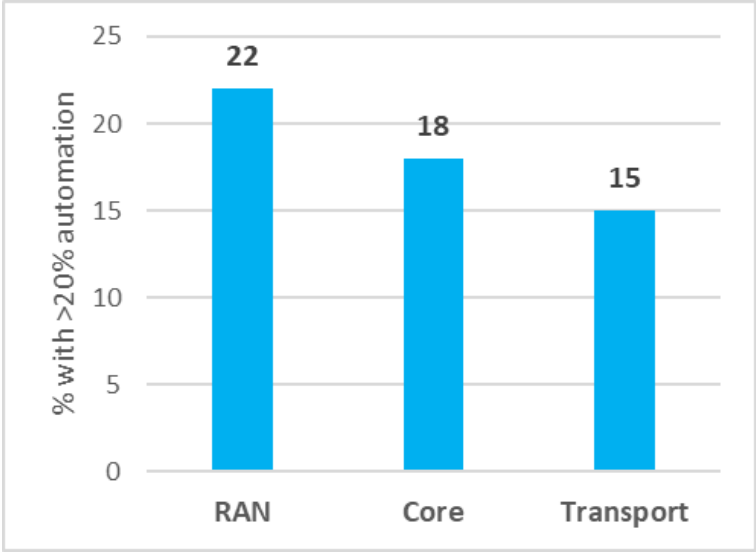


Figure 2. Key enablers of the commercial goals for a 5G network (% of respondents placing each factor in their top two).

NB. Respondents were first asked to list all the important enablers for them; from the 10 factors which were most commonly cited, they were then asked to select the top two.

Why is end-to-end automation urgent now?

Figure 3. Percentage of operators which claim to have automated at least 20% of processes, by network domain



Operators have been introducing automation into some aspects of their networks for several years but in most cases, this has been limited in its impact. For instance, some MNOs have implemented SON (self-organizing networking) with RET (remote electrical tilt) to automate the interaction and antenna tilt of their base stations. Applications such as power management and provisioning of new cells are done with limited manual intervention in some networks.

However, the effect on the network's cost and efficiency has not been dramatic because only selected functions are automated, while the majority remain manual. Figures 3 and 4 show the selective way in which most MNOs have automated network functions in conventional plat- forms. There is inconsistency in how automation is applied to different network domains (Figure 2), with a larger

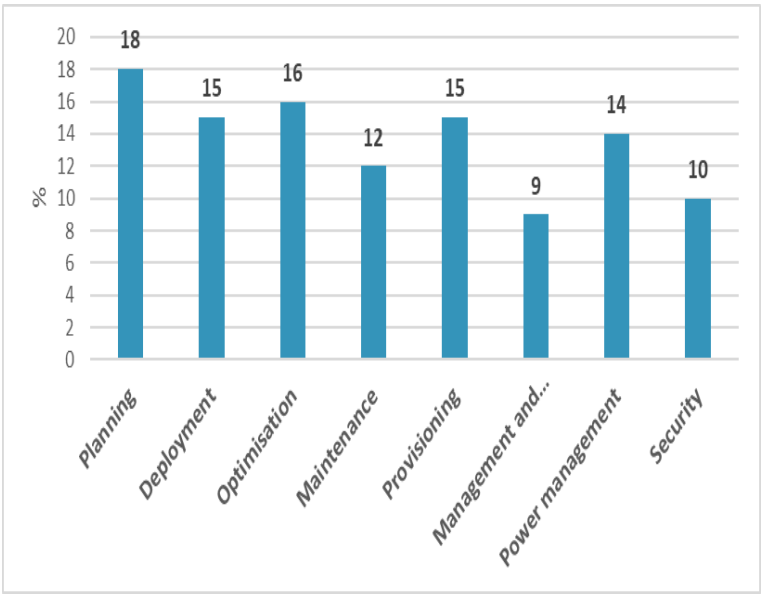


Figure 4. Percentage of operators which claim to have automated at least 20% of processes, by process

percentage of survey respondents saying they had automated at least 20% of processes in the RAN, than in core or transport.

Similarly, there is inconsistency in the network processes which have been automated, rather than a holistic view across all elements. In our survey (Figure 3), RAN planning and optimization were the functions where operators were most likely to have begun to automate, though even in these cases, fewer than 20% had done so.

In the 5G era, this scattergun approach will be ineffective in delivering operators' key goals of radical cost reduction, a transformed user experience, and a fully flexible services platform. Of course, these were objectives of the 4G network too, but the 5G business case requires them to be delivered on an unprecedented scale, which will be impossible without automation and openness.

Why? This is because a brand new architecture will be required to deliver a network that can support large numbers of use cases and industries, with very varied connectivity requirements. This will entail a huge number of physical and virtual elements. For instance:

- Some smart city and IoT applications will require ubiquitous coverage (even in areas like underground tunnels and car parks), which will entail a large number of cells

- Densification of the network will be necessary to enable very high capacity and data rates in areas of heavy usage such as transport hubs and business parks

- Many services will benefit from data processing close to the user, driving deployment of a distributed edge cloud network in parallel with the small cells

These trends mean that, with traditional architectures, densification will greatly outweigh the falling upfront costs of base stations, because of the number of elements to manage (Figure 5). Falling cost per base station site since 3G has always been cancelled out, in terms of TCO, by the number of sites required, so capex and opex have continued to rise. If networks are not automated and virtualized, the same will be true in 5G, which will

require more than 50 times more sites than 4G. In fact, continuing with conventional architectures will no longer be an option. They would make the economics of 5G - with its rising demands in terms of data traffic, resilience and security – entirely unsustainable.

In addition, to support a large number of different services on an on-demand basis, networks will have to be virtualized and, with the introduction of the 5G core, cloud-native and containerized. That will entail huge numbers of virtual network functions (VNFs), which will be scaled up and down according to traffic patterns, leading eventually to fully dynamic end-to-end network slicing. In a network where large numbers of functions are disaggregated, and microservices are rapidly changed via continuous delivery methods, human operators can no longer cope with collecting and analyzing network data and alarms.

