Networks on Cloud: a clear advantage

WHY AND HOW TELCO NETWORKS SHOULD TRANSFORM TO CLOUD

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Capgemini RESEARCH INSTITUTE

Introduction

"A mobile-telecoms revolution is under way – one reminiscent of the way personal computers replaced mainframes in the 1980s, and cloud-based apps are replacing traditional software today," wrote Tareq Amin, CEO of **Rakuten Mobile,** in 2021.[1] Amin was referring to the "telco cloud transformation" – the transition to hosting network functions in software form and in the cloud, as opposed to physical storage in vast server "farms." In 2020, Amin had led the rollout of the world's first fully cloud-native mobile network for Rakuten Mobile.[2] Since then, several telcos have stepped up to the plate with plans to build and operate their own cloud-based networks:

In April 2021, **Dish –** the 4th-largest mobile network operator (MNO) in the US – announced its partnership with Amazon Web Services (AWS) to host its radio access network (RAN) and mobile core on AWS Cloud.[3] Dish plans to spend $10 billion overall, including on the deployment of its cloud-native network, on realizing its 5G network ambitions by 2025.[4]

In June 2021, **AT&T** announced that it will move its 5G mobile network to Microsoft cloud. By 2020, AT&T had already virtualized 75% of its network, and it aims to shift its network resources to Microsoft's Azure for Operators platform over the next three years.[5]

Spanish operator **O2 Telefónica** recently announced that it is working with Google Cloud and Ericsson to transition its 5G core network in Germany to cloud;[6] given that the core network currently processes the mobile data and voice traffic of around 47 million mobile subscribers in Germany, this is a significant operation.

The transferal of mobile networks to cloud – particularly, 5G network core, which can be deployed in a cloud-native form – has been a key driver of telco cloud transformation. Having already made a start on transitioning their network core, many telcos are now looking at transitioning other network functions in their edge, radio, and transport networks. Industry-specific use cases for enterprises and end-consumers include:

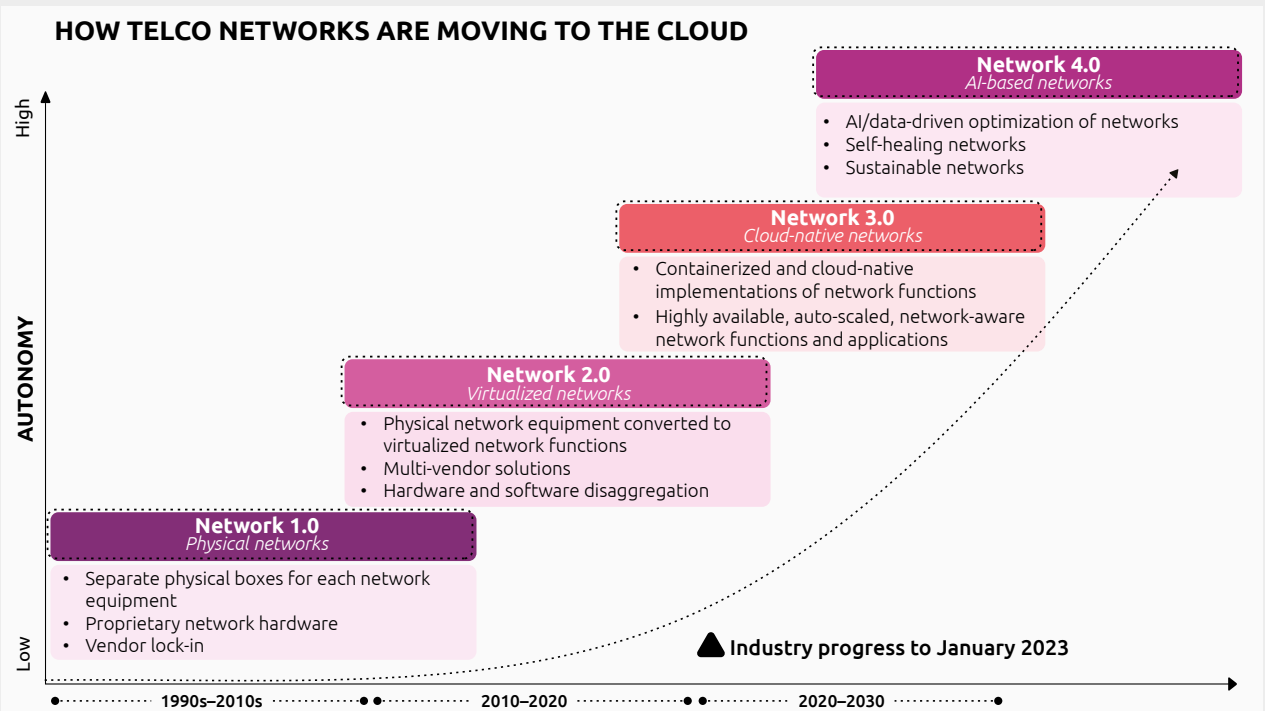
- Highly automated smart factories involving remote control, video surveillance, and robotic production lines, driving seamless and low-cost operations
- Private 5G networks at distribution centers, ports, oil fields, mines, chemical storage, and processing units, etc., enabling real-time process analysis and modification
- Predictive/preventive maintenance facilitated by large-scale sensor networks
- Augmented reality/virtual reality (AR/VR) or metaverse-enabled remote operations, monitoring, and training, leading to more efficient, safety-conscious employee onboarding
- Remote surgeries carried out via low-latency wireless networks

Introduction

5G's combination of high-bandwidth and low-latency – which powers many of the applications above – can help unlock the full potential of cloud-native networks, replacing legacy physical systems (see Figure 1). The 5G technology architecture itself allows for cloud-native deployment of the core, called 5G "Standalone" core – making it the default choice for new deployments and technology refreshes at the end of life of previous-generation technology. This is a key driver for telcos striving for transforming their networks to cloud, in addition to rising network capital expenditure (CAPEX) and operational expenditure (OPEX) requirements.

Figure.1

Telco networks are rapidly evolving from virtualized to cloud-native



Source: Capgemini Research Institute analysis. The term "Network 1.0/2.0/3.0" does not correspond to any standard industry terminology and is solely for representative purposes. See the glossary for definitions of the various technical terms used in this chart.

Introduction

The "virtualization" of network functions – implementing network functions in software form, as opposed to via dedicated physical equipment – which serves as a starting point for telco cloud transformation, has been ongoing for several years. Virtualized network functions (VNFs) facilitate the 'programmability' of telco networks and promote the efficient use of computing resources. Cloud-native deployment of network functions promises to take these benefits to the next level, and will also offer additional benefits:

Containerized network functions CNFs are network functions that can be packaged together with all the programs that they require to run on any infrastructure – making network functions truly hardware-agnostic. Moreover, CNFs facilitate the use of standardized cloud hardware and customized software, which can be developed by a wider range of vendors, circumventing vendor lock-in. They also make it possible to run a variety of services on the same cluster and more easily onboard already-decomposed applications – reducing computing/storage requirements and the deployment time of various network functions.

Cloud at the edge offers ultra-fast response times – critical to time-sensitive applications such as emergency response, disaster recovery, and real-time alerts.

Scaling of cloud resources quickly ramps up network capacity to serve new regions or customers. It is crucial to "greenfield" operators in terms of capturing market share, as well as for "brownfield" ones to migrate their large customer base from legacy tech. Additionally, **auto-scaling –** allowing idle network assets to be dynamically shut off and brought online as required – can enable more efficient use of networking resources, leading to lower energy use and thereby reducing the telco network's overall carbon footprint.

Cloud-native deployment also employs **microservices–** small, loosely coupled and independent services that make up an application. These can be developed and deployed independently of other services, with any modifications to them easily isolated from the application as a whole. Use of microservices enables much more rapid development of new features and services, leading to a reduced time to market. **Application programming interfaces (APIs)**, which can integrate with network functions, can offer seamless network access to third-parties such as partners and developers, in a manner far superior to what was possible via VNFs.

These benefits are in addition to the inherent advantages of cloud infrastructure: **CAPEX and OPEX savings, improved performance, resource utilization, resiliency,** and **scalability.**

Introduction

However, there are still some significant obstacles to overcome. Monetizing of 5G services to enterprises and end-consumers is still being worked out. Moreover, the reliability of running some network functions on cloud infrastructure is yet to be fully proven. To run ultra-reliable, low-latency communication (URLLC) applications may be so demanding that far-flung data centers cannot cope, with the network being obliged to deliver the service from a location nearer to the customer. This will involve both technical transformation and adjustments in terms of business, operating, and recruitment models. Any transition to telco cloud, therefore, must be accompanied by a sensitive cultural transformation of the organization.

Whichever challenges the transformation to cloud-native throws up, the potential benefits are too numerous and significant to ignore. If the decision to transform is a given, therefore, the outstanding questions for telcos are how they should go about their individual transformations and what will that mean for their people and processes.

This research will look for answers to the following questions:

- Why are telcos "cloudifying" their networks, how much are they investing, and how far have they come in their transformation journeys?
- Which benefits does the telco cloud offer and do they outweigh the costs?
- Are there examples of leading telcos realizing greater business and technological benefits from telco cloud?
- How can telcos harness the full potential of telco cloud?

Executive Summary

Telco cloud is poised for 50% growth in the next five years

- Overall, the 31% of telco network capacity (globally, across 4G/5G networks) that is entirely serviced by cloud-based platforms today is expected to grow to 46% in the next five years (at a CAGR of 8%).
- Globally, 29% of network functions have been virtualized – a key first-step in transitioning to cloud in a brownfield transformation.
- Network scalability (52%), reduced network complexity (48%), and increased operational efficiency (39%) are the top three drivers of telco cloud transformation.
- Private cloud is the most preferred cloud deployment model, with nine in ten telcos preferring private cloud deployments across network domains.
- Telcos plan to invest $206 million per year on average in telco cloud in the next five years (based on a typical operator in our study with average annual revenues of $21 billion).

Telco cloud offers significant business and sustainability benefits

- Telcos realize increased customer lifetime value, risk sharing with partners, and improved customer experience using telco cloud.
- Financial benefits from telco cloud make a convincing business case for investment. A typical telco in our study with average annual revenues of $21 billion can:
  - Expect to optimize network total cost of ownership(TCO) by 13%, resulting in cost savings to the tune of $260 million to $380 million per year.
  - Expect to realize $110 million to $210 million in additional revenues from attaining early-mover status in markets enabled by cloud-based platforms.
- Besides business and operational benefits, telcos that have undertaken cloud transformation expect to reduce their greenhouse gas (GHG) emissions by 5% in the next 3-5 years.

Executive Summary

Leading telcos are already reaping the benefits of telco cloud

- Early Adopters have focused investment priorities in R&D, cloud management, and innovation.
- Early Adopters are more ambitious in their expectations from telco cloud: they expect to recover almost half of their investment (47%) within the next five years, whereas Laggards expect to recover only 34%.

We recommend that telcos who wish to harness the full potential of telco cloud consider adopting our five-point plan:

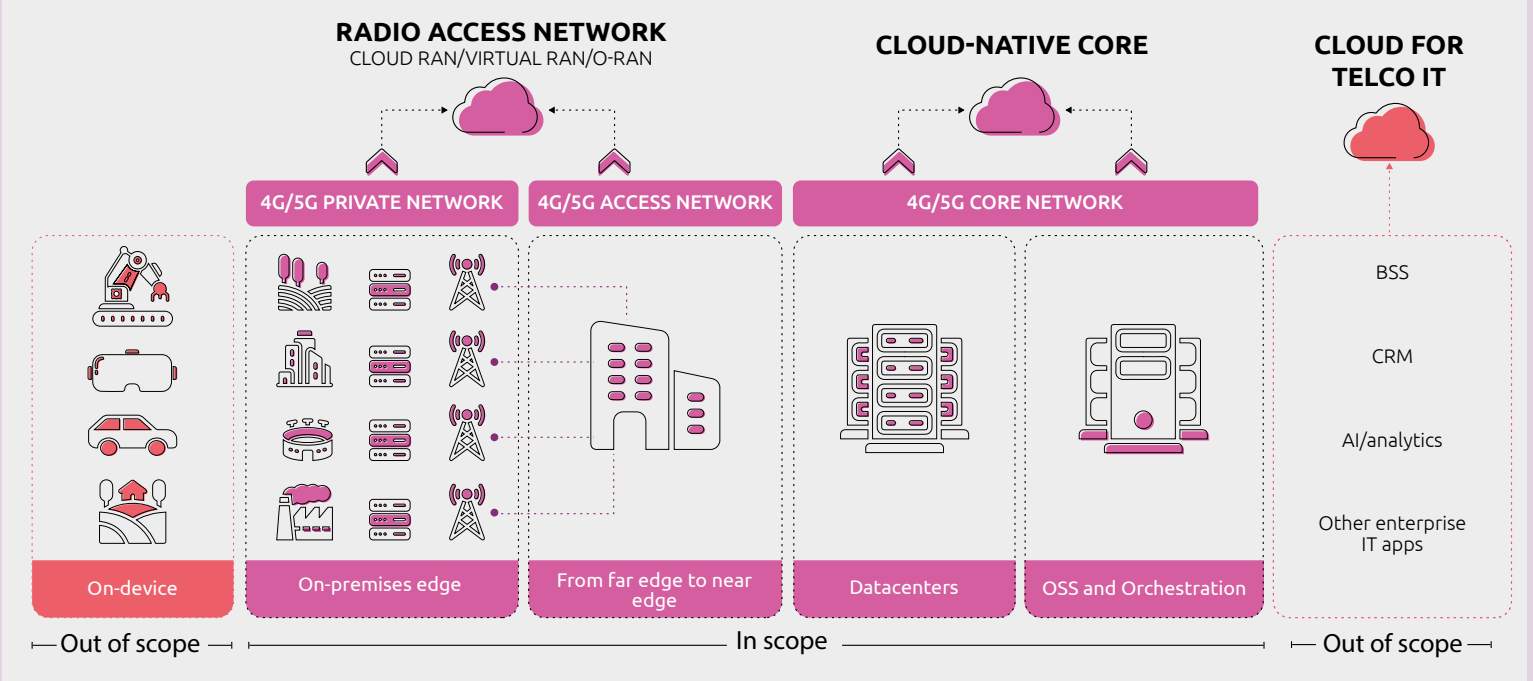
- Devise a comprehensive telco cloud strategy.
- Aim to achieve rapid, efficient monetization of new services.
- Harness new talent and automation options to foster innovation and agility.
- Attempt to form strategic partnerships within their business ecosystem.
- Ensure that cultural transformation goes hand in hand with technological transformation.

What do we mean by telco cloud?

In this research report, we use the term "telco cloud" to refer to the transition of wireless network functions (such as routers) and domains (RAN and core) to cloud-based infrastructure (see Figure 2). In this report, we are focusing solely on mobile networks' transformation to cloud.

Figure.2

Wireless/mobile network functions transitioning to cloud

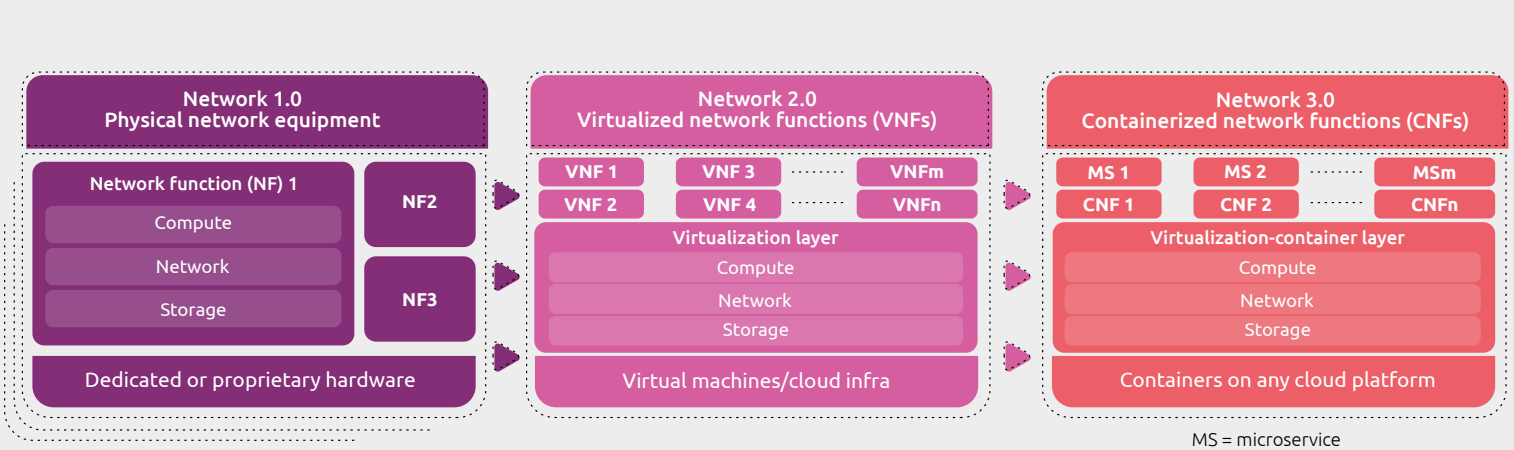


Source: Capgemini Research Institute analysis. Refer to the glossary for definitions of the various technical terms used in this chart.

