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Chapter 2: Transitioning from traditional hardware-based infrastructures to flexible and scalable cloud-native telecom environments

2.1 Introduction

Today, the telecommunications industry is witnessing massive growth trends that demand a new, cloud-native approach to delivering services and supporting customers. Gone are the days of proprietary infrastructure and displays of impressive feature sets meant to woo potential investors more than customers. Telecommunications, particularly from the customer viewpoint, are largely about seamless continuity and real-time operations (Mijumbi et al., 2016; Bhamare et al., 2017; Cziva & Pezaros, 2017). This is an industry where an "always on" mentality has become de facto, where change is the norm and not the exception, and in terms of the physical infrastructure, cannot be done within data center confines.

Thankfully, we have technology to thank for the necessary framework and philosophies to operate in this light. Service-driven endpoint, cloud-native design, IoT integration, and dedicated machine-to-machine backend services are all themes that have arisen over the years in this industry. In short, the Internet dictates the most effective infrastructure, services, and direction for any provider looking to stay competitive across distributed marketplaces. Though leveraging the cloud offers some much-needed advantages, even the staffing and culture change brought on by cloud-native is a welcomed evolution in this traditional industry.

The purpose of this study is to explore potential cloud-native solutions to the cavalcade of problems affecting this industry today. Throughout this study, we will discuss the benefits of utilizing container technology, the various implications of service mesh creation, and strategies for when and how best to leverage continuous deployment chains that are AI-informed. Where appropriate, we will also help set the stakes by providing a review of the current telecommunications industry and why the development is significant for operational stakeholders. These potential industry outcomes will be discussed with the results. This study is important for all telecommunications operators and related professional organizations to include both national governmental technology councils.

2.1.1. Purpose and Scope of the Study

The purpose of this study is to provide valuable data and a deeper understanding of the journey of transitioning telecom systems to cloud-native architectures. This process involves replacing hardware with software wherever possible so that services can be scaled rapidly and operations automated. The technologies are exciting, but understanding the benefits and the challenges of the shift is more important for the industry than understanding the detailed technologies. Therefore, apart from segmenting technologies involved in the shift, our study also focuses on the expected benefits and the challenges raised by cloud-native architectures. Telecom operators are increasingly under pressure to cut costs and to deliver all new services instantly to keep their customers satisfied. This is why telecom networks are increasingly moving towards offering their services in an application-based manner where almost everything is done together in the software. This process of moving from a hardware environment to a software environment is called virtualization or softwarization. But this is still not enough; services from cloud providers have conditioned the world to expect to be able to run the same service at a different scale, instantly. Software networks enable running a service at different scales by spinning up more software components, but there is no automation in the process and it is done manually by the network operator. In this study, we define a cloud-native telecom environment, including technologies, benefits, and challenges that the telecom operator needs to address. The study will take a deep dive into the complexities and confusion that the transition to cloud-native environments entails and which need to be understood by anyone aiming to provide technology, solutions, or services in this domain. While a cloud-native environment is designed for software, much of the detailed planning and control of these environments will still be executed by staff used to manage hardware, which is of paramount importance for any study to take stock of. This study is thus meant for professionals who can make use of the insights in decision-making for technology procurement and partnerships, or as inputs for R&D efforts aiming to provide the best solutions for operators eyeing cloud-native.

2.2. Overview of Traditional Hardware-Based Infrastructures

For decades, telecom infrastructures have revolved around hardware-based solutions (Sabella et al., 2016; Taboada et al., 2020). They are composed of a hodgepodge of proprietary, single-purpose devices such as session border controllers, deep packet inspection equipment, customer premise equipment, and others. Rigid and limited, traditional hardware systems are slow to adapt to changing needs or opportunities. They're also limited in how they can scale up or down. The result is that innovation is slow and customer adoption cycles are lengthy, making it difficult to keep up with rapidly moving market demands and technological change. Hardware systems are more expensive to maintain, too, by resisting automation, orchestration, creation of a self-service model, and widespread use of software. As hardware ages, maintenance grows more manual, costly, and labor-intensive.