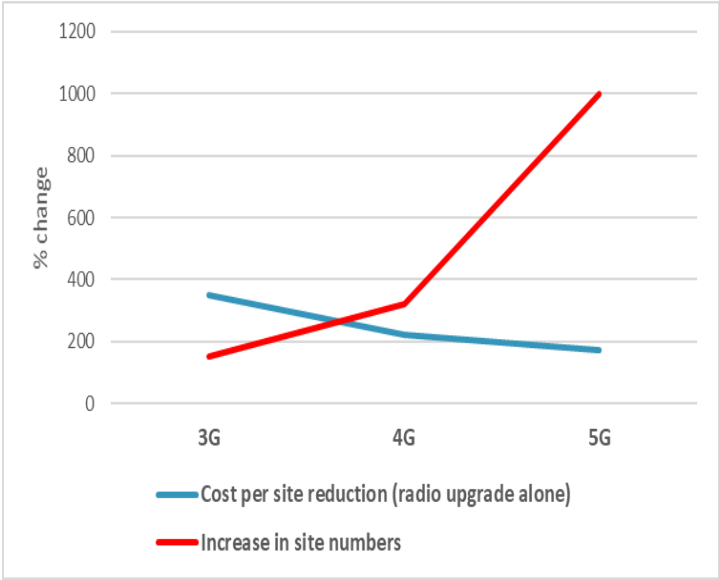


Figure 5. Percentage fall in cost per site from 3G to 5G (projected), compared with percentage increase in site numbers

These are examples of the high number of elements that will need to be deployed, optimized, scaled up and down, and orchestrated, dynamically and in near real-time, according to the needs of each application or even each end user. Clearly this cannot be done manually, and clearly, since all the functions are intertwined, automation will have to be applied to each one of them. Only in this way can operators achieve their goals of supporting transformed user experiences and a host of new services.

These architecture changes are making end-to-end automation essential rather than desirable, although it will be no small task to achieve it, as it will require significant change to operators'

organizational structure, processes and skills. MNOs were asked which architecture changes would drive them to invest significantly in network automation processes and tools, from testing to deployment to ongoing operations, in the first three years of a 5G deployment (Figure 6). The key concerns are:

- to start the evolution towards full zero-touch networking, with the associated savings in terms of personnel and other operational costs (55% said this was a top 2 issue)
- support for increasingly dense networks (52%).

Also in the top six drivers were:

- the aim to deploy network slicing in the medium term
- the impact of the 5G New Radio on network orchestration, especially with regards to large numbers of spectrum bands and antennas
- the rising levels of virtualization and the need to orchestrate huge numbers of VNFs
- the adoption of cloud-native RAN (though for most operators this is a longer term goal)

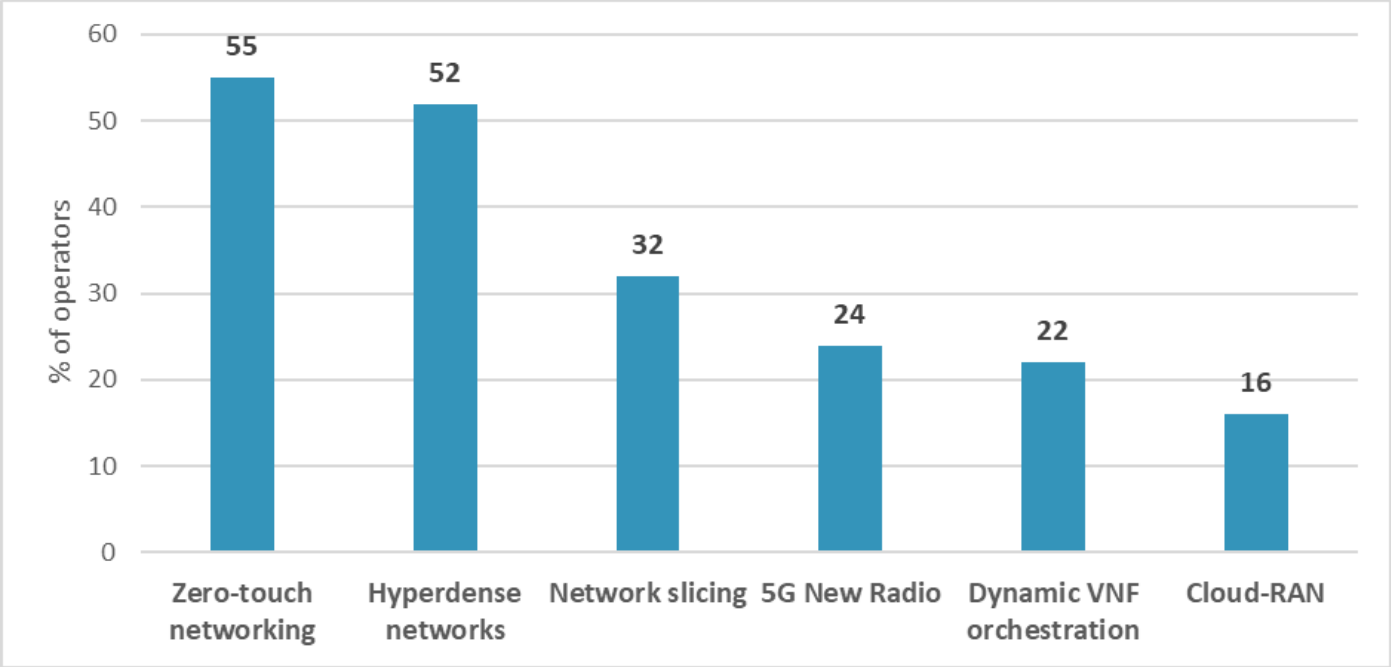


Figure 6. Percentage of MNOs placing each architectural change in their top 2 drivers to adopt E2E automation.

NB. Respondents were first asked to list all the important drivers for them; from the 6 factors which were most commonly cited, they were then asked to select the top two.

The full benefits of automation come from open platforms

Chapter 2 outlined the major changes in network architecture, from cloud-native to densification, which many MNOs will be adopting over the next few years. Another radical change in approach is emerging, which will further increase the economic impact of the new cloud-based, automated networks. This is the adoption of fully open network platforms and interfaces such as OpenRAN, which will shake up the operators' supply chains and enable them to orchestrate and automate elements from multiple vendors.

To achieve the maximum impact from end-to-end automation, operators are looking at adopting open systems. Operators are increasingly recognizing the need to adopt open architectures to achieve their economic goals. In the survey, almost 60% of respondents considered end-to-end open networks to be essential or desirable for the 5G era (Figure 7), and this level of interest will provide