In addition, for the purpose of this report, we refer to "cloud-based" or "cloud-native" networks as those composed of network functions in a containerized form and deployed directly on cloud infrastructure as “cloud-native” (see Figure 3).

Figure.3

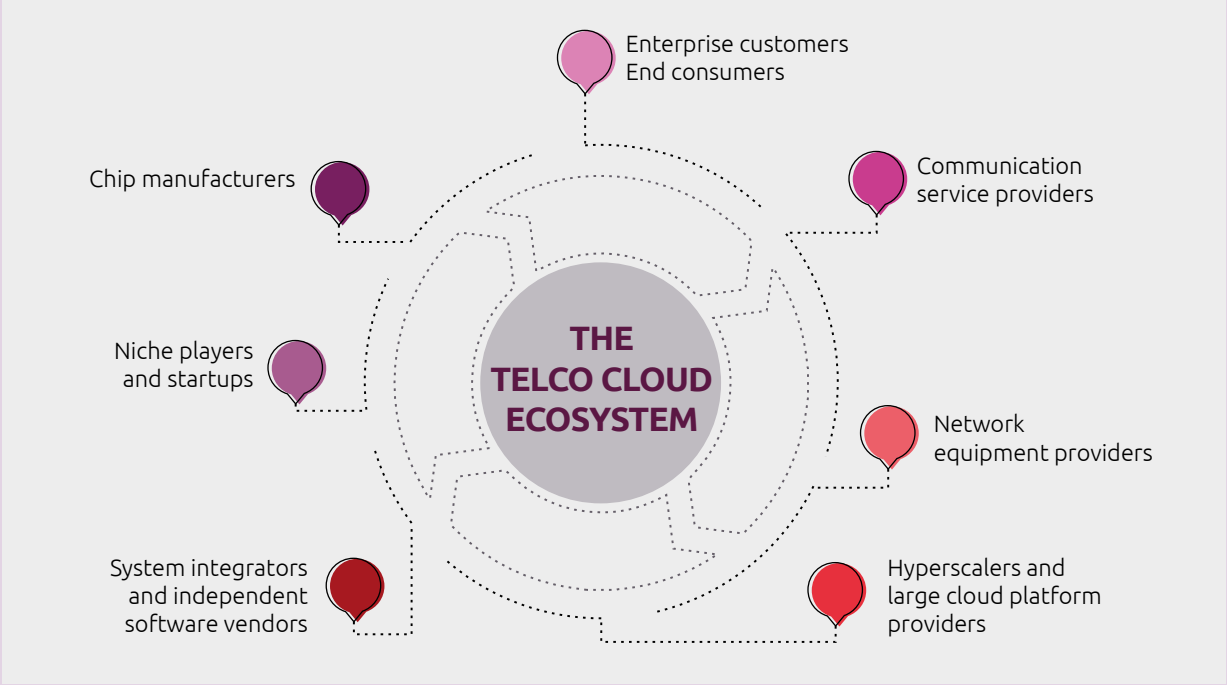
What is telco cloud transformation?



Source: Capgemini Research Institute analysis. The term “Network 1.0/2.0/3.0” does not correspond to any standard industry term and is solely for representative purposes. Refer to the glossary for definitions of the various technical terms used in this chart.

Figure.4

The telco cloud ecosystem of players



Source: Capgemini Research Institute analysis.

"A mobile-telecoms revolution is under way – one reminiscent of the way personal computers replaced mainframes in the 1980s, and cloud-based apps are replacing traditional software today"

Tareq Amin
CEO of Rakuten Mobile

01 Telco cloud is poised for 50% growth in the next five years

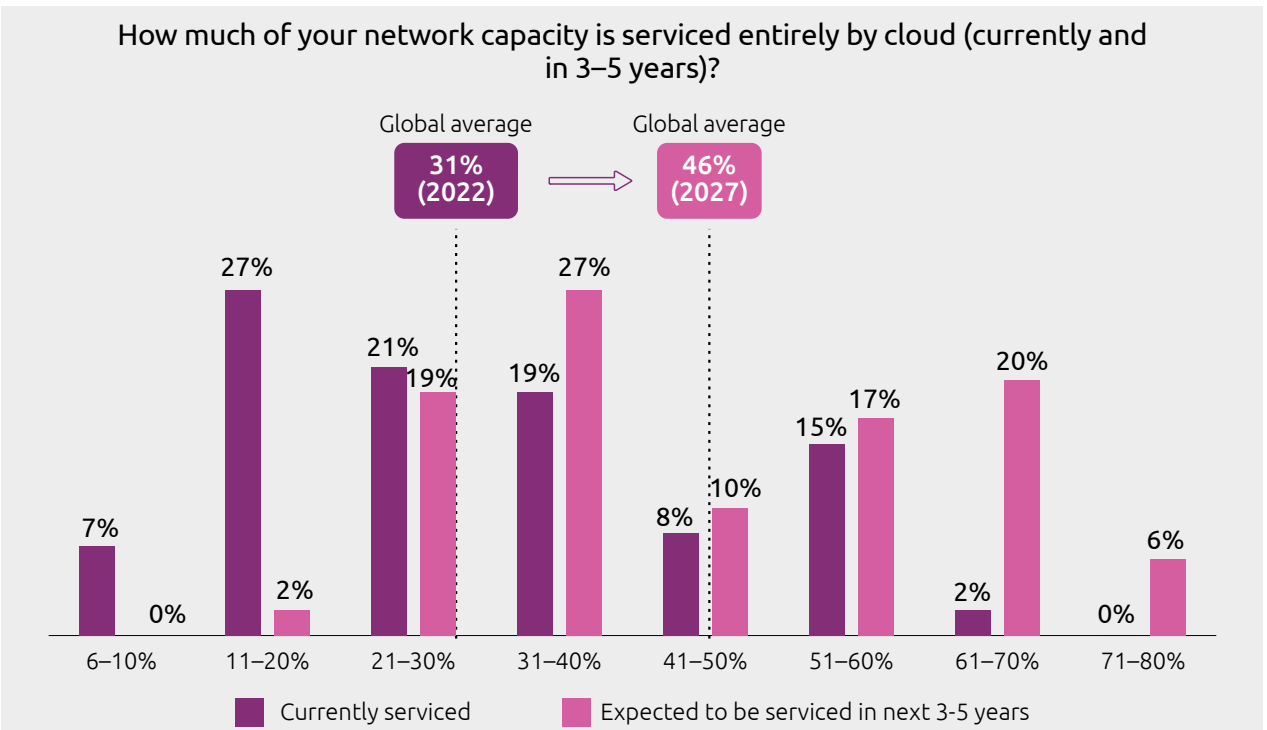
Nearly half of telco network capacity will be cloud-native in the next 3-5 years

Today, 31% of global telco network capacity (across 4G/5G networks) is entirely serviced by cloud-based or cloud-native platforms (see Figure 5). This figure is expected to grow to 46% in the next five years. Network capacity is the amount of traffic that a network can handle at any given time.[7]

Scott Andersen, Distinguished Solution Architect at Verizon, comments: *"For telecom networks, this is the decade of transformation. The largest tier-1 carriers – with direct connectivity to the internet – already host a majority of global network traffic on cloud-based systems. I expect most of the second-tier carriers to get there in the next three to five years, and most of the smaller telcos in a slightly longer horizon. Cloud-native networks will be the norm by the end of this decade."*

Figure.5

The share of global network capacity that is serviced by cloud will grow by 50% in the next five years

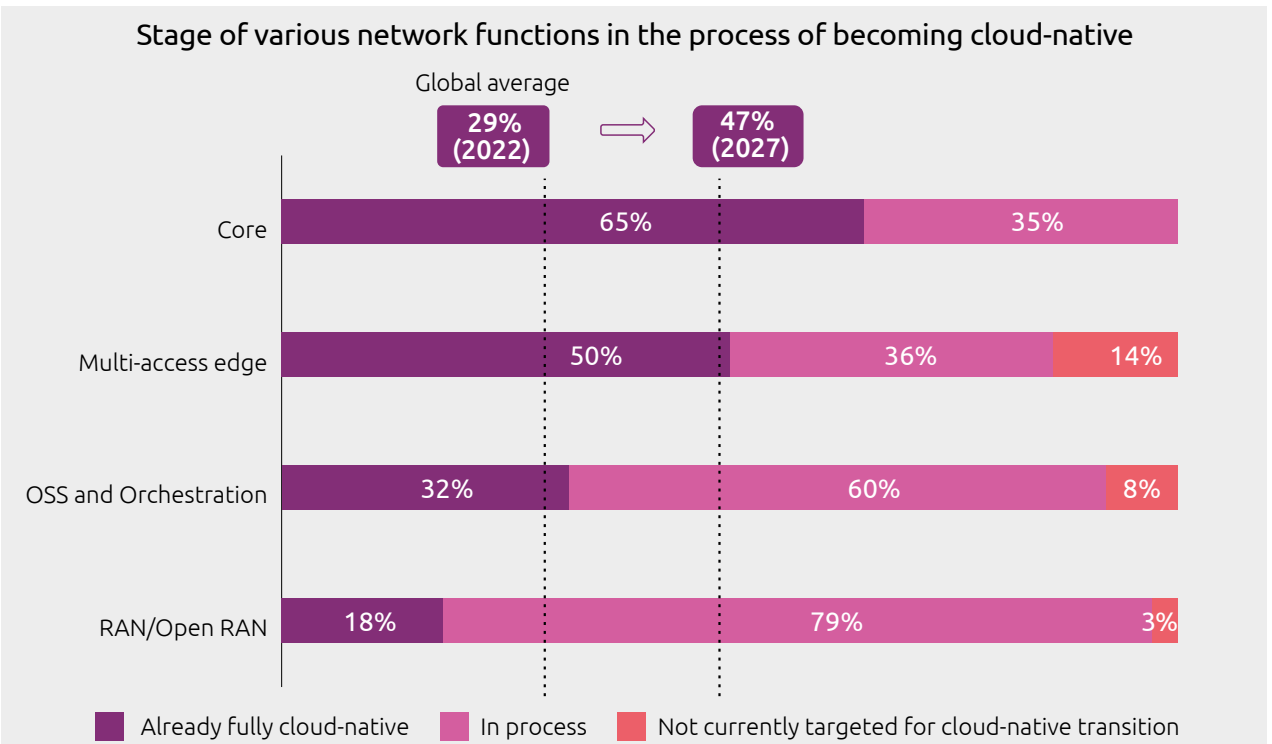


Source: Capgemini Research Institute, Telco Cloud Executive Survey, November-December 2022, N=124 telco tech executives.
*"Network" here encompasses core, multi-access edge, RAN/Open RAN, OSS and Orchestration. Refer to Glossary at the end of the report for definitions of these terms.

Virtualization of network functions – another indicator of telco cloud transformation is expected to proceed at a similar pace. Globally, the share of VNFs (VNFs are key to brownfield transformation – to cloud-native networks) currently stands at 29%, and it is expected to grow to 47% by 2027 (see Figure 6). More than 60% of core network functions are already virtualized compared with less than 20% of RAN. There is a slight difference in the share of network capacity serviced by cloud vs. the share of VNFs as both are different measures, although they are correlated. Capacity measures the amount of traffic a network can handle while the share of VNFs measures network functions serving cloud-based traffic.

Figure.6

By 2027, the share of virtualized network functions (VNFs) is expected to grow 1.6x



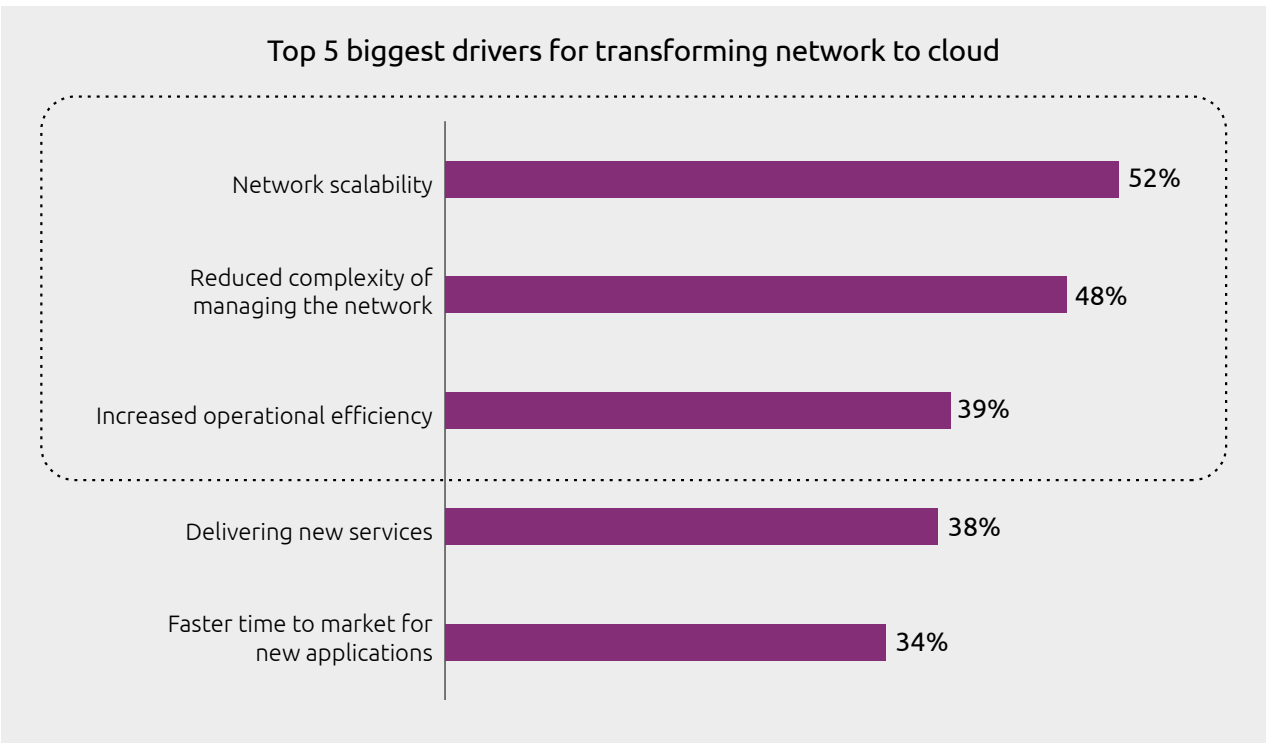
Source: Capgemini Research Institute, Telco Cloud Executive Survey, November–December 2022, N=124 telco technology executives.

Greater scalability and reduced complexity are the biggest drivers for transition to telco cloud

Making networks scalable is the biggest factor driving telcos to transition their networks to cloud. It is possible to deploy and scale 5G standalone core rapidly in a cloud-native environment. Other top factors are reduced complexity of managing the network (e.g., owing to reduced a number of physical infra and data centers that need to be deployed) and greater operational efficiency.

Figure.7

Top drivers of telco cloud transformation



Source: Capgemini Research Institute, Telco Cloud Executive Survey, November–December 2022, N=170 telco executives.

Private cloud is the preferred cloud-deployment model

The head of IT architecture and infrastructure strategy at a large French operator states: *"Large parts of our legacy infrastructure are moving from physical to virtual servers. Additionally, infrastructure that is largely non-legacy is deployed on our own private cloud. There are only a few applications that we have started deploying directly on public cloud. We need to be really sure of what we can put on public cloud due to data sovereignty, security, and network-reliability requirements."* In relation to multi-cloud, he adds: *"We are not using cloud services from multiple vendors for the same kinds of workload […] primarily due to challenges in interconnection and interoperability between different public-cloud vendors."*

Telcos have traditionally imposed fairly stringent requirements around quality of service, network security, and capital and operational expenses in relation to cloud. While those requirements remain strict, concerns around the use of external cloud providers are diminishing. For network core, telcos across geographies prefer proprietary, private-cloud deployment (see Figure 7).

Further analysis of this data from our survey yields some interesting observations:

- For RAN, European telcos prefer private cloud by network equipment providers (NEPs) more than those in other regions (70% vs. 42% in the US and 39% in APAC).
- Edge sees the most preference for private cloud offered by hyperscalers – 58% in Europe, 50% in the US, and 44% in APAC – compared to all other cloud deployment models.