Fig 2 . 1 : Cloud-native Telecom Environments

But going straight from hardware-depending systems that date back 150 years to the modern, IP-based world of IT infrastructure is not enough to cope with the demands and opportunities of the coming broadband century. However, over the past two decades, as telecom technology has converged with IT technology, revolutionaries have worked to modernize the field through next-generation networks based on internet protocol, software applications in top-of-rack switches, software-defined networks, network orchestration, network functions virtualization, cloud-native applications, microservices, containers, and more. The capabilities and promise have continued to evolve to the cloud and between the private, public, and edge cloud environments that telecom networks will soon use as infrastructure.

2.2.1. Transitioning from Legacy Systems to Cloud Solutions

Though cloud solutions provide many benefits, transitioning from legacy infrastructure to cloud-native solutions is a complex, multi-phased, strategic process. The process of transitioning to the cloud environment typically consists of requirement analysis, planning, adoption of best practices, setting future state and final migration, and stakeholder sign-off. To be effective, the transition must ensure uninterrupted operation and non-disruption of existing services during the migration process. The transition to the cloud can typically be based on one of the following methods: phasing out legacy systems in favor of cloud solutions; developing cloud-native technologies for greenfield deployments that run alongside existing legacy technologies; or adopting from Network Functions Virtualization to Cloud-native Network Functions while keeping the underlying cloud environment static.

The technical aspects of transition are typically complex. Decisions need to be made to improve productivity by leveraging challenges posed by existing systems when adopting absolute replacement architecture or a hybrid approach. Additionally, technical and end-user training and adaptation are key adoption criteria for network orchestration and SDN/NFV/cloud-native transition since employees often resist change. Although cost considerations are the primary driver for cloud adoption, transitioning network functions and operations to cloud domains does not always yield cost or operational improvements. An organization-wide evaluation must ascertain if a physical and virtual transition is both technically feasible and justified.

2.3. Understanding Cloud-Native Technologies

Cloud-native technologies are a programming model and environment for building applications in a way that takes full advantage of cloud computing models. Cloud-native applications are made up of microservices and are best packaged as containers or through serverless models where no particular infrastructure is targeted. From a purely architectural viewpoint, cloud-native technologies are accelerated through deployments that use containerized microservices and functional programming to enhance scalability, elasticity, and availability. By definition, cloud-native is an architectural model not restricted to any specific infrastructure or deployment stack. Cloud-native technology has evolved over the last few years, and containers and container orchestrators have become the big names in technology.

The telco version of the cloud-native core is a highly available, scalable, and secure environment for support operations, monitoring, and control in the telecom end-to-end services and connectivity functions. Telco cloud-native technologies introduce new developments in automation, manageability, and customer innovation. Some central goals of cloud-native technology transitions include the ability to deliver services much faster to market and enhance service availability using the cloud. The most significant benefit claimed by cloud-native advocates is agility. Cloud-native telecom is aligned with several technology trends and brings an agility difference to managing and integrating the software with infrastructure. The agility of cloud-native technologies delivers tight integrations and enhanced experience. The adaptation from traditional processing to the introduction of newer cloud-native technologies enjoyed over a 40 percent decline in deployment voyage. All cloud-native applications are designed to offer a better customer experience.

2.3.1. Exploring Key Principles of Cloud-Native Design

Designing and deploying microservices is especially helpful since they work independently, simplifying large-scale development (Sabella et al., 2016; Taboada et al., 2020). Additionally, one of the core principles in cloud-native application development is modularity. In telecommunication applications, certain functions or processes cannot be modularized due to very low latencies or connection-level states. In most applications, however, modularity is key for variable traffic. Resilience is another key design principle for cloud-native telecommunication solutions. Telecom environments are sensitive to changes, and levels of response must be fast to maintain a high level of service quality. Mirroring software is fairly common in telecom networks, allowing a fallback mechanism in the case of problems, for example. Modularity and independence are also important in these cases.