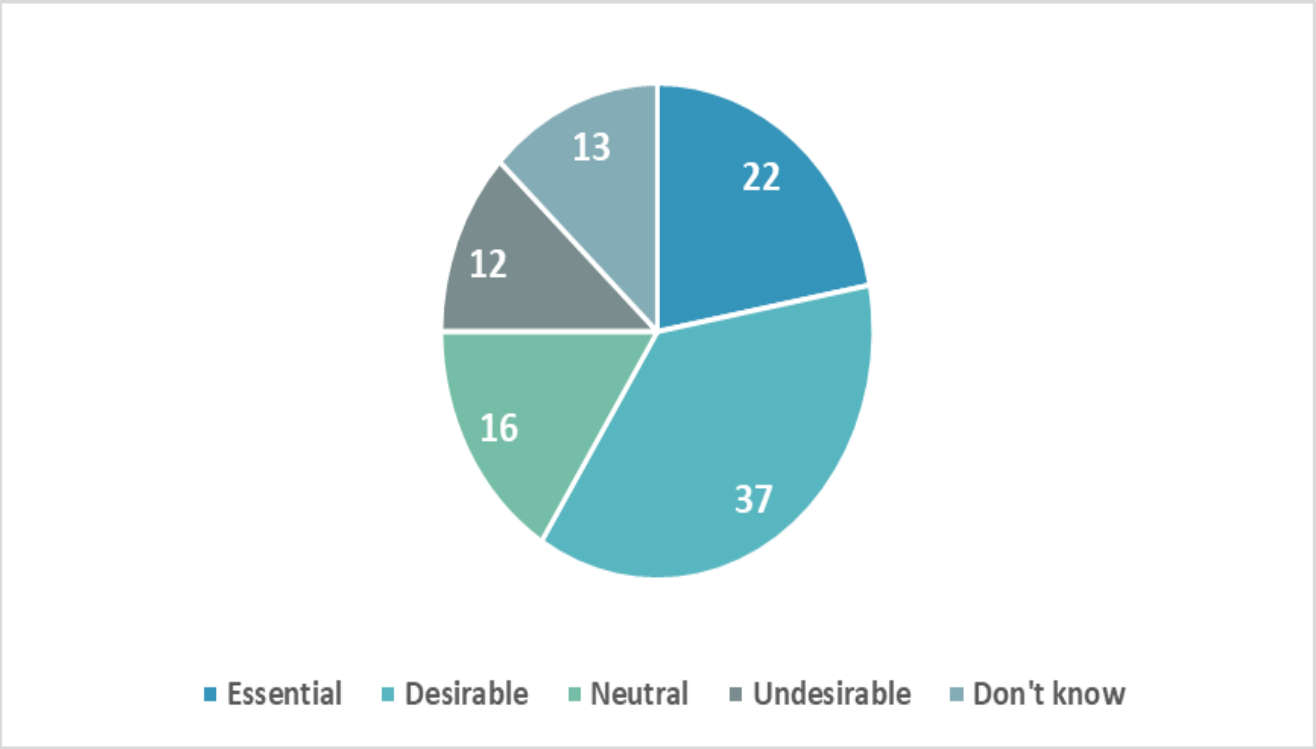


Figure 7. Attitude towards end-to-end open networks (percentage of operators)

the impetus to overcome the inevitable concerns about moving to a brand new platform and, potentially, a new supply chain.

This is a major shift – although the radio and core networks are based on 3GPP standards, these have been implemented in the past in proprietary ways, so that different vendors' equipment cannot interoperate, and lock-ins result. Operators have talked before about the need for multivendor interoperability, to stimulate price and feature competition and enable them to work with multiple suppliers. But the requisite open interfaces and merchant platforms did not emerge in time for the LTE build-outs. Without open systems, implementing a multivendor network requires expensive and customized integration.

IN THE SURVEY, ALMOST 60% OF RESPONDENTS CONSIDERED END-TO-END OPEN NETWORKS TO BE ESSENTIAL OR DESIRABLE FOR THE 5G ERA

This is changing in time for the 5G era. Several initiatives, driven by operators, are working on fully open interfaces through O-RAN, for critical elements of the network. Examples are open protocols for the fronthaul link between the radio unit (RU), distributed unit (DU) and central unit (CU) in a disaggregated, virtualized RAN; and open interfaces between different functions within a disaggregated RAN and 5G core.

Emerging open platforms include O-RAN, which has been demonstrated in a commercial network by Rakuten and Verizon; Telecom Infra Project's OpenRAN and vRAN Fronthaul; and the Open Networking Foundation's OpenCORD (Central Office Re-architected as a Datacenter).

In addition, cloud-native, interoperable network functions will run on hardware based on merchant processors and accelerators, not on proprietary chipsets. Not only are the network elements and functions interoperable in this architecture, but they can be implemented on standardized hardware from any supplier or in the public cloud.

These open architectures reduce upfront capex, and they also greatly reduce testing and operating costs by supporting standard processes which are applicable to any supplier's offerings, reducing the need for operators to carry out expensive laboratory testing, and easing processes such as network tuning. With all the elements supporting common architectures, the process of automation becomes dramatically simplified, replacing the need either to rely on a single-vendor end-to-end solution, with the risks of lock-in; or invest in expensive integrators to automate multiple non-interoperable pieces.

For instance, the O-RAN Alliance is working on closed-loop automation and end-to-end optimization, both helped by artificial intelligence (AI) and tightly linked to open orchestrators.

AI/ML—a key enabler of open automation

As outlined above, a key operator requirement for the 5G era network is to be simplified and automated. The disaggregated network provides the flexibility to mix and match different elements and functions, and removes some of the layers of the old monolithic designs. And the cloud infrastructure allows for rapid and automated scaling up or down, in response to changing requirements.

But the sheer number of microservices, devices and network changes or updates, which the network of the near future will have to handle, can introduce creeping complexity. While it is essential that testing, management and orchestration of the network is automated, it is also imperative that the automation is intelligent. This is a significant driver for adoption of AI/ML (artificial intelligence/machine learning), which will learn in detail about the network and its behavior, and will provide intelligent insights to create actionable outcomes.

This will be important to maximize the responsiveness of the network to user requirements and to any problems, in order to deliver one of the operators' top three goals – the greatly enhanced user experience, which will not only drive increased customer satisfaction, but support ultra-high reliability use cases.

The large OEMs and the open alliances are working hard on AI-optimized network automation. For instance, the O-RAN Alliance has said it will develop open approaches to AI-optimized closed-loop automation, leveraging Deep Learning (a subset of Machine Learning) to embed intelligence at component and network levels, to enable dynamic resource allocation according to a user's needs, and optimal network efficiency.

This is an area where the telecoms industry can learn significant lessons from the enterprise and webscale sectors, where the use of AI/ML to drive massive efficiencies into platforms and processes is already well underway. Many of the tools will be applicable to telecoms networks, but as with every aspect of automation, operators will have to undergo some organizational and cultural changes to benefit fully from the new technologies.