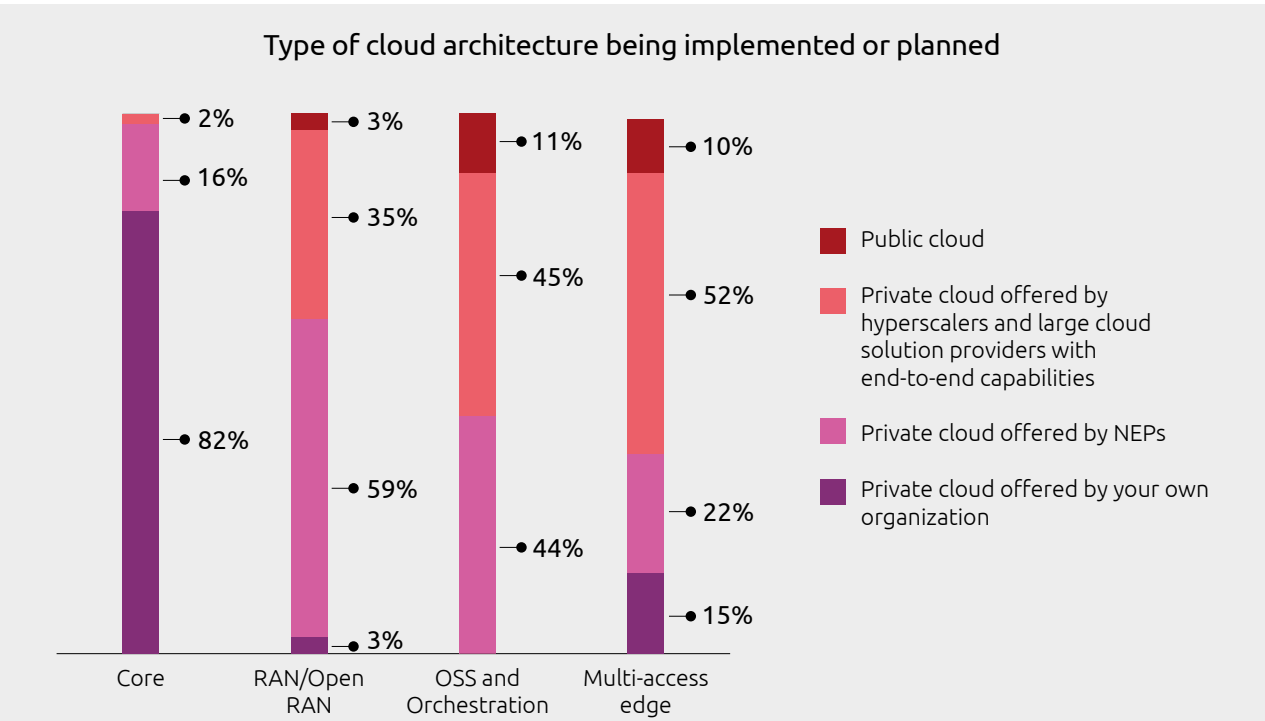
The head of supply chain (procurement) at a UK-based global telecom operator comments: *"Telcos were hesitant to outsource to cloud providers in the past, owing to the criticality and sensitivity of data, voice, and applications. However, these concerns have reduced in the last 3-5 years. Today, NEPs and hyperscalers exhibit a lot of confidence in their cloud offerings in terms of security and reliability of service. There has been a lot of innovation around cybersecurity, in particular, and related concerns have fallen correspondingly, at least for the non-core parts of the network."*

One of the factors in deciding on a cloud deployment model is availability of the latest software releases. The VP and head of technology evolution and innovation at a large European operator, says, *"The initial cloud-native deployments are likely to take place on proprietary, cloud-native infrastructure, largely in a private cloud model. The key reason for this is that the latest versions of containerized network functions provided by equipment vendors are usually available on their proprietary cloud platforms. There is usually some delay in getting the latest release for a different cloud infrastructure."*

As Figure 8 shows, telcos are more comfortable deploying multi-access edge on non-proprietary cloud infrastructure. In the US, Verizon, in partnership with AWS, has made significant strides in the mobile edge-computing space over the past three years.[8] AWS Wavelength, a provider of cloud computing and storage services at the edge of telecom networks, is at the heart of this offering. It allows application developers to refine and deploy URLLC applications (for example, those in healthcare, sports, and AR/VR gaming) at the network edge. By bringing the power of cloud computing at the edge, such services reduce the time required for data to travel through the network, resulting in faster response times; near-real-time access to data and analytics; enhanced customer experience, and the creation of new sources of revenue. The service is already available in 19 US cities and covers 75% of the US population within its 150-mile zone.[9]

Figure.8

Private cloud is by far the preferred telco cloud deployment model



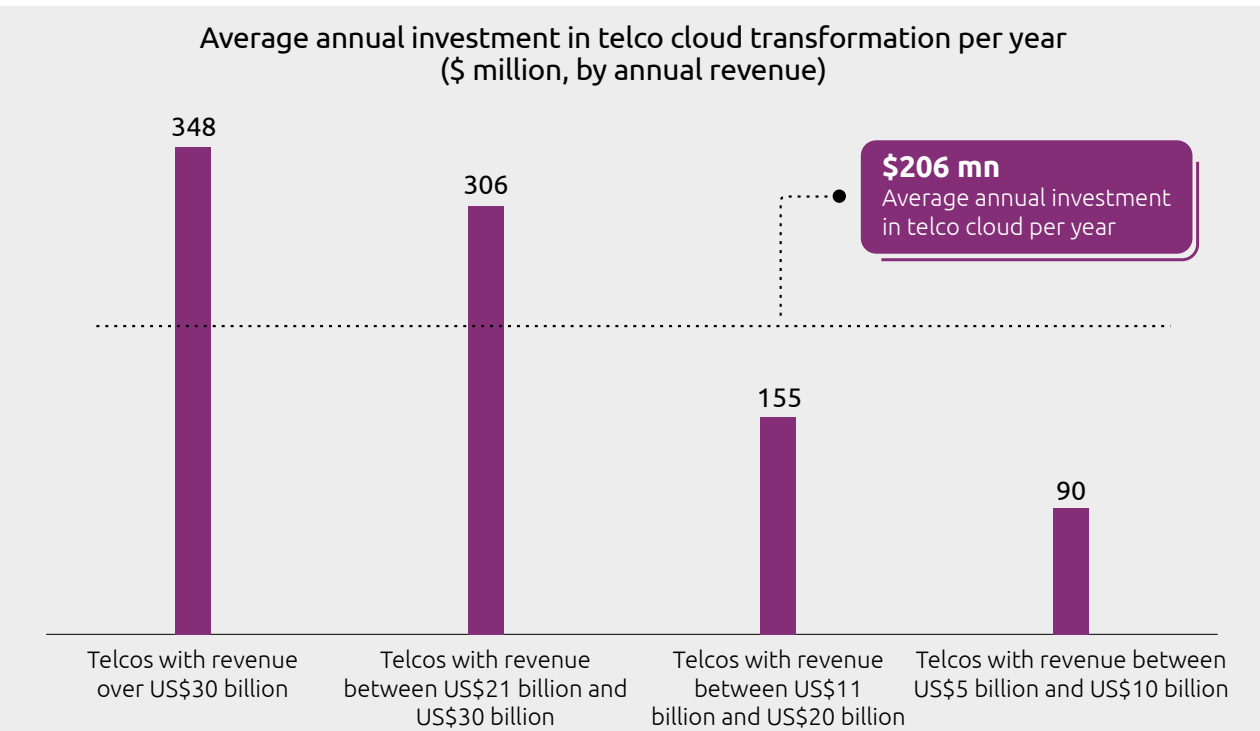
Source: Capgemini Research Institute, Telco Cloud Executive Survey, November–December 2022, N=124 telco technology executives.

Telcos will invest $1 billion on average in telco cloud transformation over the next 3-5 years

Telcos are expected to invest $1.03 billion ($206 million per year) in telco cloud, on average, over the next 3-5 years (see Figure 9). For large telcos (with >$30 billion in annual revenue), telco cloud investment will be, on average, $348 million per year. Smaller telcos are investing on par with this in proportional terms (i.e., share of revenue and network-transformation budget). Telcos of all sizes are investing 38-44% of their network-transformation budgets (the total budget set aside by telcos for various network transformation initiatives) in telco cloud. In revenue terms, this is 0.9-1.2% of annual revenue per telco per year.

Figure.9

Investment in telco cloud will top $1 billion on average over the next five years



Source: Capgemini Research Institute, Telco Cloud Executive Survey, November–December 2022, N=170 telco executives.
Note: The values in $ million indicate average annual investment in telco cloud for telcos.

This network-transformation budget set aside by telcos includes investment in the following areas:

- Research & development
- Professional services/consulting (strategy, roadmap, vendor selection)
- Technology infrastructure (hardware, software, integration)
- Product/service innovation (e.g.,internet of things, edge computing)
- Investment in the workforce
- Change management

The largest share of investment is expected to be made in the following areaas (see Figure 10):

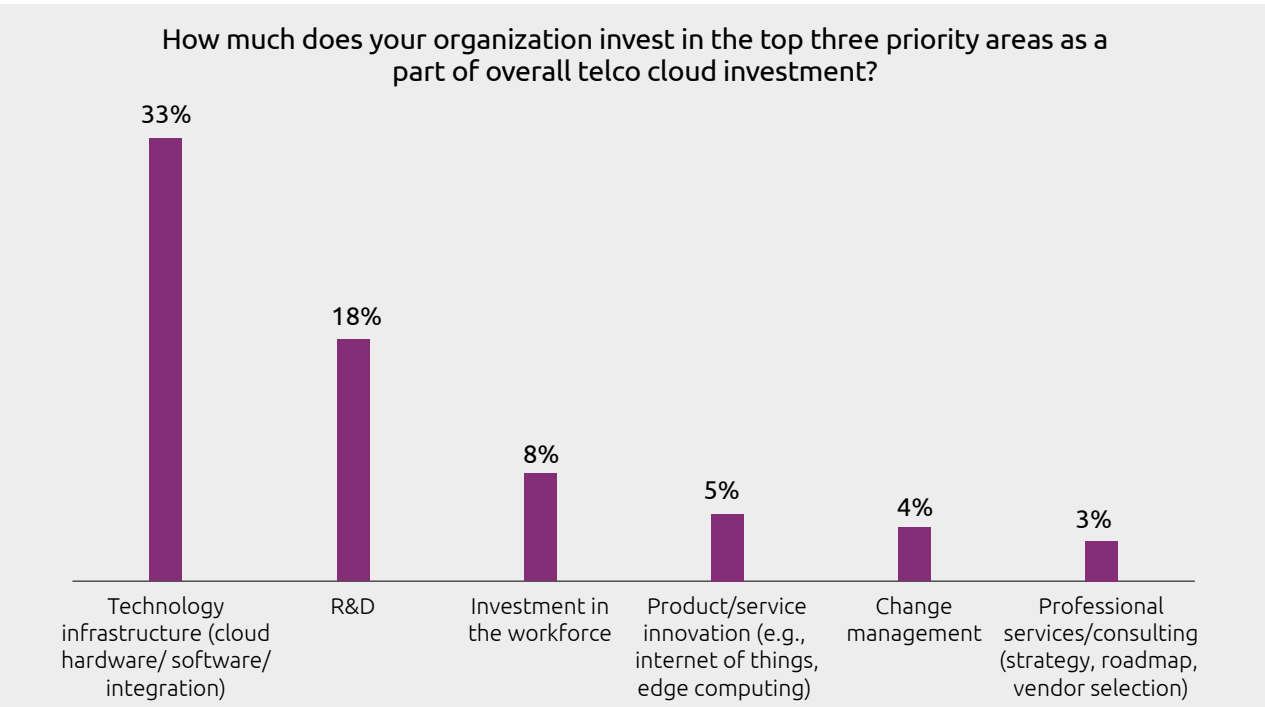
i. Technology infrastructure (33%), including cloud hardware, software, deployment, and integration

ii. Research & development (18%)

iii. Workforce (8%), involving upskilling, reskilling, and hiring for new skills

Figure.10

Technology infrastructure (cloud hardware, software, integration) will take the lion's share of telco cloud investment



Source: Capgemini Research Institute, Telco Cloud Executive Survey, November–December 2022, N=114 telco executives.
Note: Survey respondents were asked to estimate the share of investment in each of their top three areas of the telco cloud value chain.

In terms of global regions, APAC offers the largest share of telco cloud investment in technology infrastructure (36%) – ahead of Europe (29%) and the US (27%).

Nearly 60% of telco cloud investment will be made in just three areas: technology infrastructure, R&D, and workforce

"With the traditional approach, it used to take 6-9 months to deploy a new core network. However, with cloud-native deployment, it can be a matter of weeks/days."

JUAN CARLOS GARCIA LOPEZ
SVP, TECHNOLOGY INNOVATION AND ECOSYSTEM, TELEFÓNICA

02 Telco cloud offers significant business and sustainability benefits

Telcos have realized increased customer lifetime value, shared risk, and improved customer experience using telco cloud

Improved "customer lifetime value" – the total amount of money a customer spends with a business during the lifetime of a typical transactional relationship – emerges as the top benefit realized in the last 3-5 years from telco cloud initiatives (see Figure 11). Customer lifetime value can increase as a result of cross-selling and upselling more value-added services to existing customers, and increasing loyalty benefits to mitigate attrition, among other factors. Telcos also cite as top benefits the sharing of network transformation risk, improved customer experience, and optimized TCO. Henriette Haagaas, Head of Cloud & ICT at Telia says: *"Besides transforming our Networks to cloud, we are leveraging cloud to move customers to new services beyond core connectivity services - Enabling SASE and ZTN, Cyber Security services, 5G and services combining the Hyperscale Cloud services and platforms. In this way we can build trust and value for our customers on a new modern level because only operators own the ability to E2E securely connect between cloud, edge, and users - hence securely orchestrate their Cloud adoption path."*

Figure.11

Top benefits of telco cloud realized in the last 3-5 years – measured by the extent of improvement since transformation

Rank	Top 5 business benefits	Top 5 operational benefits
01	Increased customer lifetime value	Improved workload handling
02	Risk shared with partners such NEPs, hyperscalers, etc.	Greater scalability
03	Improved customer experience (QoS/QoE)	Improved network security
04	Optimized total cost of ownership (CAPEX + OPEX)	Greater flexibility in working with different vendors (reduced vendor lock-in)
05	Increase in average revenue per user (ARPU)	Increased operational efficiency

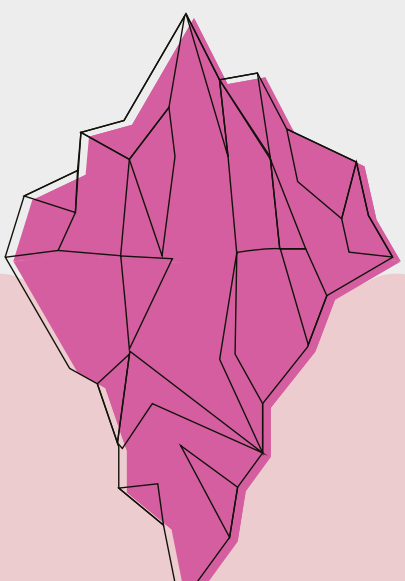
Source: Capgemini Research Institute, Telco Cloud Executive Survey, November–December 2022, N=170 telco executives.

Financial benefits from telco cloud make a convincing business case for investment

Our analysis of financial benefits from telco cloud indicates that telcos will, on average, gain $370–590 million in yearly benefits, against an average investment of $206 million in telco cloud (see previous chapter). Of this, $260–$380 million comes from optimized TCO; the remaining $110–210 million is expected to be realized as additional revenue owing to greater market share achieved through "early-mover" rolling out of cloud-based services (see Figure 12).

Figure.12

Quantifying financial benefits of telco cloud transformation



EXAMPLES OF TOP-LINE IMPROVEMENT

LG U+
Aggressive deployment of a 5G network and capturing the market early helped LG U+ get a lead of 7% of market share vis-à-vis its peers KT and SK Telecom in Korea.

Nokia
Nokia's MX Industrial Edge (MXIE) platform, a cloud-native Industry 4.0 edge solution generated growth of 12.8%, year on year, driven by double-digit growth in core network sales and enterprise solutions.

POTENTIAL TOP-LINE IMPROVEMENT

$110–210 MILLION
Per year per operator

EXAMPLES OF BOTTOM-LINE IMPROVEMENT

Chunghwa Telecom
Chunghwa Telecom, Taiwan's largest integrated service provider, has been able to reduce CAPEX by 16% per year by moving to a microservices-based network automation enabled by cloud.

Rakuten
Rakuten estimated that cloud-native architecture could bring it 40% CAPEX and 30% OPEX savings compared with a traditional LTE operator.

POTENTIAL BOTTOM-LINE IMPROVEMENT

$260–380 MILLION
Per year per operator

Source: Capgemini Research Institute analysis.
These numbers represent the figures for an average-sized telco operator with revenues of US$21 billion.

Telcos expect to realize over $260 million on average in TCO savings

Most of the cost savings are expected to result from a network's optimized TCO, improved operational efficiency, and more efficient workload handling. TM Forum estimates 2021 telco CAPEX and OPEX at $163 billion and $104 billion, respectively. This data, combined with estimates from our research, suggests that, on average, an operator can expect to reduce the TCO by $260 million in a conservative scenario and $380 in an optimistic scenario (see Figure 13 and the appendix for details).