Automation is fundamentally required in any telecom service; otherwise, operators may struggle to manage service delivery costs once traffic or the number of services has increased. Automation is perhaps even more important for cloud-native designs. Principles such as the need for regular releases and updates are facilitated by automation. Continuous integration and deployment are core practices in cloud-native organizations and enable greater flexibility and operational agility. Continuous integration and deployment also address the 'fear of change' problem by enabling issues to be rapidly addressed. Issues or feature requests may be handled within days or weeks rather than the months or years typically required when issues are largely resolved in major releases infrequently. Moreover, the cloud-native design heavily relies on observability and monitoring. As a result, cloud-native developers work hard to implement an up-front solution for observing applications in production. Developers are responsible for their live applications. In addition to monitoring and observability, logging metadata for troubleshooting is particularly important. When developers focus on writing logs, they focus on providing metadata for when and where an issue is manifesting and can therefore focus more efficiently on the issue.

Another core concept of cloud-native design is the operational agility to evolve into customer needs. To provide this level of agility, systems should support continuous integration and continuous deployment with a fully automated configuration management mechanism. This means that the cloud environment is fully programmable using automation, and developers could have full control of underlying orchestrators or cloud controllers. Developers maintain full control of their applications' deployment and runtime, which aim to proactively resolve problems rather than reacting after the problem occurs. Similarly, the cloud team gives full control to developers for rolling new versions of code into production without opening tickets to the cloud team. The developers are responsible for testing and the impact analysis. They could scale the service in their development environment as if it were in production to check the overall service health. Once it passes all checks, testing can be done with the actual customer load before release.

2.4. Benefits of Cloud-Native Telecom Environments

One of the most significant advantages of cloud-native telecom environments is the inherent ability to easily and seamlessly scale operations. This can be accomplished by managing workloads and solutions based on demand, ensuring that users require more resources as demand increases by orchestrating the processes and platforms. Cloud-native networking is built with adaptable and flexible components that allow for quick and seamless changes and updates. This guarantees that the available resources yield value whenever and wherever they are needed. One of the most compelling arguments telecom companies can make in transitioning to cloud-native solutions is early access to full-scale resources as well as the ability to offer fast, real-time changes. Given that consumer demand is constantly evolving, the adaptability of cloud-native technologies offers businesses a competitive edge when it comes to rapid adaptation to industry trends. Entirely distributed platform architectures are fundamental in cloud-native applications. This might mean that functions regularly hosted in central data centers and traveled significant distances to consumers' or users' endpoints may become available via metadata systems. This emerging technology speeds up and enhances the cross-facility data processing pipeline for low-latency, real-time monitoring and analytics. Additionally, integrated machine learning and automation at scale are cost-effective and efficient for operators at the edge of cloud-native telecommunications.

2.4.1. Scalability

Cloud scalability is a pivotal characteristic of a cloud-native telecom environment. Telecommunications frequently face dramatically varying demands, for instance, due to seasonalities or product or technology launches. Scalability is defined as the ability of a cloud-native environment to increase or decrease resources dedicated to services or applications on demand. By scaling services up and down more efficiently, customer demands can be met better, and disruptions of service can be avoided. Specifically, a cloud-native telecom environment will still provide services with the same level of quality but leverage more resources to do so. In other words, it will absorb more load, therefore increasing the efficiency of service provisioning. Consequently, a feature that gives a telecom the ability to absorb accumulating load can always be tied to a financial gain by cutting costs when no additional resources are necessary. Moreover, higher scalability means a lower probability of service disruption, which in turn has a direct impact on customer satisfaction.

In cloud-native technology, operational efficiency can be sustained even at higher system loads. Cloud-native services and applications are designed to run on distributed platforms available to them, to fully leverage their technologies. Although operational efficiency and service resilience are achievable on dedicated physical or groups of virtual servers, the paradigm can easily be extended to incorporate additional services when dealing with higher traffic loads. System performance in cloud technologies can easily exceed the Non-Functional Requirements specified in a project when a peak in service traffic flux occurs. An instance of a successful cloud-native telecom migration presenting increased service scalability and subsequent increased customer satisfaction is Skype. As part of the telecom traffic, although being a distributed service, Skype also benefits from the multiple cloud-based functionalities it migrated onto.