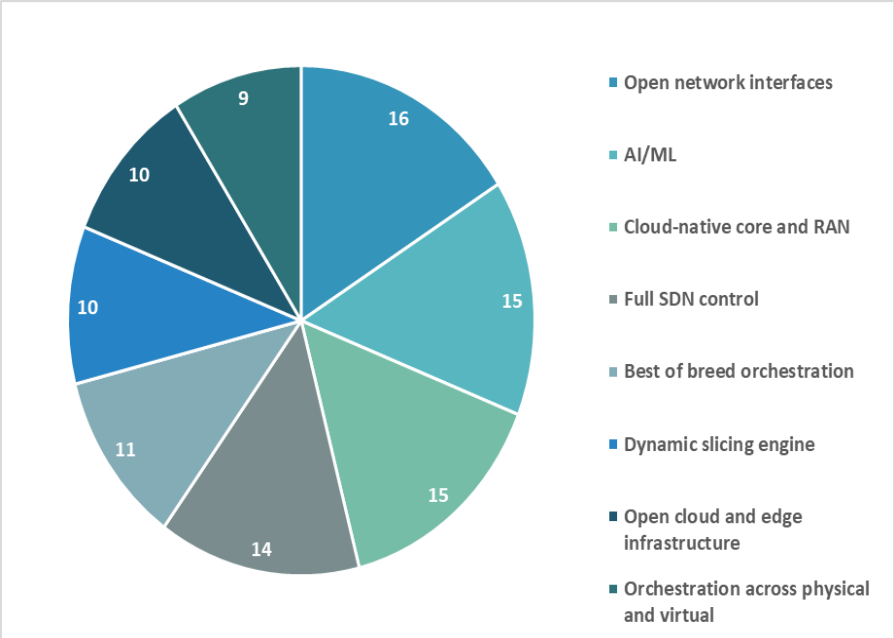


Figure 8. Most important enablers of end-to-end network automation (% of operators placing each enabler in first place)

NB. Respondents were first asked to list all the important enablers for them; from the 8 factors which were most commonly cited, they were then asked to select the most important.

Companies which are AI/ML frontrunners have the opportunity to double their cashflow by 2030, according to a study by McKinsey, but prerequisites of this success are to have a "strong starting IT base, a higher propensity to invest in AI, and positive views of the business case for AI."

Few telcos might tick all those boxes today, but many are aware of the need to embrace AI/ML. The operators surveyed for this white paper regarded AI/ML as second only to open interfaces, as a key enabler of a fully automated network (Figure 8). For 15%, this was the most important enabler, while almost two-thirds placed it in their top three.

Other critical enablers of a fully automated, multivendor network, according to the survey, include a cloud-native architecture in all network domains, full SDN control, and open orchestration which can work across multivendor components, and across physical and virtual functions.

A large percentage of operators expect to adopt AI/ML for at least some network processes before 2022 (Figure 9). Although fewer than 20% will implement it by the end of 2020 in commercial networks, two years later, 60% or more expect to have introduced it to network planning, optimization and maintenance processes, as well as applying it to enhancing the customer experience (see above), and streamlining the testing of devices.

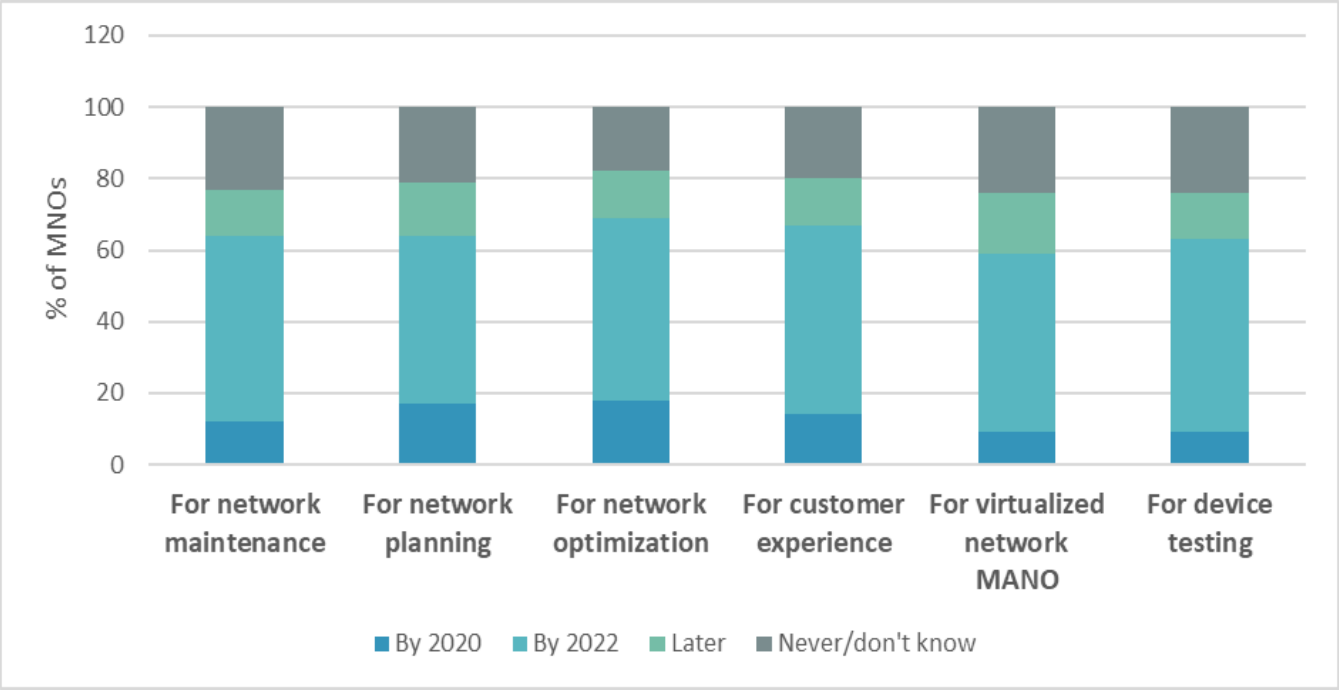


Figure 9. Percentage of MNOs which expect to introduce AI/ML to their network processes, with timescales

There are still perceived risks for the industry to address

It is clear that many operators have a strong appetite to drive a new open ecosystem in order to improve the economics of an automated, cloud-native network.

But there are still challenges that cause the majority of MNOs to proceed with caution, and it will be imperative for the industry to address these as quickly as possible, in order to instil confidence in taking the huge leap into a new architecture and supply chain.

The first wave of 5G network roll-outs have been largely conventional in nature and most operators say they are several years away from implementing a cloud-native 5G core, let alone a cloud-native RAN. Both the operators and their vendors have decades of experience of deploying and managing networks in a certain way, so it is unsurprising that there are perceived risks to taking an entirely new approach.