Figure.13

Telco cloud can help optimize network TCO by over $260 million

Telco cloud TCO savings potential	Estimated value ($ billion) for non-cloud deployment	Optimistic estimate ($ billion) for cloud deployment	Conservative estimate ($ billion) for cloud deployment
A. Total network TCO for operators in our study	122	98.3	98.3
B. Average expected TCO per operator using estimates from our research and secondary data to arrive at the optimistic and conservative scenario	1.97	1.59	1.71
C. TCO savings per year for an average operator in our study with revenues of $21 billion		**$380 million (1.97-1.59)**	**$260 million (1.97-1.71)**

Source: Capgemini Research Institute analysis. Refer to the appendix for detailed calculation and assumptions. Survey estimates derived as average values reported by N=62 operators who took part in the study. The cost savings refer to average gain and will vary depending on the size/revenue of every telco. All numbers are estimates.

These benefits will be felt most readily by greenfield telcos, given their lower upfront CAPEX requirement and low OPEX on the latest and up-to-date network architecture. Notwithstanding, significant savings will also accrue in brownfield network transformations that use 5G SA installations on a new stack and involve the migration of existing subscribers from old to new technology. The timing of these migrations is critical to maximizing the savings opportunity (for example, moving applications or functions to cloud when legacy platforms are ready to be retired).

i. On the CAPEX front, while there will be some initial increase for deployment of cloud infrastructure, over the lifecycle of the technology, telco cloud will result in markedly lower CAPEX. A significant portion of network CAPEX comes from RAN – signaling the need to virtualize RAN components and further shift towards Open RAN deployments. Studies have suggested that the cost of building and operating virtual RAN (vRAN) can be 37% lower than for conventional RAN. Optimization and automation of the network drives further savings.

ii. OPEX improvements are most visible at the initial stage of telco cloud deployment. There is an upfront reduction in deployment time. Juan Carlos Garcia Lopez, SVP, Technology Innovation and Ecosystem at Telefónica, told us how much quicker and more efficient it is to deploy network functions on the cloud: *"With the traditional approach, it used to take 6-9 months to deploy a new core network. However, with cloud-native deployment, it can be a matter of weeks/ days."* There are also cost savings and operational efficiencies:

   – Rakuten Mobile's network operating costs are now 30% lower than those of other MNOs [10]

   – Highlighting the savings in manual effort, Shinsaku Shimizu, Software-Defined Network Section Manager, Cloud Platform, Rakuten Mobile says: *"We are managing 48 fabrics with just 15 engineers […] It's a huge time and cost advantage for us."*[11]

Telcos expect to optimize network Total Cost of Ownership (TCO) by 13%, resulting in cost savings of $260-$380 million per year on average

Telco cloud can yield an early-mover advantage of $110-210 million a year

Our analysis shows that telcos can gain additional revenues of $110-210 million a year on average through a more efficient rolling out of cloud-enabled services and by being an early entrant in the market (see Figure 14). We estimate this by using the market potential of top 5G services that telcos have been rolling out for consumers and enterprise customers. We then estimate the additional market share that an early-mover telco can generate over and above its competitors by being first to roll out these services. We estimate this advantage to be 5–10% of additional market share (and thereby additional revenue) in a year, taking a cue from the following examples. It is worth noting that this is the value of an "early-mover advantage" to roll out these services faster through cloud-based platforms, and not the overall revenue potential of these services, which is much higher. Also, this is just the advantage for the first year of operation and is likely to grow manyfold over the next few years as the telco consolidates its position in the market.

In April 2019 **South Korea**'s three operators jointly launched 5G services. In the following six months, **LG U+** -the third-largest telco in the country – managed to secure a market share of 29% by being more aggressive in launching 5G services. This was about 7 percentage points higher than its 4G market share at that point.[12] In addition to its faster 5G rollout, LG U+ also offered the fastest 5G speeds, low latency, and AR/VR-based content for consumer use cases, giving it an edge over its rivals, **KT** and **SK Telecom**.[13]

Reliance Jio launched its 4G services in India in 2016, attaining about 14% market share within a couple of years. Although Jio was not the first mover to offer 4G services in India, unlike its peers, its entire network was future-ready (LTE-enabled), and it had a 4G presence across the country. Jio had also made large investments in fiber-optic cables, ensuring high quality data transmission. It was also the only firm to offer Voice

over LTE (VoLTE), leading to better call quality.[14] Jio also offered unlimited free voice calls; highly affordable data plans; and free access to video, music, and content for the first four months.

We estimate that telcos launching 5G value-added services such as AR/VR gaming and Network-as-a-Service (NaaS) backed by a telco cloud platform for faster time-to-market, will potentially achieve a similar gain in market share (~5-10%) in a year's time. However, as Jio's example shows, several other factors will contribute to providing this advantage, such as:

1. Robust network infrastructure to support fast speeds, high reliability, and low latency.
2. Ease of service provisioning and troubleshooting.
3. Ability to manage increasing subscriber volume and scaling up of network (and cloud) resources; this would require revised end-to-end processes from order to fulfilment, with tools and platforms to support the transition.

Figure.14

Telco cloud can help telcos accumulate over $100 million a year as early movers in cloud-based 5G services

5G services: potential early-mover advantage enabled by telco cloud	Estimated value ($ billion)
A. Global market potential for some of the top 5G services (e.g., AR/VR for gaming, Multi-access Edge Computing, and Network-as-a-Service, among others) by 2024	45.1
B. Market size of 14 surveyed countries in global telecom services market (The 14 markets in our study represent around two-thirds of global telecom revenues)	66.2%
C. Market potential for the selected 5G services in surveyed markets by 2024 (A x B)	29.9
D. Average market potential for the selected 5G services in one market (C/14)	2.1
E. Potential market-share advantage that can be captured by an early- mover telco enabled by telco cloud (estimate based on research estimates and secondary data)	5% (conservative) 10% (optimistic)
F. Potential revenue advantage for an early-mover telco (for an average telco in our study with revenues of $21 billon) (D x E)	0.11-0.21 **($110-$210 million)**

Source: Capgemini Research Institute analysis. Refer Appendix for detailed calculation and assumptions. The advantage refers to an average amount of gain and will vary by individual telco. All numbers are estimates.

Telcos will need to push new services aggressively to improve their top lines (e.g., by rolling out new services faster to gain market share, monetizing new services earlier, and increasing ARPU by upselling new services to existing customers). Deutsche Telekom (DT), in a move to front-load ROI, is focusing on new-revenue generation and creating B2B differentiation through industrial connectivity, edge cloud, internet of things (IoT) ,and new 5G SA core, with quality of service (QoS) and slicing. DT is targeting revenues of more than $100 million from 5G campus networks by 2024.[15]

Scott Andersen, Distinguished Solution Architect at Verizon, comments: *"As we seek to monetize 5G technology, we are examining various use cases, such as utilizing private 5G networks to establish secure bubbles that protect sensitive information and equipment in hospitals."* He adds, *"We're going beyond simply offering Edge cloud computing services to really enabling ultra-reliable and low-latency applications. For example, automatic and real-time vehicle license-plate recognition for law enforcement. Applications like these have a variety of use cases that are only now becoming possible."*

"We're going beyond simply offering Edge cloud computing services to really enabling ultra-reliable and low-latency applications. Applications like these have a variety of use cases that are only now becoming possible."

SCOTT ANDERSEN

DISTINGUISHED SOLUTION ARCHITECT AT VERIZON

Chunghwa Telecom has been able to reduce digital-service launch time from around four months to an astonishing nine days through network-operations automation enabled by cloud.[16] A director of private 5G networks and edge computing at a leading global semiconductor manufacturer adds: *"Telecoms have focused mainly on retail consumers and not enterprise customers. They do not have the Edge infrastructure and the applications to monetize it."*

An AVP, 5G products and use cases, at a large Indian operator says: *"Container-based Architecture-as-a-Service has helped accelerate deployment, as we can set up a whole network within a month. The focus should be on finding new use cases. Enterprise use cases are building up in automation, AI/ML applications, and robotics. For instance, robotic surgery in healthcare would increase and, in such cases, cloudification and 5G use cases would rise."*

Telco cloud is expected to reduce telco GHG emissions by 5%

Besides business and operational benefits, the sustainability benefits of telco cloud are increasingly in focus. For telcos, the current average share of GHG emissions from network assets stands at 42% (see Figure 15). In light of such high impact, organizations are working towards an average reduction target of 5% in overall GHG emissions through telco cloud. Telco cloud can also yield sustainability benefits from lower emissions from facilities (e.g., reduced physical hardware footprint, reduced power usage, auto-scaling of network on demand, and managing power consumption of mobile towers by using AI and machine learning). (See box: Telco cloud and sustainability).

A notable initiative is Vodafone's Net Zero Carbon Target, which aims to achieve net zero carbon emissions from Vodafone's operations, and use of its products and services, by 2040. Vodafone has also set a target of achieving a 50% reduction in the carbon intensity of its network by 2030, from a 2016 baseline.[17]

Reducing emissions by means of telco cloud may appear to be simply "shifting" emissions from direct (Scope 1 and 2) to indirect (Scope 3) sources by outsourcing them to cloud platform providers.

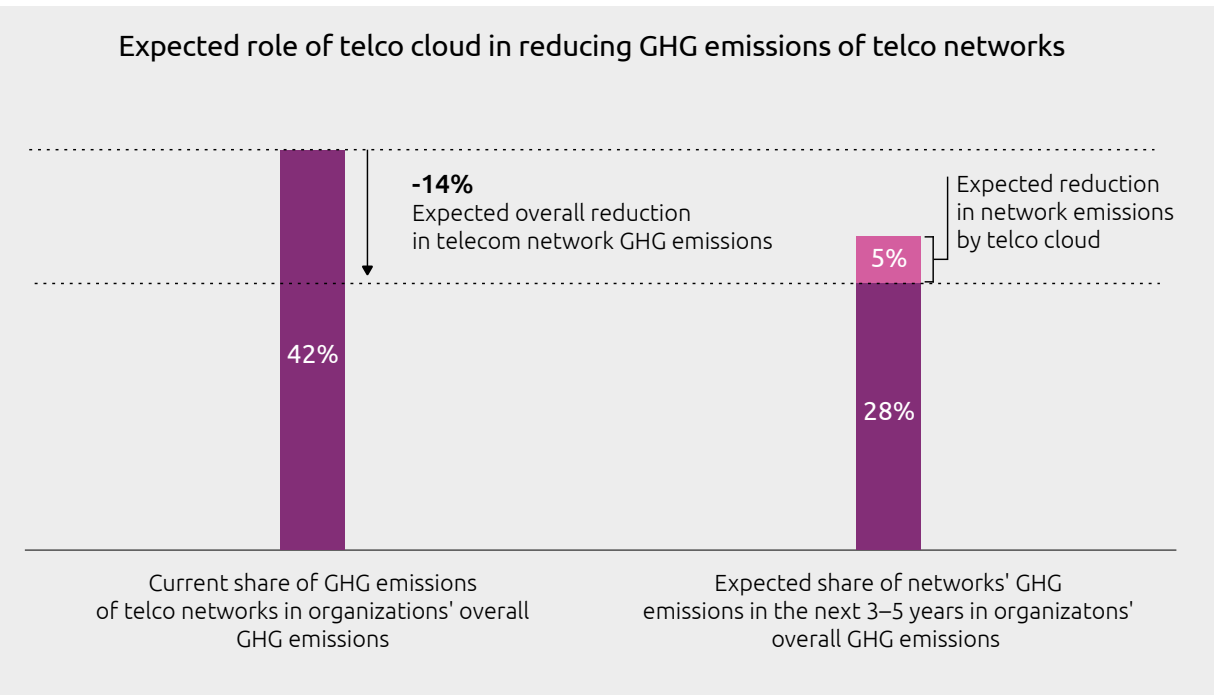
However, a large share of these emissions will still originate from activities owned and controlled by telcos, owing to their strong preference for private cloud architecture ("direct" emissions) as opposed to public cloud ("indirect" emissions). Even network functions that will be deployed on public cloud are likely to benefit from the various environmentally conscious emissions-reduction initiatives usually taken up by hyperscalers for improving their power-usage effectiveness (PUE) – a measure of the energy efficiency of a data center.

However, tweaking the categorization of emissions does not absolve telcos from the responsibility of reducing them.

Telcos that have undertaken cloud transformation expect to reduce their greenhouse gas (GHG) emissions by 5% through telco cloud.

Figure.15

Telcos expect telco cloud to deliver more than one-third of their GHG emissions reduction from networks



Source: Capgemini Research Institute, Telco Cloud Executive Survey, November–December 2022, N=170 telco executives.

Telco cloud and sustainability

Sustainability in telecom network cloud transformation refers to the integration of environmental, social, and economic considerations into the design, deployment, and operation of telecommunications networks that have transformed from a traditional infrastructure to a cloud-based one.

One of the main drivers of sustainability in telecom network cloud transformation is the increasing demand for data and the corresponding need to expand and upgrade telecom networks. This has led to the proliferation of large data centers and new infrastructure, such as cell towers and submarine cables. However, these traditional infrastructure models are energy-intensive and can have a significant environmental impact.

Telco cloud can promote sustainability in telcos in a number of ways:

- Lower emissions from facilities (e.g., reduced physical hardware footprint, reduced office-based power usage)
- Auto-scaling of cloud applications and network functions for more efficient, demand-triggered resource use
- Improved utilization of storage and compute power through bundling of these resources on the cloud
- Managing power consumption of mobile towers by using AI and machine learning to optimize network traffic and energy usage

While many of the operators we spoke to are in the early stages of telco cloud, they are confident of its potential. Telecom operators can work with their cloud providers to ensure that the energy used to power their data centers and other infrastructure comes from renewable sources. This can help reduce the environmental impact of telecom networks and contribute to the transition to a low-carbon economy.

Martin Kurze, Research and innovation Director at Deutsche Telekom says: *"Leading telcos are using cloud-based AI mechanisms; for instance, they can predict periods of low data traffic and turn off base stations accordingly, reducing energy consumption and, ultimately, emissions. They are also working towards producing energy requirements locally (e.g., at base stations) with solar panels and wind turbines."*

Laurent Leboucher, Group CTO of Orange and SVP of Orange Innovation Networks, recently shared some of the work the operator is doing to meet its target of becoming net zero by 2040.[18] Key measures include: sharing network infrastructure; using energy-saving features in network and IT systems; supplying renewable energy to radio sites; and using data and AI to optimize network deployment and operations.

03 Leading telcos are already reaping the benefits of telco cloud

We analyzed the level of preparedness of telcos participating in our survey on the basis of the following criteria:

- Presence of a comprehensive telco cloud strategy with well-defined goals and timelines
- Proportion of network functions that have been virtualized
- When they expect a majority of their network capacity (>50%) to be on the cloud

We found that 23% of telcos are Early Adopters, being among the most advanced on these three dimensions; 67% are Telco-Cloud Followers, whose transformations are in progress; and 10% are Laggards, who have the most ground to cover in terms of their transformations.

Our analysis of these three categories of telco shows that Early Adopters are ahead, not only in terms of the state of their transformations, but also in terms of realizing larger benefits, focused investments, and higher ambitions in relation to cloud.