2.4.2. Flexibility

Flexibility. The telecom market today is more dynamic and competitive than ever. Thus, the ability to quickly and frequently adapt services is a key consideration. In a cloud-native environment, new features and functions can be rapidly developed and tested against market aspirations, prioritized, and moved into production through infrastructure-as-code type release processes. Conversely, trial services can be rapidly decommissioned, freeing resources to be reallocated to services that resonate better with market requirements. The increasing adoption of hypervisors and containers, together with the ability to fully automate deployment, brings the promise of rapid service reconfiguration and redeployment. Other architectural considerations also play a part, particularly those that result from the employment of microservices and capabilities.

Feature and function integrations allow IT systems to consume services that were not considered or even conceived at the time of the original system design. It is “knit the service” not “the interworking or system” perspectives that drive integration. One significant operator recognizing this fact noted: “We kicked off our platform journey many years ago following an open API-first approach including modularization, decomposition, and modernization of existing services.” Digital integration has also long been recognized as a vital capability. It is through integration that services become the material for the innovation factory – the ability to define, deliver, evolve, and innovate rapidly is enhanced. This is a software delivery investment opportunity – much like the ability to rapidly develop and release apps that are then “glued” together, reducing end-to-end lifecycle development release times. Time to completion delivery time reduction is at the heart of integration – respectively, the experience of industry innovators in such areas points to these realizable benefits closer to “days and weeks” – not “ten years” for full realization. A new indicator capturing “API/Optimal Digital Integration Delivery Time Reduction Experience” will be created in future surveys.

2.4.3. Cost Efficiency

In a cloud-native environment, a telecom operator can significantly reduce its capital expenses and operational costs. Typically, under the pay-as-you-go concept, capital expenses for IT are minimized or spread out across the forecast. Infrastructure is often pre-provisioned in terms of CPU choices, speed, memory, and storage, and is often already available and in use, which reduces the costs and resources needed. Unused or underused infrastructure resources affect the integrity and productivity of telecom operators. Agencies need to prepare and spend deeply on building infrastructure based on the estimated amount of resources available for future usage.

Cloud computing is available to anyone who has an adequate connection to the Internet and the capital to purchase any resources they need. Cloud-based communication services can also eliminate the need for physical hardware support and have the option to stop physical hardware support, which can be specifically designed to provide cloud-based communication services separately at lower costs. Maintenance and repairs are often performed more quickly because the hardware architecture is maintenance-friendly. Concerned about cost, leading-edge companies see huge savings by switching from outdated or unpatched hardware that is old and less efficient to better-managed services that facilitate more frequent updates. Cloud computing has become the norm during mobile security with the growth of Internet-specified services. Enterprise networks are leveraging the unique opportunities that come with the dynamic nature of cloud infrastructure. Cloud architecture can and must establish cost-efficient deployment. Several companies have made an impressive transition and significantly reduced costs in their operations.

2.5. Challenges in Transitioning to Cloud-Native Environments

One of the first steps for a telecom company is identifying what challenges need to be surmounted during the transition. For Tier 1 and 2 telecommunications service providers, the primary issue is the cultural resistance of long-established technical staff in moving from monolithic systems to container-based microservices. Network engineers never attempt to find new ways of working because that incurs risk, and the best way to get themselves fired is by having a major network outage. If the switch to cloud-native is being impacted by such teams, perhaps the best solution is an outsourcing strategy that draws a clear line in the sand, indicating there is the old network and a new one, that can be developed and operated.