Indeed, the timelines to adopt full end-to-end automation have lengthened as commercial 5G has come closer, and there remains a gap between the strength of the vision of open networks, and the cautious progress of operational reality. Globally, fewer than one-third of operators expect to have more than 40% of their E2E network automated by the end of 2022, according to the 2019 survey. This is actually more cautious than a similar survey conducted in 2018, in which the figure was 40%, suggesting that operators in the earlier study had underestimated the challenges of adopting full automation and a new network architecture.

Figure 10 (overleaf) highlights the key perceived risks which need to be addressed if operators are to adopt the new automated, open, cloud-native architectures for their main networks. The key barrier is the fear that these automated platforms, for all their efficiencies, will not deliver the same level of performance as traditional networks optimized by human experts. Others relate to uncertainty – about immature or

incomplete standards, unproven return on investment, and doubts about full multivendor interoperability. This is inevitable when the stakes are so high for operators' businesses, and the new systems are so new and largely untried. Confidence will grow as a few trailblazers start to deploy at scale and share their results, and as the industry coalesces around a few agreed standards.

It will also be important to address perceived risks to adoption of open platforms, since these will be essential if the automated network is also to be multivendor, cost-effective and fully flexible. Again, most of the barriers relate to the immaturity of the ecosystem and the radical nature of the change that operators are facing, not just to their technical architectures, but to their supplier relationships, their skill sets and their cultures.

The major challenges they see (Figure 11) are led by fears that open, and particularly open source,

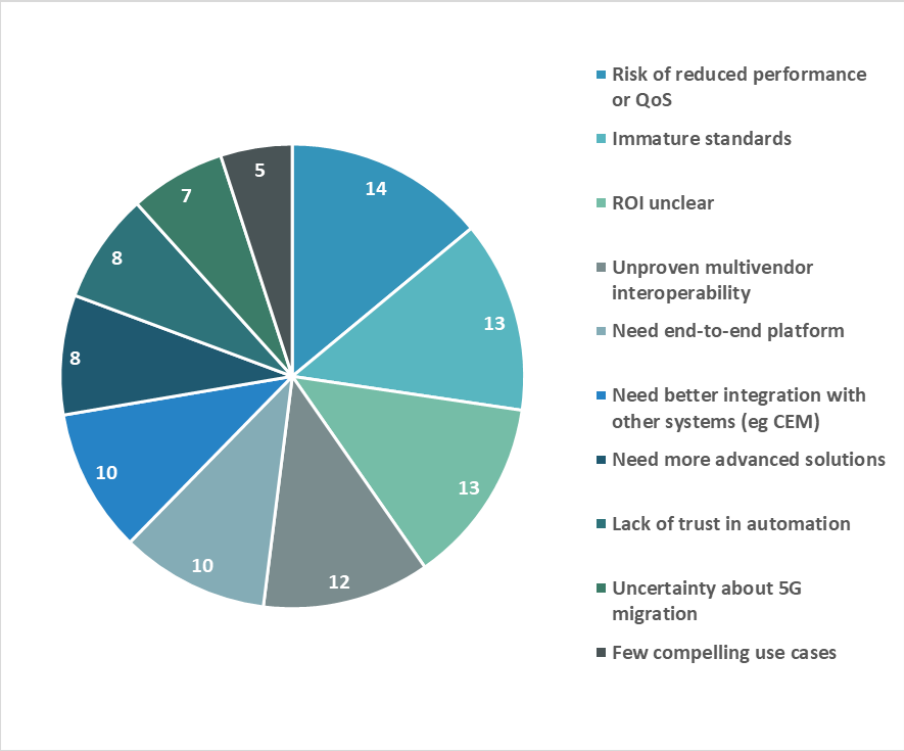


Figure 10. Operators' top 10 perceived risks for adoption of end-to-end automation

NB. Respondents were first asked to list all the important enablers for them; from the 10 factors which were most commonly cited, they were then asked to select the top one.

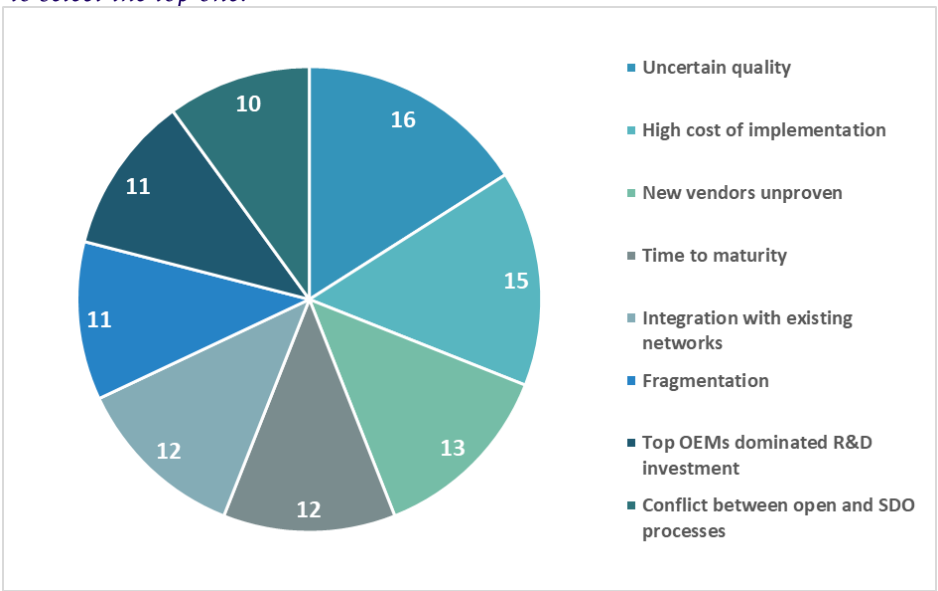


Figure 11. Operators' top 10 perceived risks for adoption of open networks

NB. Respondents were first asked to list all the important enablers for them; from the 10 factors which were most commonly cited, they were then asked to select the top one.

platforms may be of variable quality, especially if technologies are immature and fragmented. They are also frustrated about setting aside decades of investment and experience in traditional networks, and the ability to integrate the new open systems with legacy platforms. And there are also worries that open platforms may come with high implementation costs, because of the need to integrate them in such a way as to be truly carrier-class.

The biggest risk, however, lies in excessive caution

Many of the risks outlined above are increasingly perceived rather than real, as open automation enablers start to mature. But none of the operators' fears are irrational, and they must be taken seriously by open alliances and by individual suppliers.

Otherwise, the biggest risk of all will materialize – that the new economics of 5G will not be achieved in this generation after all, with a devastating effect on return on investment and on the pace of roll-out of new technologies and services.