Early Adopters have realized greater benefits from their transformations

The level of benefits that Early Adopters have realized is greater than those realized by Followers and much greater than those realized by Laggards (see Figure 16). For instance, Early Adopters believe that they're able to share the risk of network transformation over 16% better with their partners through telco cloud whereas Laggards have experienced less than half of that so far. Henriette Haagaas, Head of Cloud & ICT at Telia adds: *"If we don't move fast enough, someone else will. There are no geographical boundaries anymore in the digital economy. Telco's have a lot of legacy, but Telco Cloud offers a way for telcos to break out of the constraints of legacy core systems and be faster to market with new services and features. To really benefit, telcos must radically transform their business model at the same time, to utilize the scale, and generative innovation capacity that is inherent in the "cloud". And if they do, I believe this is an efficient way to offer customers the quality of service and total solutions that will give them great benefits in their own industry and market."*

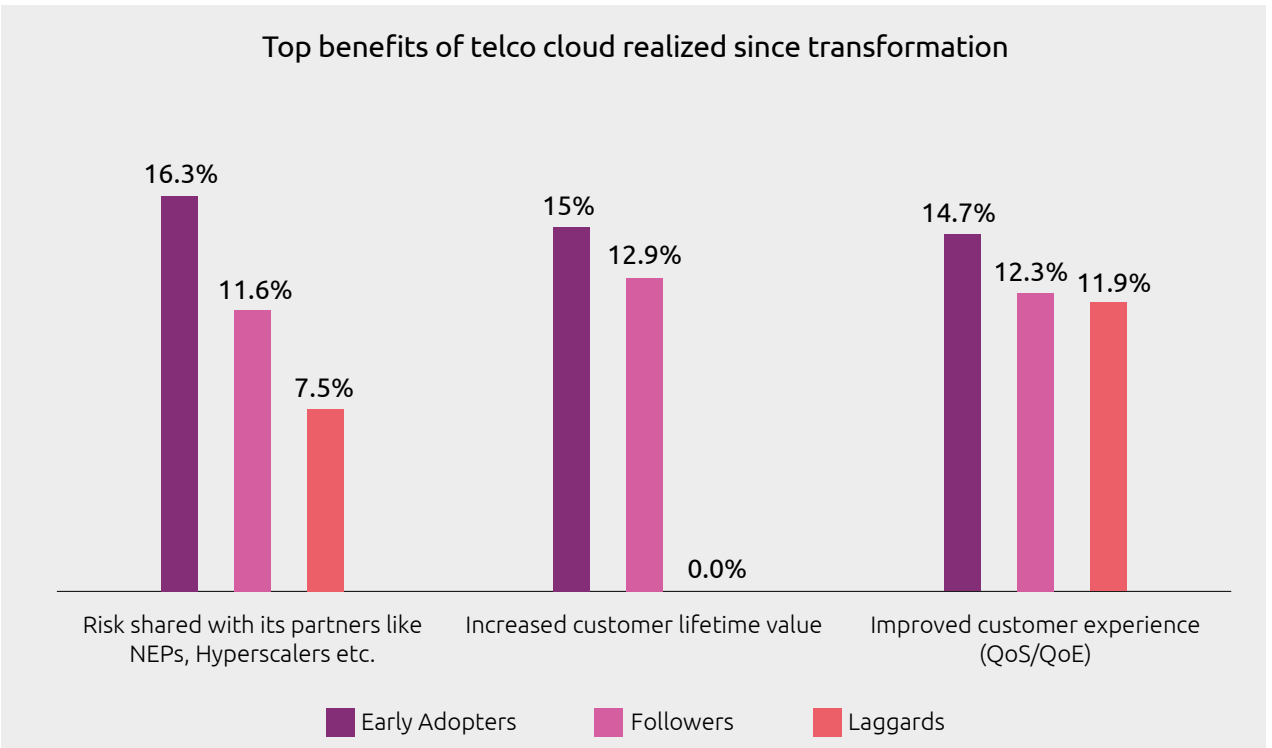
23% of telcos in our study are Early Adopters – having a comprehensive telco cloud strategy, high virtualization, and a shorter timeline for transitioning to cloud

In June 2021, Microsoft and AT&T announced an industry-first collaboration to evolve Microsoft's hybrid cloud technology to support AT&T's 5G core network workloads. Development teams from AT&T's Network Cloud organization moved into Azure for Operators, directly integrating the intellectual property into a Microsoft offering and assuring a seamless transition.[19]

This strategic alliance provides a path for all AT&T's mobile network traffic to be managed using Microsoft Azure technologies. This collaboration puts AT&T in a position to deliver new services faster and more flexibly across Azure public cloud and on-premises by employing common tooling and services, reducing time to market for a cloud-native approach. Microsoft believes this will result in: greater resiliency across the network; cost advantages when it comes to scaling existing services; and more effective introduction of new services, resulting in continuous improvements to the customer experience. AT&T relies upon Microsoft to scale compute and storage capabilities at the edge, while AT&T will retain control of its network stack and market offering.

Figure.16

Early Adopters of telco cloud have realized more benefits from their transformations



Source: Capgemini Research Institute, Telco Cloud Executive Survey, November– December 2022, N=170 telco executives.

R&D, cloud management, and innovation are investment priorities for Early Adopters

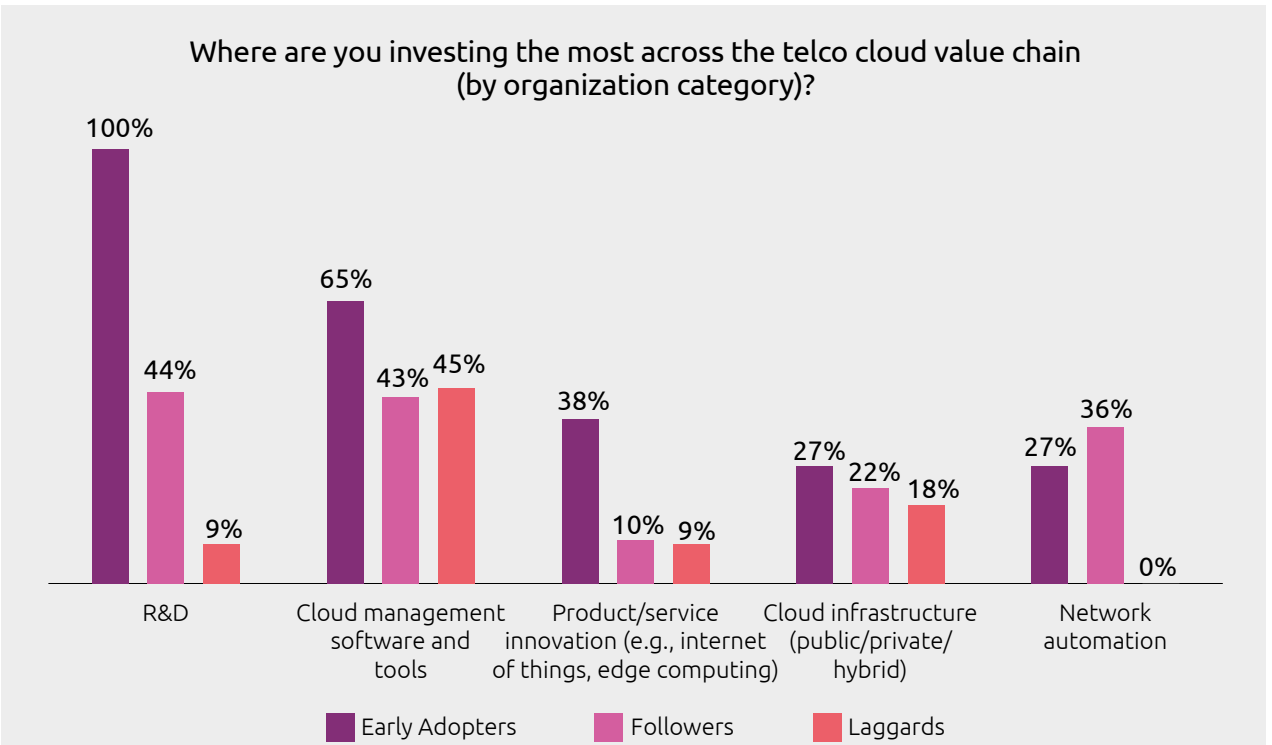
R&D, cloud management, and product/service innovation are the top three investment priorities for Early Adopters (see Figure 17).

Rakuten Symphony (Rakuten's new business that brings together all of Rakuten's telco products) acquired leading Silicon Valley-based cloud-technology startup Robin.io. The addition of Robin.io's multi-cloud mobility, hyper automation, and orchestration capabilities to the Rakuten Symphony portfolio has facilitated the creation of highly efficient and consistent high-performance cloud infrastructure and operations, from edge to central data center.[20]

No such clear priorities exist for Followers and Laggards, although Followers are leading in network-automation investment.

Figure.17

Early Adopters have clear priorities across the top areas of investment in the telco cloud value chain



Source: Capgemini Research Institute, Telco Cloud Executive Survey, November-December 2022, N=114 telco executives.
Percentages represent the share of executives selecting top three areas of investment across their telco cloud value chain.

Early Adopters are more ambitious in their expectations of telco cloud

Early Adopters expect to recover almost half of their investment (47%) in telco cloud within the next five years, whereas Laggards expect to recover only 34%.

The VP head of strategy at a large, global network-equipment provider comments: *"It's important that telcos see some kind of cost advantage to be able to recover the investment that they have to make in their networks. We still don't see mass adoption of applications like VR, AR and 5G networks, so it seems that there is still time to be on the other side of the challenge, but also because the applications and content are not there yet. Private 5G networks being rolled out is a big opportunity. However, the market has to be ready for adoption."*

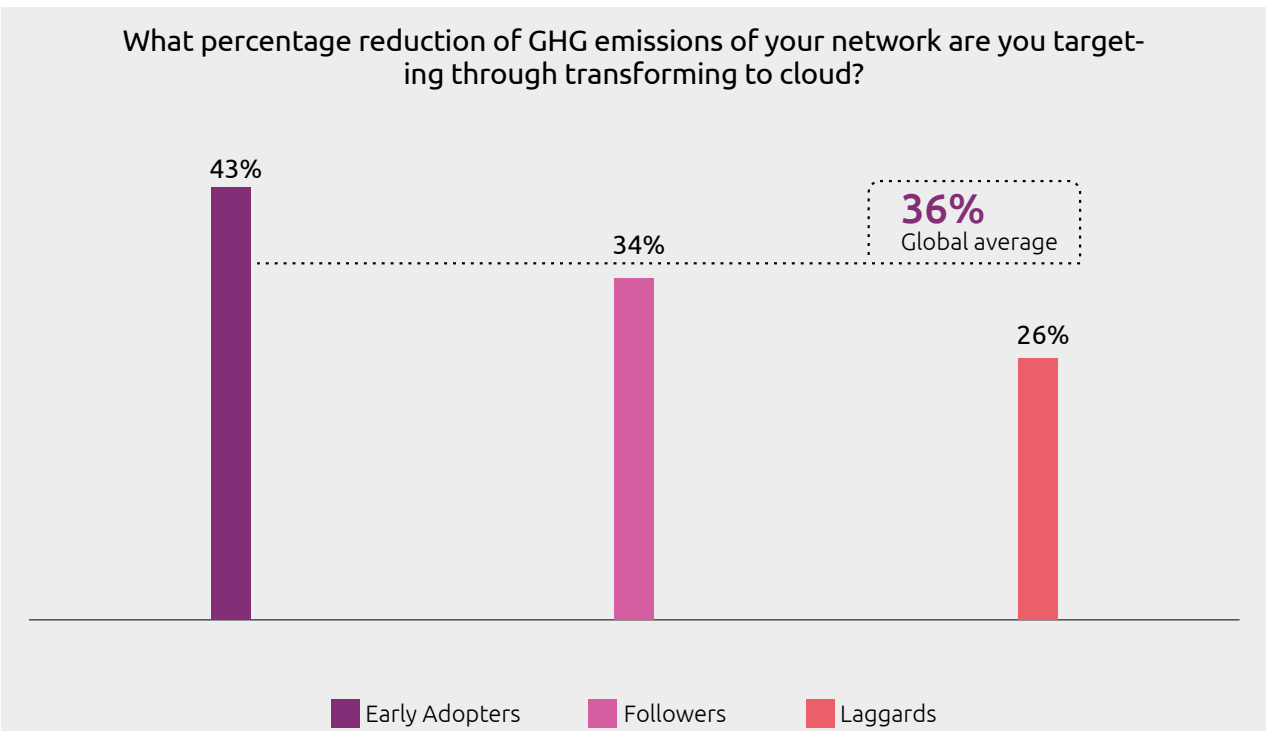
Early Adopters have set a higher target in terms of reducing their network GHG emissions the by transforming to cloud (see Figure 18).

While Early Adopters believe that 43% of the reduction will come from transformation to cloud, Followers have set a goal of only 34% and Laggards of 26%. The head of supply chain (procurement) at a large UK-based telecom operator confirms this: *The most important aspect now for all of us, especially big telco players [like Vodafone, Telefonica, AT&T, Verizon], is to work in a carbon-free environment and all interactions with partners/suppliers/ customers are carried out with a consciousness of GHG/ carbon footprint/sustainability. Through optimum usage of cloud infrastructure, we are consuming less energy and working towards our targets of reduced GHG emissions."*

Early Adopters believe that 43% of the network GHG emissions reduction will come from telco cloud, much more than Followers (34%) and Laggards (26%).

Figure.18

Early Adopters aim to reduce their network GHG footprint most from the cloud transformation



Source: Capgemini Research Institute, Telco Cloud Executive Survey, November–December 2022, N=170 telco executives.
Global average is the average target set by telcos for reducing network GHG emissions by transforming to cloud.

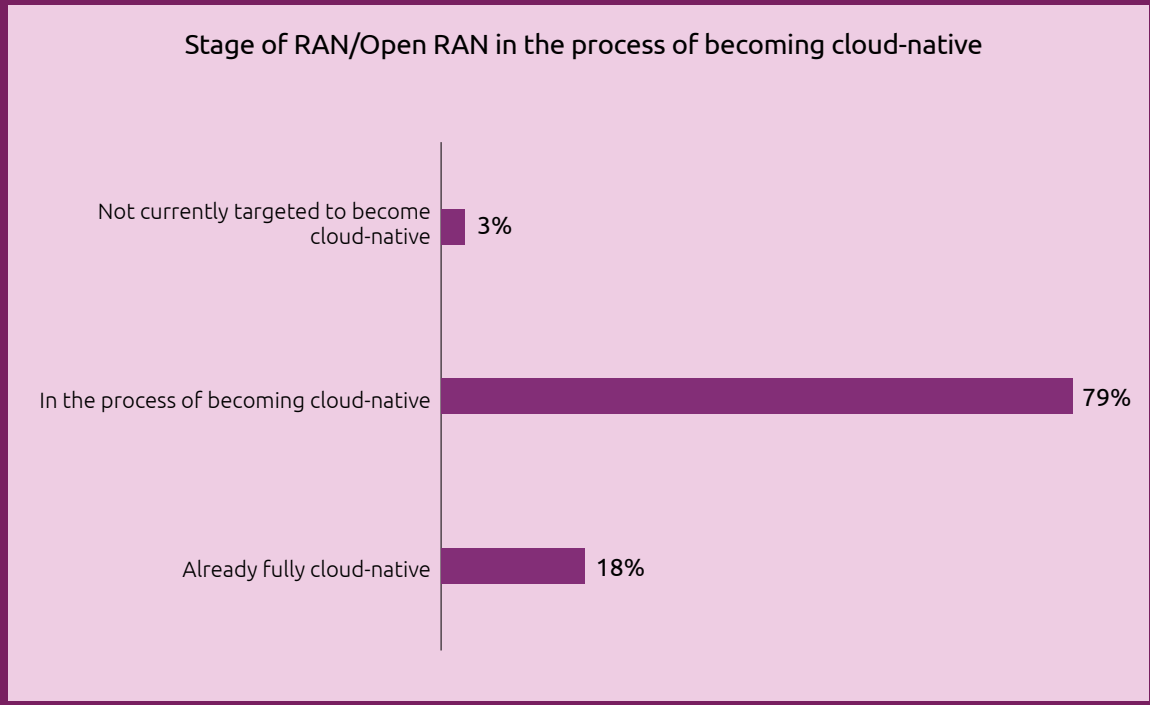
Challenges and opportunities in cloudifying RAN

As the telecom sector moves away from hardware-driven models toward virtualization and software, open radio access network (RAN) technology offers hardware and software components that are not inextricably coupled. Today's networks use largely proprietary RAN equipment, which means that hardware and software parts are typically bundled together or purchased from the same supplier to guarantee network effectiveness, security, and efficiency. An Open RAN network architecture offers an ecosystem-based approach, where network functions in RAN can be assembled from a variety of providers collaborating on a standard set of protocols and specifications. Open RAN has the potential to unlock innovation, lower TCO, and uncover new revenue opportunities.

GSMA Intelligence survey data shows that 5G will be a significant driver, with 75% of operators planning to use 5G as the entry point for adding open networking, including Open RAN, into their networks (albeit this remains a negligible amount compared to the current range of mobile networks).[21] In Germany, the Federal Ministry of Transport and Digital Infrastructure has said it will provide €300 million ($326 million) over several years to support innovative development and testing of new, software-controlled network technologies (Open RAN) and the manufacturing industry in general in Germany.[22] According to our research, 79% of RANs are in the process of becoming cloud-native and, among these, about a third (32%) will be fully deployed in the cloud in 2–3 years (see Figure 19).