New hires and teams of individuals are most likely to be supporters of new cloud future technologies. Telecom companies have to ensure that all new hires have the right operational capabilities to work in the DevOps domain. But what about the constraints of existing staff and turning them into DevOps believers, who are not technology enterprise-based consultants and professional services that want contract-based professional services engagements and not ongoing operations? It is important to understand how the requirements of the different organizational groups align with cloud-based environments. For example, to understand if development teams are implementing quick fails or successes, technology would have to be implemented to speed up the network service deployment. In some cases, where the technology enables the shortening of network downtime or deployment, it may mean a shorter SLA requirement from the networking group to be less than the SDLC average turnaround time. If they do not align, then the technology implementation would offer no business benefit to the organization. Ensuring the technologies employed can help meet an organization's deployment SLA is crucial. Without this, there would be a lack of business support for the transition.

2.5.1. Cultural Resistance

Although the overall transition continues to be a hot topic, discussion about the more human side of cloud adoption is often avoided and, if it does take place, it tends to be largely superficial. In the end, culture is at the heart of it all and needs to be addressed in a very practical manner. Cultural resistance is often the greatest barrier to cloud adoption for the carrier, with petrified employees objecting to the loss of their jobs. The truth is that the world is changing, and this is either accepted and embraced or left to pass. Agile is a curious thing in many organizations, in that it is often played at versus truly embraced. An Agile organization is no more to see post-it notes everywhere than a silo-free organization is its reporting structure. A culture of change is crucial, allowing people to do things differently and even to ignore the sacred cows when developing services for and with customers. In the telecom industry, there are some not-so-very successful case studies with the new "Cloud-Native" and a few that went very well at some impressive scale. With the former, organizational culture has often been one of the major, if not key, barriers. Many, but not only, smaller operators have talked about the dread of the "cultural transformation" required. A representative from one operator described the legacy of his business as affecting every aspect, "including spaghetti works cultures." Also, one large telco talked about "captured governments" that saw earlier rebrands and restructuring that were just window dressing with the same people still running the show. Given buy-in at all levels, unnecessary and outdated leaders could often hold the change and culture back at the top. In contrast, a European operator explained just how easy it was for Eircom to pry management out and bring it down way under a turnaround in the culture of the newly rebranded company. Reasons cited for the acceptance of the new logo and other signifiers of the name change in a large Irish telco were the need for change and a genuine feeling that it represented something the workforce could get behind. Staff turned up to work one day and found the logo replaced. As that was the only remaining sign of the old organization's change, compliance was high.

2.5.2. Skill Gaps

The rapid pace of progress in cloud-native technologies and architectures can quickly lead to captive staff who lack the necessary skill set to effectively manage the new environment. Ensuring that an organization can effectively operate cloud technology is imperative in today's environment, and skill gaps can thus be classed as vertical risks, impacting directly on the achievement of strategic goals. A demand for operators has been found who possess a deeper understanding of technology and automation, and the ability to manage functions across multiple technology domains more efficiently than previously. These are additional skills on top of the existing in-depth network expertise currently resident in the staff member.

Fig 2 . 2 : Cultural Resistance

Global organizations expect to expand their cloud footprints but face the challenge of filling skill shortages as they shift to cloud operations. To best fill these shortages, they plan to increase headcount, boost entry-level talent, and train staff. Currently, cross-functional skills are the most sought-after, with a significant lack of talent skilled in cloud-native development and front-end development focusing on cloud resources. As these resources become available and staff are re-skilled, IT departments can shift their focus from simply executing the migration to operating the environment, which is not a one-off effort but ongoing and will need to be a core focus for the whole organization if they are to be successful.

A strategic approach to talent management and development, particularly of existing resources, should form part of the plan for transitioning to a cloud-native architecture. Filling these skill gaps can be achieved through training and development, and crowdsourcing talent who are already skilled not just in cloud technologies but hybrid cloud and augmented intelligence. Further developing the organization's release management capability by establishing requirements for the skills and experience of release managers and embedding them in the management career path, and investing in a release management career path to build depth in this discipline and provide a conduit to release engineer roles.