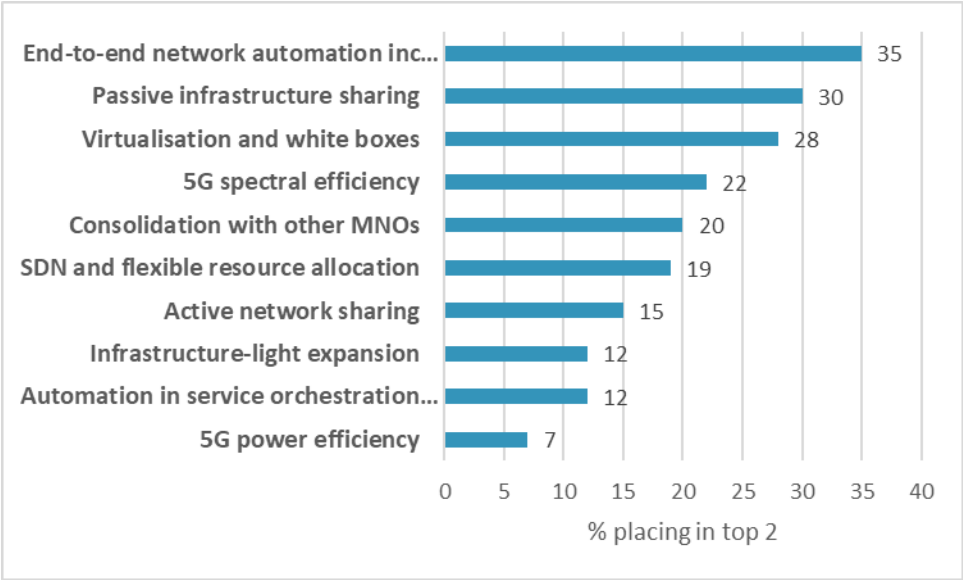
This risk is that operators will retreat to their comfort zone and rely on a large supplier to automate a single-vendor end-to-end network. This would be a mighty blow to the critical requirement to slash the TCO of next generation networks, which relies on the increased price competition supported by open, multivendor networks, while enabling operators to pick and choose the best offerings from many suppliers. The industry needs to accelerate the process of defining, testing and uniting behind a set of standard architectures. And it needs to demonstrate the risk to the 5G business case if operators do not move ahead quickly to adopt open, automated networks.

They would certainly have to scale back their stated objectives for reducing TCO and accelerating delivery of large numbers of new services, which would entail a deep rethink of their business models. On average, operators in the survey are targeting TCO reduction of 11% in the first three years of a commercial 5G deployment,

compared to the first three years of LTE; and TCO reductions of up to 35% over 6-7 years, compared to the same baseline.

While lower capex, driven by a more competitive supply chain and by commoditized hardware, will be important, reduced network operating costs will be even more significant to the 5G case. Operators were asked which changes would be most important to achieving their opex reduction targets by 2025, and end-to-end network automation emerged as the most significant (Figure 12). In total, 35% rated automation, including AI, as one of their two most important enablers of reduced opex and TCO.

Figure 12. Top 10 enablers of reduced network opex by 2025 (% of MNOs placing each in their top 2)



Also in the top 10 factors were several factors closely related to the open, automated network vision – virtualization and white boxes; SDN; and automated service orchestration (slicing).

For those operators planning to introduce end-to-end automation in the coming few years, it is important to set goals and expectations for the savings it will support. Among the most important cost impacts that the MNO respondents expect from automation are overall opex reduction, capex deferral, reduced staff costs combined with increased productivity, and reduced network downtime.

On a consensus basis, the operators believe they can target opex reduction rising from 22% in the first two years of deployment of an open, automated network, to more than 40% when that network is completed, after four or more years. Some targets are even more

ambitious – a 56% reduction in downtime for each cell once the network is complete. Operators are looking for staff costs to fall, and productivity to rise, by about one-third in a mature automated network, while they can also aim to reduce capex by almost 20% by deferring or eliminating spending, because of better use of existing resources.

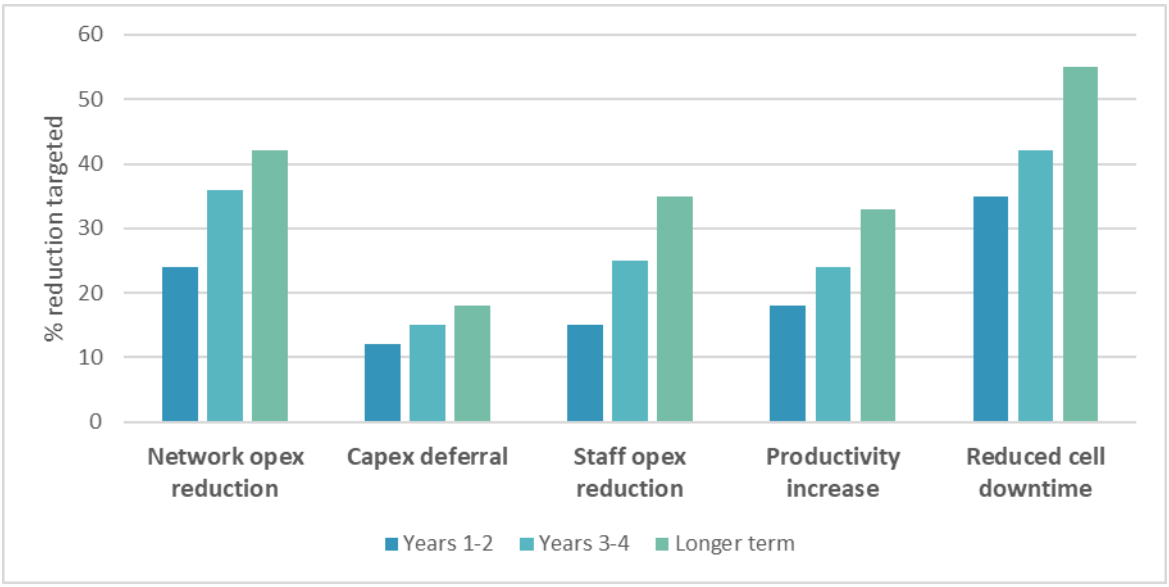


Figure 13. Consensus targets for cost reduction and other KPIs as a direct result of E2E network automation

Some of the specific processes where operators expect to see a significant impact from automation are highlighted in Figure 14. This shows that these processes are addressing all three of the core objectives for 5G, though operators expect the impact on TCO and customer experience to be felt more immediately. In the near term, fewer of the processes are directly related to new services and revenues – of the eight factors prioritized by the respondents to the survey, only two