Figure.19

A majority of Open RAN will be cloud-native in the next 3-5 years

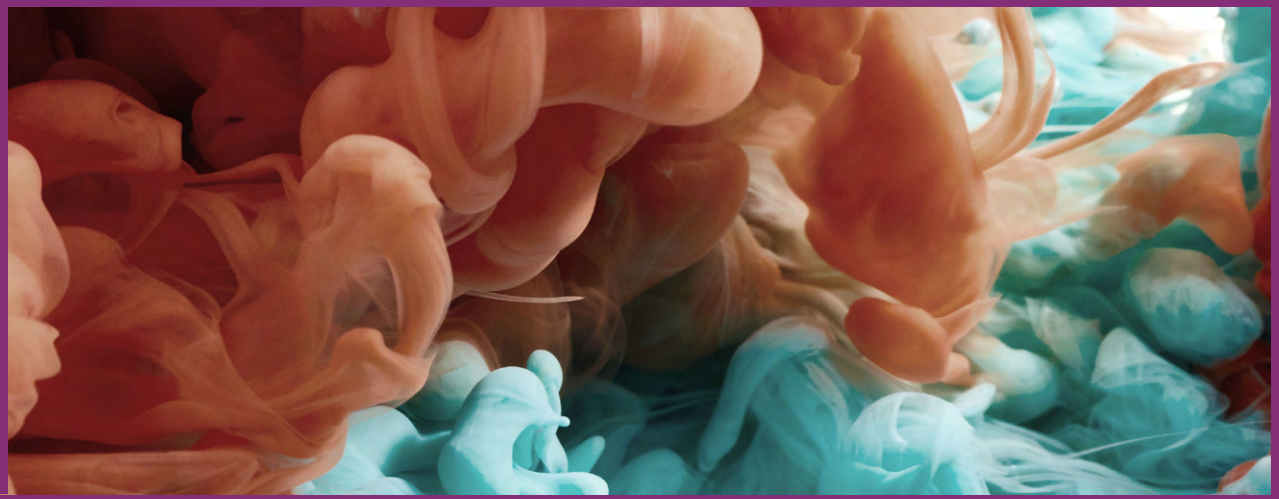


Source: Capgemini Research Institute, Telco Cloud Executive Survey, November–December 2022, N=124 telco tech executives.

Rakuten Symphony has deployed the world's largest Open RAN coverage, with over 275,000 cells managed by a team of only 250 people (as of April 2022), indicating that Open RAN can be scaled and can provide high-density coverage in urban areas.[23] Vodafone has switched on the UK's first 5G Open RAN site in Bath, Somerset. The new site is the first of 2,500 planned and marks the beginning of the first scaled Open RAN project in Europe.[24]

The main benefit of Open RAN is that it enables businesses to use as many ecosystem components as they like. By enabling the selection of "best of breed" network components from a multivendor ecosystem, Open RAN offers greater flexibility and potential, which results in a significant TCO reduction for operators. Juan Carlos Garcia Lopez, SVP, Technology Innovation and Ecosystem at Telefónica adds: *"With Open RAN, we have been able to define a full RAN, a complete radio system, selecting the different components and using a pattern to integrate them. This is a flexibility we never had before and helps us not only to create alternatives for supply chain but also to design and develop specific solutions for specific customers or verticals."*

In an Open RAN deployment, telcos can modify the RAN hardware and software to give specialized functionality based on the enterprise use case and deployment requirement. With open reference designs, the adoption of Open RAN in private networks also promises to simplify the implementation and management of private cellular networks. Alessandro Miranda, Director of Radio Access Network (RAN) Design and Optimization at ZTE Corporation says: *"A very useful part of Open RAN is that you can deploy private 5G networks on top of it, and so support the enterprise network services, such as network slicing, at short notice and reduce the cost of private 5G networks."*

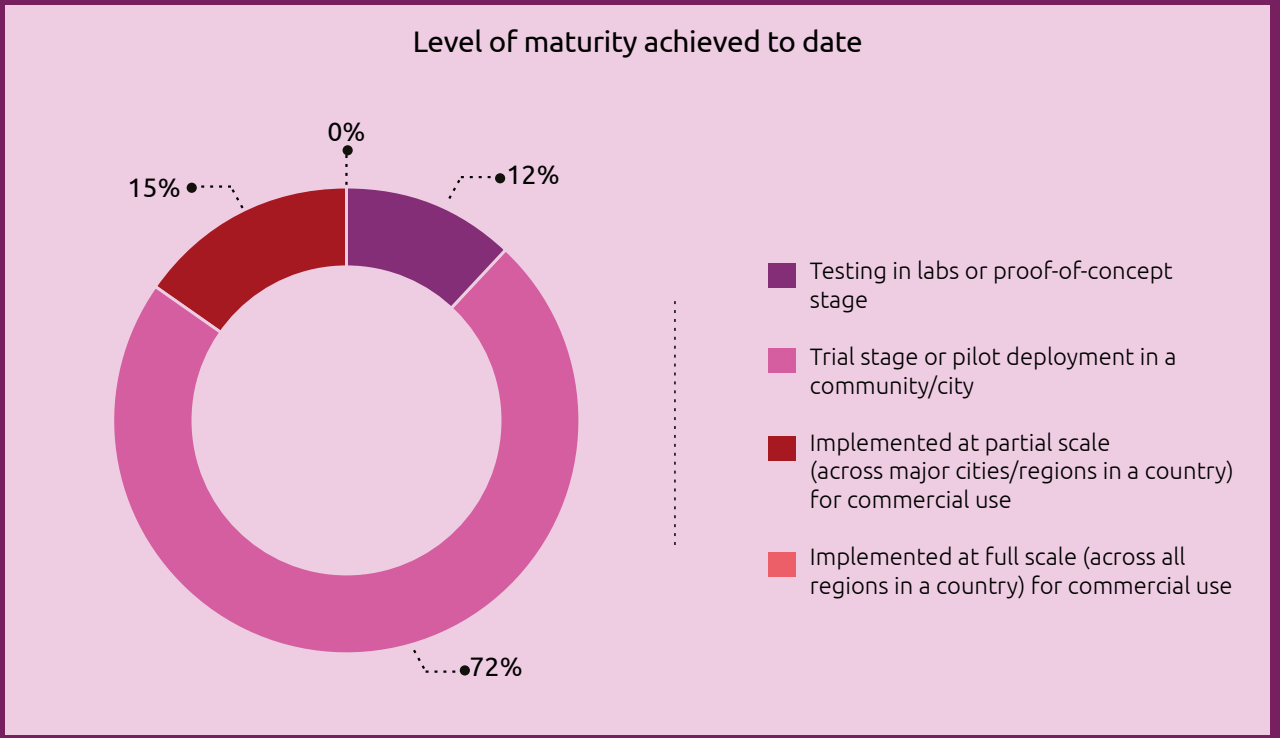


It is also important to understand that telcos face significant obstacles to deploying Open RAN solutions, slowing the adoption rate. The complexity of system integration is increased by Open RAN's potentiation of multi-vendor setups that demand integration between various software modules or between software and hardware solutions. This setting may provide extra difficulties for a brownfield operator, as they would have to consider legacy technology already existing in the network.

According to a study by GSMA, RAN infrastructure will remain the most prominent MNO cost component, at 45-50% of network TCO.[24] Operators do not have a strong understanding of how Open RAN will affect the TCO of the network because the technology is still in its early stages. According to our survey, the majority of RAN/ Open RAN (72%) is still at the trial stage (see Figure 20). Ajay Simha, Director solutions architecture at VMWare confirms this: *"Open RAN adoption is happening right now and is still not very mature. So, for telcos to realize the cost savings, it will take three to five years where they can see year-over-year cost savings in operating the network by doing a high amount of DevOps and automation."*

Figure.20

Open RAN is in the early stages of deployment



Source: Capgemini Research Institute, Telco Cloud Executive Survey, November–December 2022, N=124 telco tech executives.

"Open RAN adoption is happening right now and is still not very mature. So, for telcos to realize the cost savings, it will take three to five years where they can see year-over-year cost savings in operating the network by doing a high amount of DevOps and automation."

AJAY SIMHA

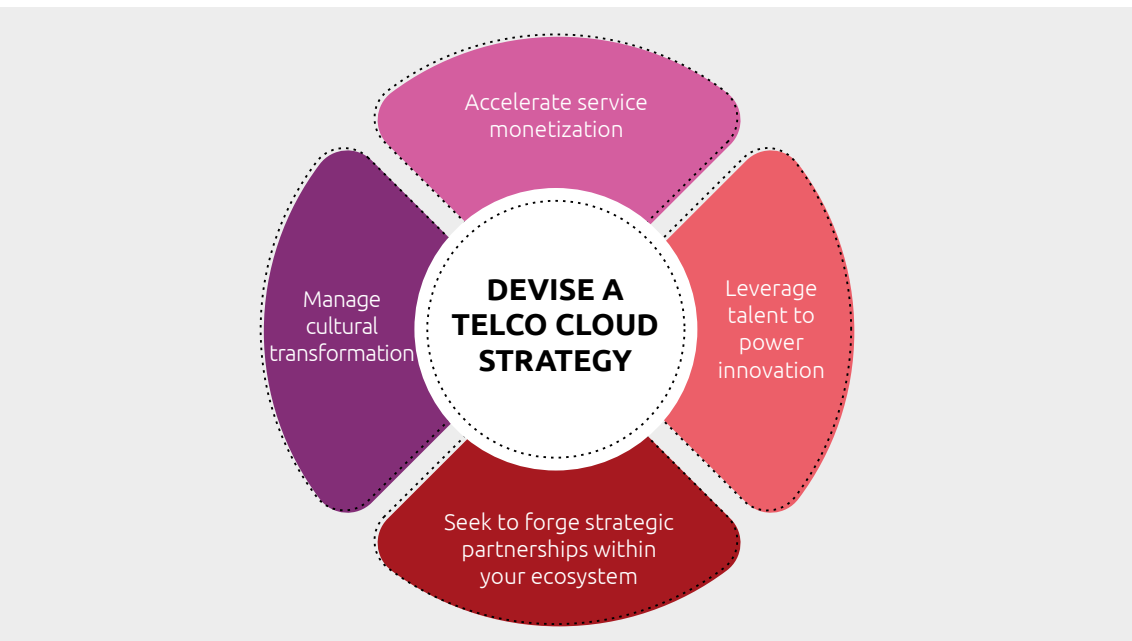
DIRECTOR SOLUTIONS ARCHITECTURE AT VMWARE

04 How can telcos harness the full potential of telco cloud?

Our experience of working with large global operators on their telco cloud journey, and extensive research into telco cloud, has allowed us to devise a five-point plan to help telcos harness the full potential of telco cloud (see Figure 21).

Figure.21

Harnessing the full potential of telco cloud requires a five-point plan



Source: Capgemini Research Institute analysis.

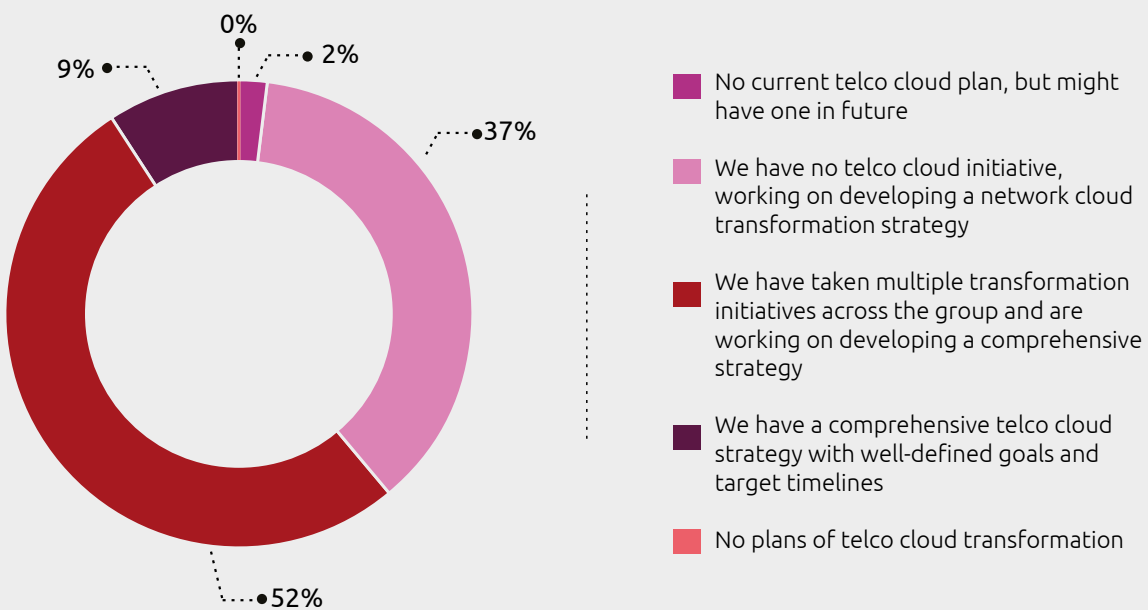
I.Devise a comprehensive telco cloud strategy

In our survey results, nearly one in ten telco executives (9%) said their organization has a comprehensive telco cloud strategy; as many as half (52%) say that their firm has a few telco cloud initiatives but no comprehensive strategy (see Figure 21). Over a third of telco executives (37%) say their organization has no telco cloud initiative at all. This is concerning, as organizations that are delaying telco cloud transformation will find themselves falling further and further behind their peers.

Martin Kurze, Research and innovation Director at Deutsche Telekom, says: *"Telco cloud is a business transformation more than just a technological one. Moreover, it allows for a continuous innovation cycle. A leading telco strategy is designed to reflect that. Software and cloud will give telcos the flexibility to leverage as-a-Service modes. That's a fundamental shift in terms of business, operations, people, and processes."*

Figure.22

Fewer than one in ten telcos has a comprehensive telco cloud strategy



Source: Capgemini Research Institute, Telco Cloud Executive Survey, November-December 2022, N=170 telco executives.

Deutsche Telekom (DT) is taking advantage of its favorable market position to digitalize its operations systematically, taking it from leading European telco to leading "digital telco" globally. Progress in terms of disaggregation and virtualization is facilitating the movement of more network functions to the cloud, and, in turn, enabling the creation of "telco-as-a-platform."This will facilitate integration of the telco's own technical infrastructure with those of its chosen partners and vice versa, allowing DT to access partner networks for its customers, orchestrating a "network of networks," including third-party infrastructure.[26]

A key aspect of the telco cloud transformation strategy is timing. Deployment of 5G SA core acts as a key trigger for implementation of telco cloud; however, not all telcos start with 5G SA core deployment. Many telcos began their 5G journey with 5G NSA deployment that harnesses existing 4G LTE core. Large-scale technology transformations are usually planned as part of a technology refresh – replacing legacy tech with state-of-the-art options and with subscribers/users migrating over time.

II.Aim to achieve rapid, efficient monetization of new services

As we saw in an earlier chapter, monetizing 5G services – and at a quicker rate – will be essential to recouping investment made in telco cloud, and in 5G technology in general. Telcos will need to include service monetization as a core component of the telco cloud strategy and establish leadership and governance approaches to pursue it. In broad terms, it will involve the following stages:

1. **Devise a strategy and identifying core services to productize and monetize**
2. **Assess the market**
   - a. Analyze market demand for various services
   - b. Gauge enterprises' and end-consumers' technological readiness
   - c. Assess customers' willingness to spend
3. **Get the infrastructure ready to provide cloud-based services at scale**
   - a. Run proof-of-concepts and trials in a limited scope
   - b. Firm up go-to-market partnerships
   - c. Create a developer ecosystem to crowdsource services innovation
   - d. Adopt a CI/CT/CD framework to test, develop, and launch new features and updates on an ongoing basis

Capturing the market early with innovative services, and updating regularly in response to data-linked customer needs is key to successful monetization. For instance, Orange and Nokia have announced the deployment of a 4G/5G private network combined with network slicing at Schneider Electric's plant in Le Vaudreuil, France. Network slicing is a key feature of the management of end-to-end 4G/5G quality-of-service and the security of industrial processes, operations, and applications in Industry 4.0. Nokia's slicing solution supports existing LTE, 5G SA and 5G NSA devices. The telecom vendor has also said that its solutions include domain-controller software in RAN, core, and transport layers. This will also enable full slice connectivity.[27]

Only about one in ten telco executives (9%) said their organization has a comprehensive telco cloud strategy

III. Leverage new talent and automation to foster innovation and agility

Many skills required for successful cloud transformation are new and telcos do not necessarily have ready access to them. Naturally, significant investment is required either to build these skills internally (via upskilling and reskilling the workforce) or by hiring them. Our survey shows that telcos will invest 8% of their overall telco cloud transformation budget in workforce-related areas – the third-largest investment area after technology infrastructure and R&D. Most of these investments are likely to be in ramping up talent in software/technology-related areas, for instance:

- Kubernetes, containerization, microservices, and APIs
- DevOps, DevSecOps, and MLOps
- Cloud management (hardware and software)
- Continuous integration/testing/delivery (CI/CT/CD), and automation
- Network security
- Product/services innovation
- Data analytics and machine learning

A principal packet core and infrastructure architect at a UK-based mobile operator says: *"A lot of the skills needed in telco cloud transformation are not easily found internally within telcos. This gap is either filled via hiring from outside or through technology partners, and the contract workforce."*

"Acqui-hiring" is another potential route, as demonstrated by Rakuten Symphony with the acquisition of Robin.io (see above).[28] In 2021, when AT&T announced its 5G mobile network would be run on Microsoft cloud, the deal involved Microsoft acquiring AT&T's Network Cloud engineering team.[29] LabLabee – a startup tackling the gap in telco cloud trainings –recently raised a €1.4 million ($1.5 million) pre-seed round from a broad range of investors.[30] The startup's cloud-based platform, built on standard hardware and open source code, helps learners/clients experience practical use cases across 14 different types of lab platforms across 5G, Open RAN, and SDN, among others.