2.5.3. Data Security Concerns

Concerns about data security during the transition to cloud-native telecoms are among the top reasons for not migrating yet. That is understandable since the transition to a cloud-native architecture involves treating data as a security boundary instead of network boundaries, as telecoms do today. Once data is in a cloud environment, the logical segregation through virtual networks that telecoms are used to having is effectively lost, prompting legitimate concerns over data leaks. While currently only a small percentage of organizations have migrated their core network functions to the public cloud, many are apprehensive about it. Maintaining data security and trust is of paramount importance to any telecom operator.

Protecting customer data from unauthorized access is not only a priority but for the telecom environment, it is often stipulated by law. Key security topics to consider include best practices for data protection of personal and sensitive data, including encryption, role-based access controls, and robust identity management practices. Data already housed in public cloud environments managed by telecom operators and private data centers will need to find additional, innovative solutions to comply with regulations that do not permit foreign ownership and operation of high-speed digital asset networks. The newly designed security systems should also consider the ability to manage security at every service layer. Just one year before the COVID-induced explosion in the adoption of digital communication, consumer confidence in cloud technology was, on average, high.

2.6. Key Technologies in Cloud-Native Telecom

Cloud-native applications and their operation rely on a set of novel technologies and operational paradigms. With this section, we aim to familiarize the reader with the key technologies required for building and operating a cloud-native telecom environment. Understanding these building blocks is essential to effectively leverage cloud-derived solutions. First, cloud-native applications are based on a microservices architecture. Microservices are loosely coupled services that communicate with each other via standard APIs. Another important technology in cloud-native is container orchestration. Containers are lightweight environments bundling together an application with only the necessary components to allow it to run consistently across any environment.

One of the important subfields of cloud-native technologies to mention is serverless computing. In this technology, the cloud provider is responsible for running a developer's functions and automatically managing the stateless compute resources. Each triggered function will access the cloud provider's managed infrastructure to serve the request independently of all other functions. In 5G environments, with their capability exposure to third parties via APIs, serverless computing could prove very valuable in combination with mobile edge computing in enabling new mobile edge applications. A unique example comes from a Taiwanese subsidiary of a major tech company, which has launched the world's first cloud gaming service running only on serverless computing.

Several technologies are integrated and leveraged in order to better operate cloud-native applications. For CMICT, one of the more important ones is continuous integration and continuous deployment. Continuous integration and continuous deployment are practices to increase a team's ability to deliver applications and services at a high velocity. ReturnValue is built entirely on a state-of-the-art cloud-native telecom stack and aims to provide an architecture allowing rich contextual capabilities, providing the utmost self-learning assurance services.

2.6.1. Microservices Architecture

Microservices are a key pillar in the telco cloud-native environments, capturing the attention of telecom service providers for various reasons. This represents an architectural approach to software design that allows the individual software components, called services, to be developed and operated independently by small teams. There are several reasons why telecom service providers are turning towards microservices architecture: Developers can use small, focused teams to develop applications as a collection of loosely coupled services, so-called microservices. This architectural philosophy has been driven by a combination of requirements, such as the need for high-quality applications, the demand for fast and frequent delivery of new applications or functionality, and the pre-existing availability of a common platform that allows service developers to focus on their value-generating function, as well as by the need to operate efficiently.

A microservices model offers several other benefits, such as the ability to quickly scale out a service with a simple restart, resulting in system-wide high availability. Microservices can also be quickly replaced if experiencing problems, as well as provide simple service maintenance, making regular updates to production an efficient and relatively painless procedure, as well as reducing the run-time production footprint of all services under management. However, distributed systems and microservice design bring with them challenges in managing issues such as service communication and orchestration, updating service interface contracts, service discovery to determine service locations, and improving network resilience to work around intermittent connection and latency issues, among other things.