High impact on this KPI in years 1-3

Moderate impact on this KPI in years 1-3

Limited or deferred impact on this KPI in years 1-3

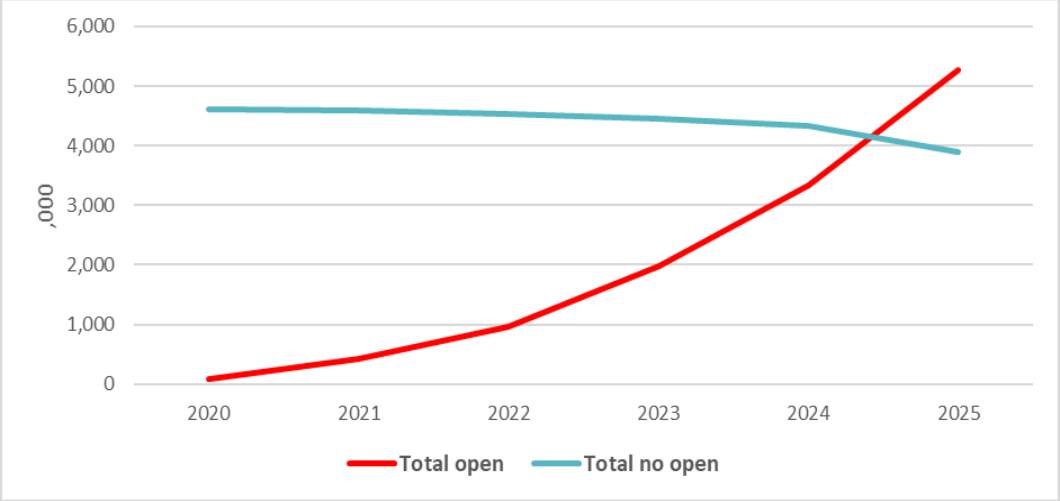
Figure 14. Top 8 processes which operators expect to transform with E2E automation in the first three years of implementation, and expected level of impact on core KPIs

were expected to have the maximum effect on revenues in the near term (dynamic orchestration, and flexibility to map network capabilities to requirements), while most of the factors were clearly linked to cost and experience.

If these cost efficiency targets are reached, it will accelerate build-out of new networks at far greater scale because of the improved economics. That will give the early movers a significant headstart in terms of cost and service agility, making it hard for slower rivals to respond.

In particular, open automated networks will make densification cost-effective for many types of builder, allowing more cells and edge nodes to be deployed for the same cost, which in turn will enable new use cases and user experiences. Figure 15 shows our forecast for deployments of small cells in the 2020s, including traditional designs and fully open, automated networks. Assuming open platforms are fully commercialized at some point during 2020, it will take these systems only four years to overtake traditional networks in terms of new deployment.

Figure 15. Projected deployment of open and non-open small cells (radio units) 2020-2025, assuming open platforms are commercialized in 2020



More importantly, open platforms will drive the deployment of an additional 12m radio units over a five-year period, compared to a scenario where only traditional architectures were available.

Individual stakeholders and industry alliances are starting to calculate the economic impact of their architectures in some detail now as specifications are completed and the number of proof-of-concept demonstrations, tests and trials mount up. Mavenir, supplier of open, cloud-native end-to-end networks, is one company which believes the operators' targets, as revealed in the survey, are realistic, as Figure 16 shows.

Mavenir, which has demonstrated 5G data transmission over an O-RAN interface, has set out the expected cost reductions achievable with open RAN architectures, including a fall in TCO of about 34.5% compared to a traditional RAN; and reductions of 40% in capex and 33.5% in opex. Meanwhile, about 45% improvement in performance could be expected thanks to automated and efficient resource allocation and response to change.

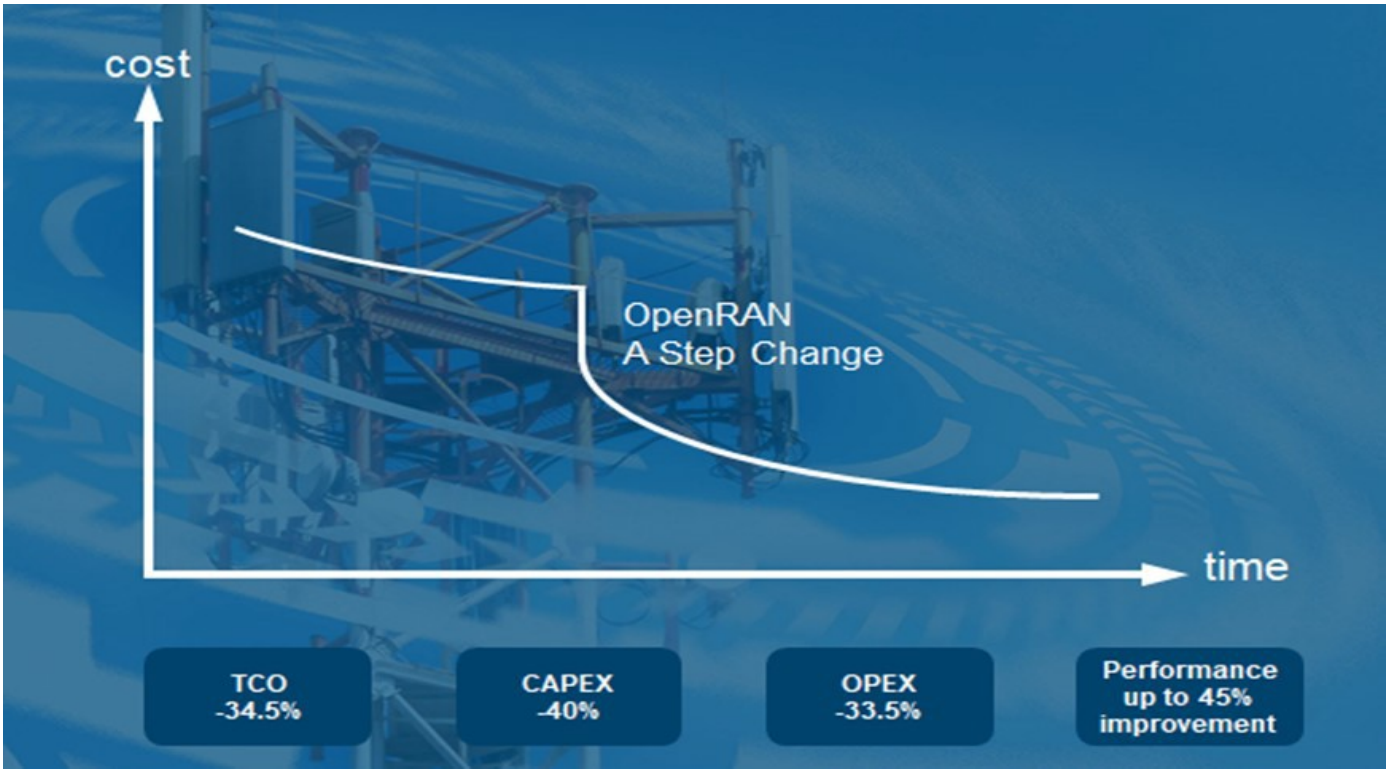


Figure 16. Mavenir's cost reduction expectations from adoption of OpenRAN architectures

Source: Mavenir

The potential impact on the 5G cost base is best illustrated with reference to the most expensive element of the mobile network to deploy and run, the RAN, which can account for up to two-thirds of total TCO. Figure 17 (overleaf) shows the high level results of two case studies based on real composite operators.