The level of automation enabled by telco cloud will also be a significant dictating factor in terms of talent acquisition over the next few years. Our survey shows that, following the shift to telco cloud, around two-fifths (41%) of the work of network engineers, architects, and administrators has the potential to be automated. As cloud-based platforms and processes facilitate the automation of these tasks, the network workforce should be reskilled and upskilled to take up more complex and value-adding tasks such as cloud management, cloud administration, developing applications for enabling network-as-a-service, and managing enterprise clients' private networks. Our survey also shows that close to one in four (23%) network engineers, architects, and

administrators will need to be reskilled to allow them to work with newer technologies and processes, and undertake more value-adding jobs (see Figure 23).

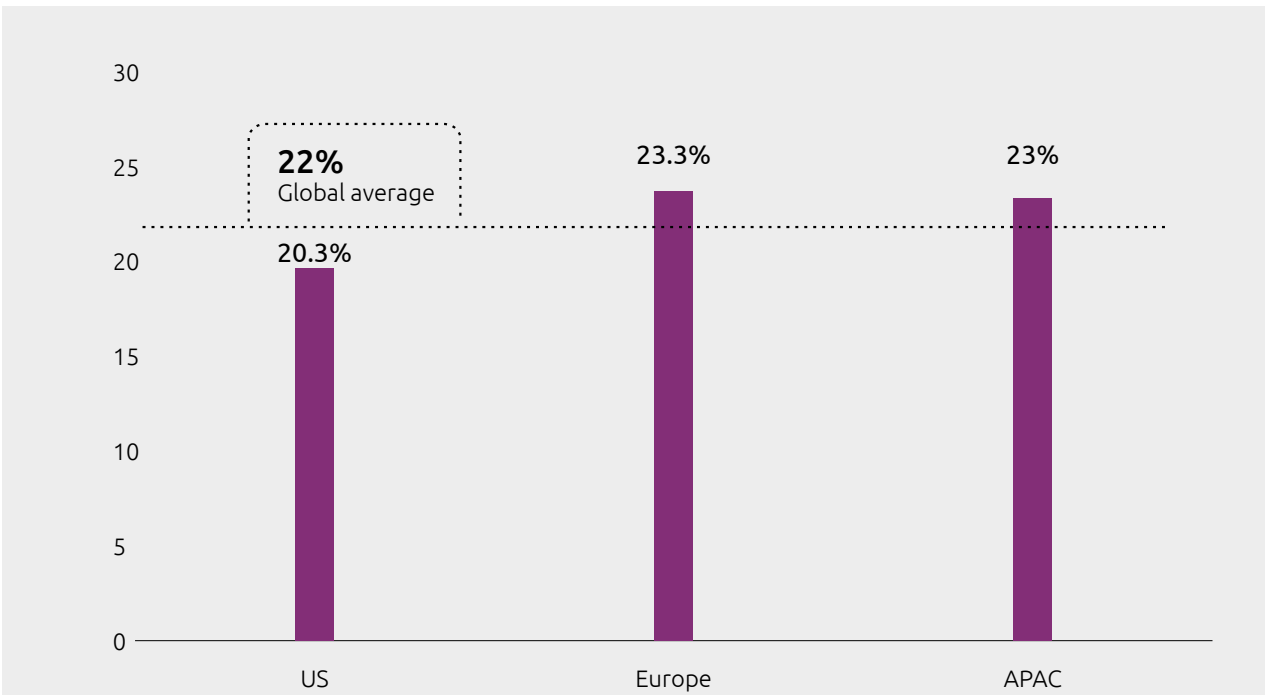
Santiago Tenorio, Fellow and Network Architecture Director at Vodafone told us: *"As you transform your network to cloud, suddenly you have all these new components that require cloud architects and cloud engineering skills. A lot of these skills are scarce, some very expensive to hire, although not all require deep understanding of telco or network domain."*

As automation takes hold, some parts of network workforce's time can be routed towards driving innovation and agility for networks of the future. Juan Carlos Garcia Lopez, SVP, Technology Innovation and Ecosystem at Telefónica explained his organization's innovation priorities: *"Our most important innovation initiative relevant to telco cloud is what we call the 'autonomous networks journey.' Its focus is to make our networks more automatic, better orchestrated, supported by artificial intelligence and machine learning. It's going to make our operations data-driven, efficient, sustainable, secure."*

In addition to automation, agility in service delivery can also be driven using continuous integration (CI), continuous deployment (CD) and continuous testing (CT) – a framework where software is continuously built, tested, deployed, and validated throughout its lifecycle. Of the Early Adopters in our study , 9 in 10 are implementing the CI/CD/CT framework at a partial or full scale while less than half (45%) of Laggards are doing so.

Figure.23

Nearly a fifth of telcos' in-house network workforces will need reskilling as part of the telco cloud transformation



Source: Capgemini Research Institute, Telco Cloud Executive Survey, November–December 2022, N=170 telco executives.
Percentages represent the share of in-house network workforce that needs to be reskilled.

IV.Seek to forge strategic partnerships within your ecosystem

Telco cloud transformation opens up the network side to multiple vendors and partners, which may be a significant change for some telcos. The success of the transformation will hinge on bringing diverse partners together in a symbiotic relationship and orchestrating their efforts for a seamless transition to cloud. Typically, a system integrator with experience in running large-scale transformation programs involving multiple ecosystem entities can assist in setting up governance and program management.

a. Orchestrate ecosystem partnerships and establish clear governance

While involving one of the partners in program management will help, it is important to assign a leader responsible for driving end-to-end transformation, rather than delegating ownership to one of the vendors. The leader should also set up a body containing representatives from all partners to govern the transformation – deciding on prioritization of initiatives and investments, and ensuring alignment of all parties on timelines and goals.

23% Share of telcos' in-house network workforces will need to be reskilled as part of the telco cloud transformation

A VP and head of technology evolution and innovation at a large European mobile operator says: *"In many network domains, there is little choice of equipment vendors for telcos, so they tend to follow NEPs' strategy for this part of the transformation."*

He adds: *"Telco cloud transformation offers a lot of flexibility and choice to a telco. Virtually speaking, a telco can pick ten different cloud-based systems for ten different network functions or domains. However, the number of people, skills, and external support that would require far outweighs its advantages. It is always preferable to work with a small, consistent set of partners and involve a partner to help with governance and program management for smooth operations."*

b. Set up terms of agreement with clarity on cloud costs and their evolution

Lack of control and predictability of cloud costs is one of the top barriers hindering adoption (see Figure 25). Cloud platform providers must offer a level of cost predictability to telcos, providing some cushion for impact on OPEX and, by extension, margins. Offering a potential solution to this problem, a senior director of strategic partnerships at a large, US-based cloud and IT provider told us: *"Often the KPI framework within telcos is fairly complex and not 'OPEX-friendly.' It is not easy for telcos to move from a model of large, heavy investment up front to a pay-as-you-go model."* He adds, *"To have a more smooth transition from a CAPEX-based to an OPEX-based model, it might be helpful to capitalize some of the OPEX, say for one or two years, as a one-time CAPEX investment to remove a large part of the uncertainty in cloud operational costs."*

V.Manage a cultural transformation alongside the technological one

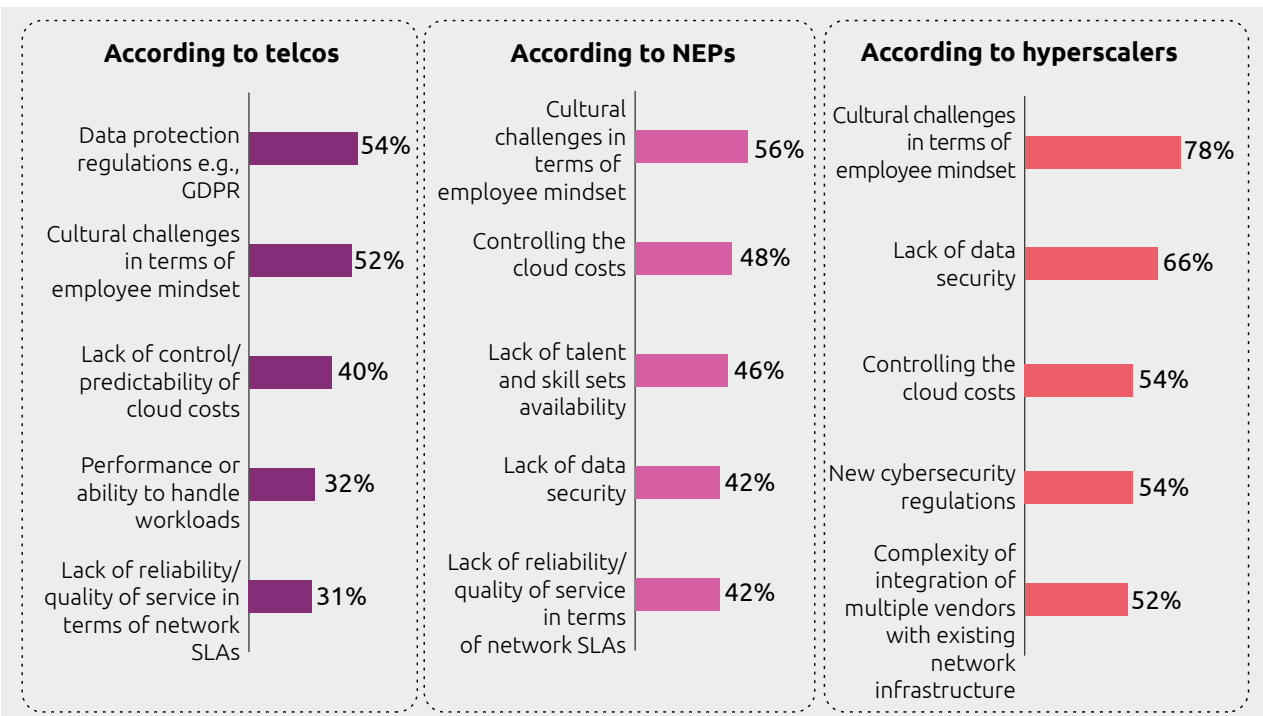
Geoff Hollingworth, CMO, Rakuten Symphony says: *"It would help the telecom industry to view cloud not as something that you buy but as something that you do. It's fundamental to the digital industrialization of infrastructure and your goals are to oversee how it performs around improving economics, resource utilization, security, governance, skills."* Clearly, it requires a fundamental rethink of the culture of telco organization to really "do" cloud well.

A majority of telco executives (52%) believe that cultural challenges (e.g., changing employee mindsets to make the best of cloud opportunities) are the biggest barrier to telco cloud transformation (see Figure 24). A similar level of NEP executives agree (56%), as do a large majority of hyperscaler executives (78%). Lack of control of cloud costs is another top barrier cited by all three players in the ecosystem. The head of IT architecture and infrastructure strategy at a France-based global operator says: *"When you move network workloads from dedicated equipment or servers to cloud-based servers, you're inherently shifting network CAPEX to OPEX. It is sometimes as easy as pushing a button and, without careful oversight, it can lead to soaring cloud operating costs."*

A majority of telco executives (52%) believes that cultural challenges (e.g., changing employee mindsets to make the best of cloud opportunities) is the biggest barrier to telco cloud transformation

Figure.24

Most ecosystem players agree that cultural challenges are top barriers to telco cloud



Percentages represent the share of executives who selected a given challenge as a top barrier to telco cloud.
Source: Capgemini Research Institute, Telco Cloud Executive Survey, November-December 2022, N=270 telco executives, N=170 CSP, 50 NEP, and 50 hyperscaler executives.

Regulatory issues, such as data protection, cloud sovereignty, and cybersecurity are also among the top concerns. A VP and head of technology evolution and innovation at a large European mobile operator comments: *"Owing to strict regulation, the choice of vendors for core and RAN is rather limited. However, specifically for private 5G network equipment or bare-metal cloud infra, there are some good options available. From an R&D perspective, I have found some of them quite useful for co-innovation of products and services."*

As telco cloud transformation fundamentally shifts network design, deployment, and management, the network workforce needs to undergo a step change in terms of its approach towards telco network. The network workforce will be infused with software and IT (programming, security, containers) expertise, and will also initiate a much more agile environment, facilitating faster turnaround times, with less resources and effort devoted to installation and maintenance and more to complex troubleshooting and client support.

This perspective highlights that a strong focus is needed on change management to transform the organization smoothly while being mindful of the people and processes it affects. Yet, our survey found that only about 18% of executives believe that change management is a top-three telco cloud investment area. On average, telcos expect to spend just 6% of their overall telco cloud investment on change management. Beatriz Ortega, Telco business development Manager at Red Hat, says: *"I'm sure telcos will invest adequately in technology, but I'd advise them to invest sufficiently in people and processes as well. The transformation will not be successful unless the telco culture transforms along with it."*

As processes and people undergo the transition, it might also require a reorganization of departmental/functional boundaries and fusing silos together. The principal packet core and infrastructure architect at a UK-based mobile operator says: *"Some reorganization of talent becomes necessary. In the initial stages of the transformation, we had the same team being responsible for everything from infrastructure to application. Now, we have a specific infrastructure team that's taking care of deployment, as we realized that the transformation requires extensive understanding of hardware infrastructure."*

Conclusion

Telco networks are steadily evolving to accommodate a future in which the software used to implement and operate the network will also run it almost autonomously, with AI/machine learning optimizing systems and directing traffic in real time. Network resources will be much more sustainable, and will be more energy-efficient, often powered by renewable energy. That future is taking shape today with the deployment of initial cloud-native network functions. It is a fundamental change in the evolution of the network that has been dominated by physical devices and infrastructure. CAPEX investments are gradually shifting to OPEX, and fixed-price business models are being replaced by flexible "as-a-service" models. Leading telcos are already on board with this transformation and are reaping benefits. Being an early mover is critical if your organization is to reap the largest rewards from this opportunity.

Appendix

Business case calculations

I. Estimating TCO savings enabled by telco cloud

	Telco cloud TCO savings potential	Estimated value ($ billion) for non-cloud deployment	Optimistic estimate ($ billion) for cloud deployment	Conservative estimate ($ billion) for cloud deployment	Remarks and assumptions
A	Global network CAPEX estimate (TM Forum, 2021)[31]	163	130.4	130.4	20% saving in a cloud-native deployment as an average estimate considering Rakuten's 40% savings
B	Global network OPEX estimate (TM Forum, 2021 and 2022)[32]	21.8	18.6	18.6	15% saving in a cloud-native deployment as an average estimate considering Rakuten's 30% savings
C	Expected network TCO (a + b)	184.8	149	149	Sum of a and b
D	Network TCO for operators in our study (0.66 x c)	122	98.3	98.3	Operators in our study represent 66% of the global market
E	Average expected TCO per operator (d/total operators in our study) TM Forum and Rakuten estimates above used to arrive at the optimistic scenario	1.97	1.59		N=62 operators in our study
F	TCO savings owing to telco at thecloud (Capgemini survey estimate, used to arrive at the conservative scenario)			13%	Telcos have reported a 13% TCO improvement on average in our survey
G	TCO for cloud-based network deployments		1.59	1.71	
H	TCO savings per operator per year		**$380 million (1.97–1.59)**	**$260 million (1.97–1.71)**	**$260–$380 million per year for an average telco with revenues of $21 billon**

Appendix

II. Estimating the potential early-mover advantage enabled by telco cloud

We take a hypothetical scenario of a typical operator in our study (with an average annual revenue of $21 billion) that launches several 5G services for enterprises and consumers (faster time to market enabled by telco cloud) in the next 6 to 9 months. The revenue advantage owing to telco cloud is estimated below:

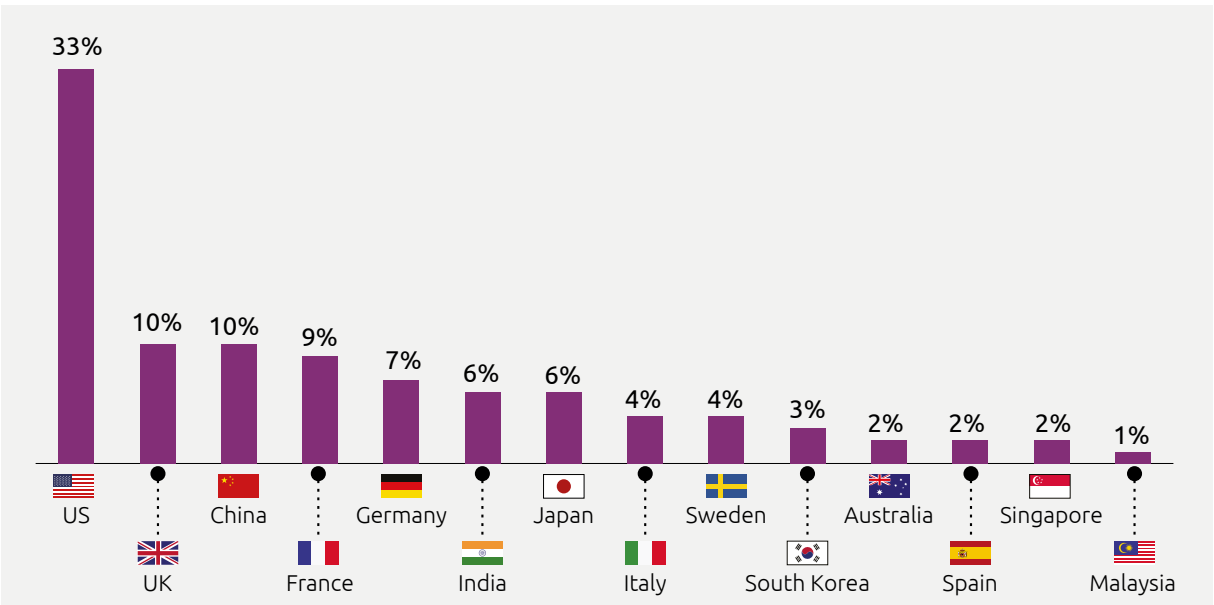
5G services: potential early-mover advantage enabled by telco cloud	Estimated value ($ billion)
A. Global market potential for some of the top 5G services by 2024	
I. AR/VR for gaming for end-consumers[33]	7.8
II. 5G slicing for enterprise customers[34]	1.3
III. Network-as-a-Service (NaaS) for enterprise customers[35]	14.8
IV. Multi-access edge computing for enterprise customers[36]	17.4
V. Private 5G network services for enterprise customers[37]	3.8
B. Total global market potential for top 5G services by 2024 (sum of Ai to Av)	45.1
C. Market size of the 14 surveyed countries in the global telecom services market (The 14 markets in our study represent around two-thirds of global telecom revenues)	66%
D. Market potential for the selected 5G services in surveyed markets (B x C)	29.9
E. Average market potential for the selected 5G services in one market (D/14)	2.1
F. Potential market-share advantage that can be captured by an early-mover telco enabled by telco cloud (estimate based on research estimates and secondary data)	5% (conservative) | 10% (optimistic)
G. Potential revenue advantage for an early-mover telco (for an average telco in our study with revenues of $21 billon) (D x E)	**0.11–0.21 ($110 – $210 million)**

Research methodology

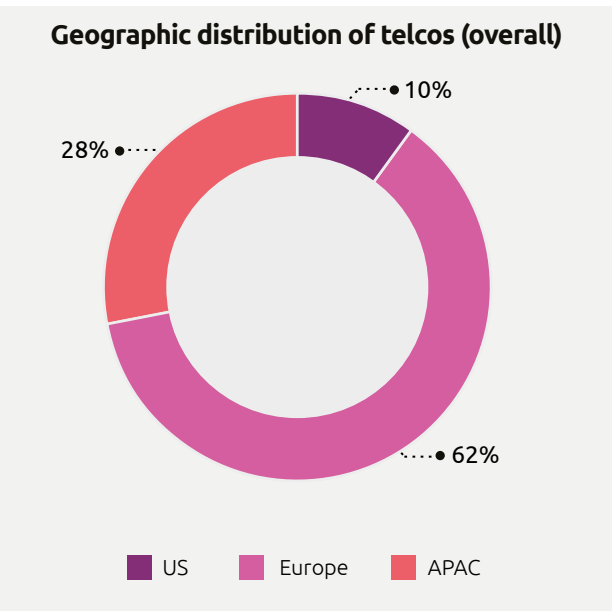
We surveyed 270 executives from large CSPs, network equipment providers (NEPs), niche equipment vendors (NEVs), hyperscalers, CaaS vendors, and large cloud providers. Of these, 170 executives belong to CSPs, 50 to NEPs, and 50 to hyperscalers.

We also conducted in-depth interviews with more than 25 industry executives.

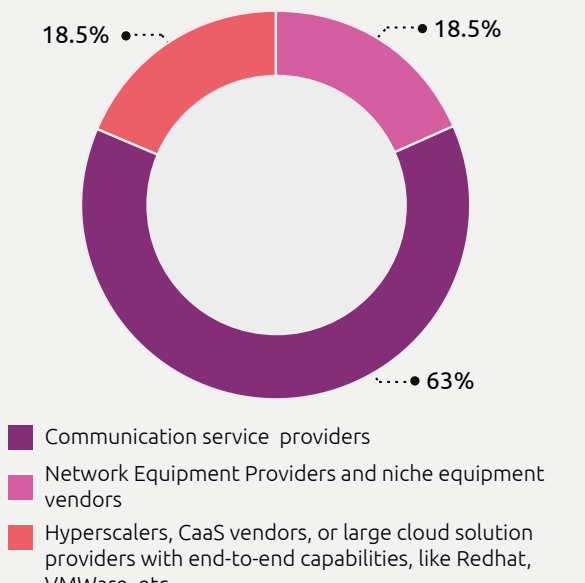
Executives by country



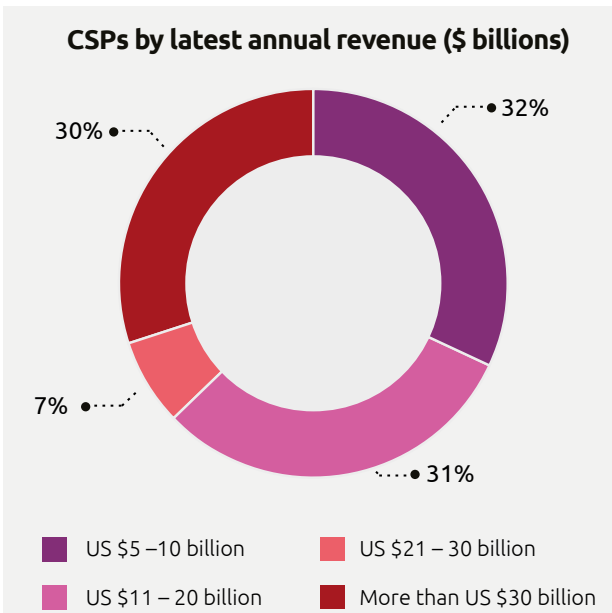
Geographic distribution of telcos (overall)



Organizations by sector

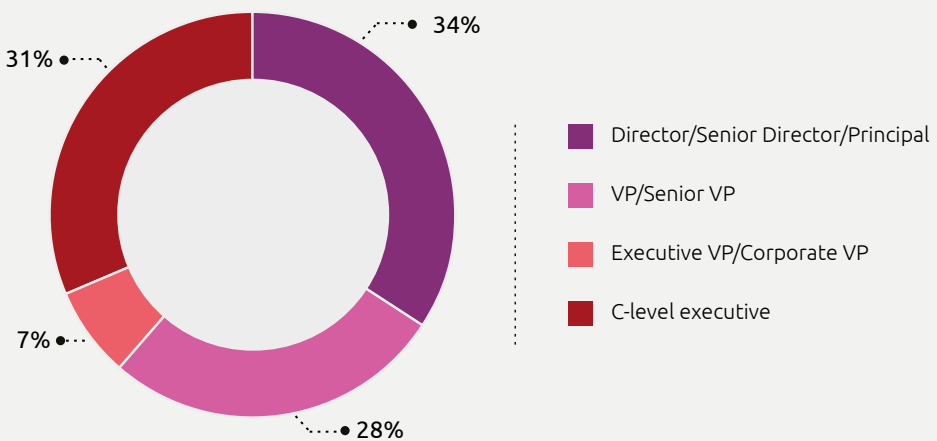


Organizations by revenue

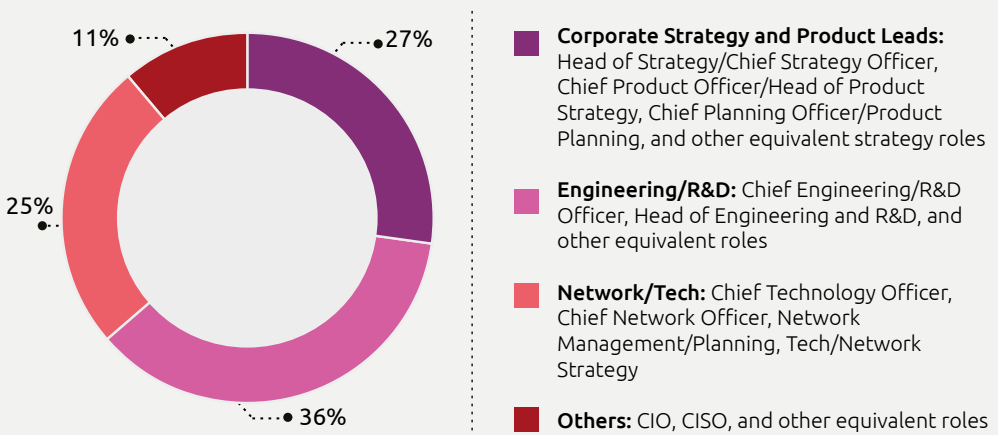


Executives by title and function

All executives (N=270)



CSP executives (N=170)



The study findings reflect the views of the people who responded to our online questionnaire for this research and are aimed at providing directional guidance. Please refer to the methodology for details about the respondents or contact a Capgemini expert to understand specific implications.

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Glossary

TERM	DEFINITION
Network function	A building block of telecom networks that fulfils a specific function (e.g., router, switch, firewall, load balancer).
Software-defined networking (SDN)	Use of software-based programs to control underlying network hardware and direct traffic on a network.
Network function virtualization (NFV)	The replacement of network appliance hardware with virtual machines.
Containerized network functions (CNFs)	Network functions designed and implemented to run inside containers. Containerization of network architecture components makes it possible to run a variety of services on the same cluster and more easily on-board already decomposed applications, while dynamically directing network traffic.
Cloud-native	Cloud-native technology is built in and for the cloud. It is optimized for this use and provides distinct benefits, including cost savings, improved performance, resiliency, and scalability.
Microservices	Small, loosely coupled, and independent services that make up an application. They can be developed and deployed independently of other services, and modified without affecting the entire application.
Kubernetes	An open-source system for automating deployment, scaling, and management of containerized applications.

Glossary

TERM	DEFINITION
Containerization	A software-deployment process that bundles an application's code with all the programs that it requires to run on any infrastructure.
Network slicing	A method of creating multiple networks on top of shared, common physical infrastructure.
Radio access network (RAN)	A part of the telecom network that connects end-user devices to the telecom network core through radio connections.
Network core	Core is the heart of a mobile network. It establishes reliable, secure connectivity to the network for end users and provides access to its services.
Multi-access edge computing	Network architecture that allows cloud computing infrastructure at the edge of networks, enabling the network edge to analyze, process and store the data. Facilitates near-real-time analysis, reporting, and automation, reducing network response time and improving customer experience.
OSS (Operations support systems)	Computer systems used by operators to manage their networks (e.g., with inventory, service provisioning, network configuration, and fault management).
Orchestration	A series of tasks or actions to set up network devices, applications, and services to achieve specific objectives.

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The key contributors would like to thank Hiral Shah, Arnab Das, Fotis Karonis, Nitin Arora, Kunal Khan, Nazirali Rajvani, Luca Quattropani, Derek Long, Sylvain Allard, Amit Joshi, Francisco Jesús Viceira Alguacil, Lukas Kuckelkorn, David Peterson, Ashish Bhasin, Letizia Bacciardi, Ramon Armada Arnau, Finn Alkskog, Ben Pietrabella, Manish Aggarwal, Stuart Ball, Subhankar Pal, Arun P Santhanam, Jean Philippe Defrance, Punam Chavan, Rupali Chakraborty, Ashwani Kumar and Kristin Morris for their contribution to the report.

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The Capgemini Research Institute is Capgemini's in-house think tank on all things digital. The Institute publishes research on the impact of digital technologies on large traditional businesses. The team draws on the worldwide network of Capgemini experts and works closely with academic and technology partners. The Institute has dedicated research centers in India, Singapore, the United Kingdom, and the United States. It was recently ranked number one in the world for the quality of its research by independent analysts.

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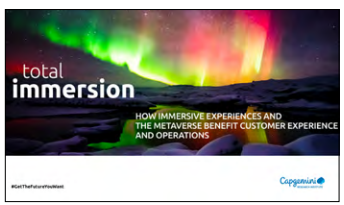
5G in industrial operations -How Telcos and industrial companies stand to benefit

Intelligent products and services: Unlock the opportunity of a connected business

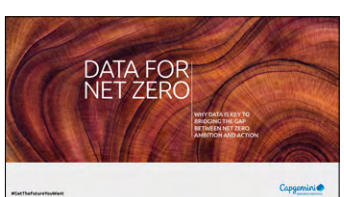


Total immersion: how immersive experiences and the metaverse benefit customer experience and operations

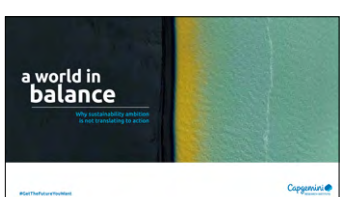
Cloud sovereignty: the road ahead

Rethink: why sustainable product design is the need of the hour

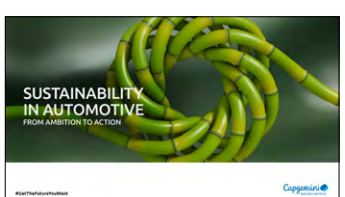
Accelerating the 5G industrial revolution



Data for Net Zero



A world in balance: why sustainability ambition is not translating to action



Sustainability in Automotive: from ambition to action

Capgemini Automation applied to Telco Cloud

Deploying containerized network functions on top of a Telco Cloud environment is a complex task, and current lifecycle is not quick enough to meet the releases and patches coming from the vendors.

Usually there is lack of collaboration among various functional teams and significant time spent on manual testing which causes multiple human errors and delays in network management and operations.

Relying on automation solutions seems to be the best choice, especially if this is based on open-source tools Integrated and available for Network Functions service deployments; this will allow bundled E2E Services with well-established CI/CD/CT Integration workflows with test equipment vendors, which can be executed in timebound manner for network functions and services

Our Capgemini Advanced Network Automation Toolset is an ideal approach adaptable to existing CSP's initiatives.

Testing all these assets require managing all the test environment, ensuring the existing labs are used by the required teams in time and manner. Lab automation and rationalization will help CSPs to save time an effort as well as minimizing delays due to poor lab resources management. Our Capgemini Testing Services and Tools may help on this transformation journey

Operations is another area where automation takes an important role. Capgemini's NetAnticipate is an award winning, self-driving network platform for realizing zero-human touch network operations:

- Predicting potential network anomalies
- Building autonomous decisions and taking preventive actions
- Providing an autonomous feedback loop that ensures the network self-learns to improve actions

We help our CSP clients accelerate their network automation journey, providing end-to-end services and accelerators for strategizing, building & transforming their network services. We help our clients along their entire network automation journey.

SERVICE ORCHESTRATION

Define a network transformation strategy with leveraging Capgemini solution blueprints

CI/CT/CD

Network functions (xNFs) in multidomain networks across any type of cloud or edge to achieve service agility and time to market

LAB AUTOMATION

Automated lab management
Automated test execution
Lab hosting services - adaptive R&D Infrastructure for testing, certification & industrialization

SERVICE ASSURANCE & OPTIMIZATION

Design & develop end-to-end service operations with smart intelligent and closed loop automation driven by AI & ML

ECOSYSTEM ORCHESTRATION & INTEGRATION	Assemble & integrate solutions to form a coherent, scalable, agile, software-driven and futureproof : • Integrate with existing customer driven tools and open-source solutions • Provide E2E standalone network automation solution	**Capgemini** **ANA**
END-TO-END INTELLIGENT OPERATIONAL SERVICES	Transform operations as a managed service towards excellent NPS , being agnostic to cloud and infrastructure ecosystem in a multi-domain environment - Multivendor Core, Transport, RAN, OSS, NFV, Edge … • Provide Smart Intelligence through data, analytics and closed loop automation	**Capgemini** **Netanticipate**

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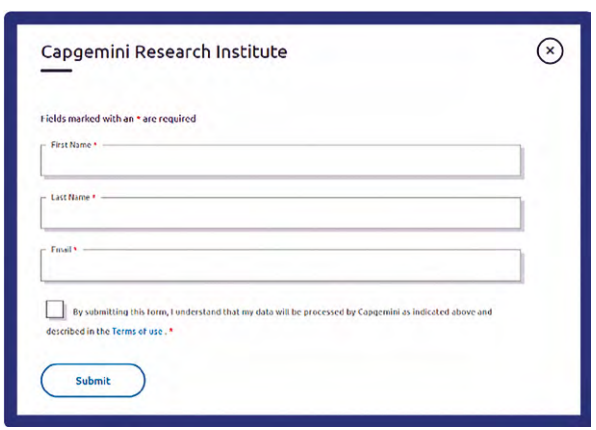

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