A characteristic way of creating modular systems is to separate the elements, or modules, of the system into independently operating sub-entities called microservices. These microservices have individual distinct business purposes and can be modified for separate business capabilities and functionalities. Moreover, by breaking down applications into small services, features can be developed and deployed efficiently. Expanding on this, in a well-structured environment with microservices, each service must be implemented with high cohesion and low coupling, be able to scale independently, and be easy to troubleshoot. To move data and communication capabilities across services, those services usually communicate through a set of clearly defined and versioned APIs. In the context of telecom, there could be a series of case studies that support this characteristic.

2.6.2. Containerization

Containerization is a crucial enabling technology for the cloud-native model. It is a form of lightweight virtualization in which an application and its runtime dependencies are packaged together in a container image that can be run on any machine. The result is that the application is guaranteed to run consistently and portably across developer laptops, on-premises servers, and the cloud. These containers are then deployed to a cluster of compute machines running a container runtime in the cloud.

There are several key reasons for this shift. First, containers offer superior resource utilization compared to VMs because they share a single operating system kernel. Second, the consistent environment in which containers run allows for extremely efficient image management. Containers are built from layers, like an onion, and if unchanged, the layers are cached and can be shared across applications and during application development processes. Third, the deployment model for containers is simple. Finally, application deployment via containers scales well: with the right container orchestration tool, managing 10, 100, or 1000 machines is just as easy as managing a single machine.

The de facto standard open-source container orchestration tool is Kubernetes. It works seamlessly with containers using its container runtime. Kubernetes manages all aspects of running containers at scale. It communicates with nodes it controls to allocate containers onto nodes and manage the containers and load balancers. If a new container needs to be scheduled onto a node, failover occurs onto another, or a component crashes, Kubernetes will figure out a plan to rebalance quickly and in line with the application's intended behavior. Just like containers, Kubernetes is designed to be lightweight, resilient, and generic for almost any IT/Telecom workload. Containerization is relatively new in telco and still in the earlier stages of early majority adoption.

2.6.3. Serverless Computing

Modern serverless computing fundamentally changed how applications can be built and deployed in cloud-native environments. Moving towards a serverless approach means abstracting away the underlying infrastructure management and letting developers focus solely on writing application code. This simplifies the development and deployment processes and abstracts the heavy lifting of server setups. Serverless computing providers are capable of uploading and executing the deployed code while taking care of all the underlying operations inside the cloud data center. Overall benefits include increased agility, innovations in service delivery, server-side logic management, and pay-as-you-go scalability among others while reducing operational costs.

When migrating or re-architecting applications towards cloud-native environments, containerization and serverless tend to be where most organizations are focused. This approach is underpinned by provisioning only the resources that an application needs, minimizing wasted resources. Serverless computing makes it possible to define event-driven functions, which are executed in a state machine-like fashion. Once the upload occurs, the serverless provider prepares the underlying resources and takes care of the execution. One of the most common misconceptions about serverless computing is that it is stateless, which is only partly true: while the functions bear no state in between executions, the execution pipeline or event sourcing defines its execution trace and keeps track of the completed tasks and matching input or progress state. Telecom organizations have reported numerous use cases and examples of the above deployment to speed up the development cycles and unleash innovation in their teams through serverless computing. This analytical cornerstone outlines that serverless computing should be treated as part of a bigger ecosystem under the umbrella of cloud-native. Serverless computing is in particular used for processing large amounts of data in near real-time, orchestrating services, handling event-driven microservices integration points including custom authentication, sending triggered emails, and as a foundation of the 'compose' services deeply integrated with the cloud provider. It is important to treat serverless as an abstraction away from serverless infrastructure.

2.7. Best Practices for Transitioning

Companies embarking on the journey to cloud-native telecom environments should begin by conducting an accurate assessment of their existing infrastructures to better understand where they currently stand and what potential issues or obstacles they may be facing. Developing an overall strategy for the transition is then of utmost importance, focusing on establishing guiding principles and incremental key outcomes. Such a strategy needs to enable the organization to identify cost savings or income-generating potential while also not taking excessive risks. Incremental improvement provides the organization with the opportunity to mitigate failures while learning about the tactical steps they wish to take next. Transition implies change and proper support is vital not just from the top but also from the people impacted by the changes. Providing training and skill development opportunities in cloud competencies is advisable to ensure there is a replacement for the old one as it is retired during the transition. Communications and change management during the transition must also be a key area of focus. Stakeholders must somehow be told what is happening in advance, and their views on the journey need to be sought, particularly how the change will affect their role. Furthermore, in low and middle-income countries, incumbents deploying greenfield solutions have a competitive advantage.