The first makes a heavy investment (at least 25% higher than the average for 5G networks) in automated digital platforms, while the second makes a far lower and slower investment. In the first case, the cost of deploying and running the RAN is stable between 2020 and 2023 before falling sharply as a result of the impact of automation, efficient resource usage and the maturing of open platforms.

By contrast, in the second case, the cost of the RAN continues to rise significantly throughout the period as the operator extends and densifies 5G, but without the benefits of a full digital and automated architecture.

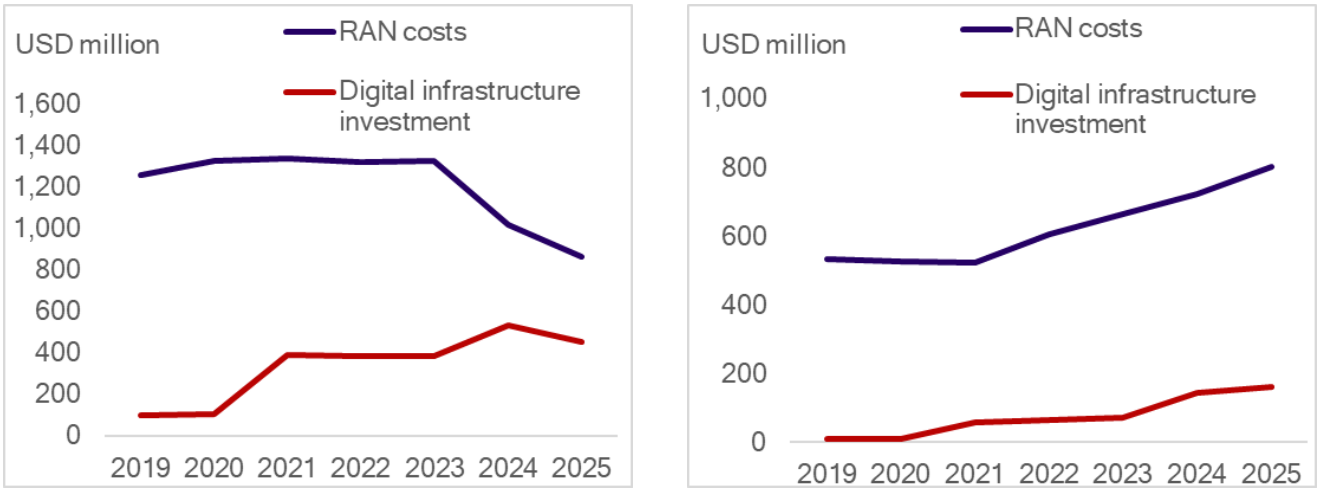


Figure 17. Comparison of RAN costs where the operator has invested heavily in digital, automated platforms (left), and where it has not (right).

Conclusion

The business case arguments for end-to-end automation across open, cloud-native networks are becoming stronger and stronger as operators get close to making key decisions for their 5G era architectures. With this scale of impact promised, it is urgent for MNOs to start to initiate clear, step-by-step plans for automation, with clear timelines, now.

This is not to dismiss the challenges of moving to such a new architecture and supply chain, but they can lower their risks by adopting open platforms, working closely with a wide variety of vendors, and learning from early adopters.

Only by working with the whole ecosystem to address the challenges, and to accelerate the emergence of fully open commercial systems, will operators be able to implement true end-to-end automation in an open environment, and achieve the maximum benefits of the 5G platform, in terms of TCO, new revenues and user experience.

Traditional network	**Key migration steps**	**New architecture**
Single vendor networks	• Virtualization • End-to-end automation in planning and management • Open interfaces between key network elements • Open source management and orchestration • Cloud-native • Disaggregated, multivendor RAN and core elements • Automation	Multivendor interoperability
Proprietary interfaces implemented in different ways		Common, open interfaces between network elements
Integrated hardware/ software		Hardware and software disaggregated
>80% processes manual		>80% processes automated
Dedicated appliances for core and base stations		Cloud-native end-to-end architecture
Static provisioning of resources		Dynamic provisioning enabled by SDN
Generic network capabilities		Network slicing

About Rethink Technology Research

Rethink Technology Research is a specialized research and consulting firm with 12 years' experience in surveying wireless, broadband, over-the-top and quad play operators. This has resulted in a broad research base of over 140 service providers (MNOs, telcos, cable and satellite operators, over-the-top providers) worldwide. These organizations are surveyed on a regular basis about their network infrastructure and business plans, and have a relationship of trust with Rethink.

Rethink also has deep relationships with the telecoms ecosystem (tier one device OEMs, vendors, technology developers, integrators, regulators etc), and is perceived as a thought leader in many areas of the telecoms and media sectors. Key areas of expertise and research experience include HetNet migration, small cells and carrier Wi-Fi; transformation strategies for the RAN and the BSS/OSS; convergence of IT and network skills and platforms; device and chipset roadmaps; spectrum strategy.

About Mavenir

Mavenir is the industry's only end-to-end, cloud-native network software provider. Focused on accelerating software network transformation and redefining network economics for Communications Service Providers (CSPs) by offering a comprehensive end-to-end product portfolio across every layer of the network infrastructure stack.

From 5G application/service layers to packet core and RAN – Mavenir leads the way in evolved, cloud-native networking solutions enabling innovative and secure experiences for end users. Leveraging industry-leading firsts in VoLTE, VoWiFi, Advanced Messaging (RCS), Multi-ID, vEPC, and Virtualized RAN, Mavenir accelerates network transformation for more than 250+ CSP customers in over 130 countries, which serve over 50% of the world's subscribers.

We embrace disruptive, innovative technology architectures and business models that drive service agility, flexibility, and velocity. With solutions that propel NFV evolution to achieve web-scale economics, Mavenir offers solutions to help CSPs with cost reduction, revenue generation, and revenue protection. Learn more at www.mavenir.com

Bristol & Exeter House
Lower Approach Road
Temple Meads
Bristol
BS1 6QS
United Kingdom

Tel. +44 (0) 1173 291480
Tel. +44 (0) 1179 257019

www.rethinkresearch.biz

Published December 2019

WP 20-12-19