2.7.1. Assessment of Current Infrastructure

Organizations considering a transition to more cloud-native environments, such as implementing edge computing and network function virtualization, should start with an assessment of their current infrastructure. The outcome of such an assessment identifies which processes, services, and applications in the current or planned infrastructure are more suited for cloud-based solutions—and those that are not. A picture of existing technical and operational strengths and weaknesses emerges as well. This picture allows for the development of a detailed strategy to ensure a smooth transition of the necessary infrastructure to one that includes a higher amount of cloud-based solutions.

There are several methods and tools available to assess the readiness of infrastructure for cloud-native solutions, and each has its strengths and weaknesses. Methodologies can investigate the current state of enterprise architecture. They include processes and tools that compare this baseline picture of the current architectural state to the future state of the architecture, thereby enabling identification of the gap between what the architecture is and what it is intended to be in the future, i.e., architectural changes are needed. Network function virtualization management and orchestration domains include cloud-ready checklists and information models and stimulate ecosystem collaboration.

These items provide solutions with optimal processing elements and device architectures. In these phases, it is essential to capture existing workload behaviors and application dependencies to build a precise application inventory. This inventory will then be used to fuel strategies for cloud migrations, including regional cloud models. In addition, organizations should focus on engaging an integrated team collaboration between infrastructure, application, and various stakeholders such as business decisions in the assessment process to provide secure and informed cloud decisions moving forward.

2.7.2. Incremental Migration Strategies

Because retrospective optimization would disrupt operations, migrations from traditional to cloud-native environments have to be incremental. Different applications and workloads are typically migrated at different times. An incremental strategy reduces the risk associated with any new complex system. Services are typically not affected during a gradual migration. Additional VMs or containers can be spun up in parallel to provide both traditional and cloud-native versions of the same application over a limited period. The application traffic is then steered based on heuristics, such as client-dependent redirection or feature flags-based routing supporting gradual application conversion.

A forward-looking migration plan breaks down the migration into manageable units. Migrations can happen directly to the cloud or to a colocation center/cloud edge that is more geographically suitable. A migration plan tries to avoid unnecessary migrations by introducing microservices for big monolithic services that require deeper analysis. Within the sections of a migration plan, the following considerations are especially important as they support the operation of traditional and cloud-native workloads: Many successful case studies describe ways to identify workloads that are to be migrated and depict strategies on how to migrate workloads or applications to the cloud transparently. Generally, the use of big bang migrations that migrate all workloads at the same time in parallel is avoided, and instead, a transition on the side of the existing infrastructure in combination with a steady migration of workloads is utilized. In such cases, constant monitoring of applications and services is required to manage and react to such a change properly. This approach responds to the challenge of adapting and fitting new technologies into the existing infrastructure and tools of an organization.

2.7.3. Training and Development

There is a growing consensus that one of the main obstacles to rolling out cloud technology in a mission-critical environment is the attainment of relevant and specialist skills in areas such as management of cloud infrastructure, security, and software development. Increasingly, both cloud vendors and CSPs are now investing in cloud technology training in the hope of raising the standard of their employees as they transition to cloud-native environments. A comprehensive training strategy can help address the main obstacles to cloud adoption. A training program in the main cloud management tools can provide the necessary base-level skills to overcome the knowledge gap CSPs currently face. This could take the form of online courses to improve the skills of those outside specific cloud management functions and/or hands-on workshops delivered by cloud operators to bring the rest of the organization up to speed with the cloud offering and open possibilities for services. Such initiatives may also need to be accompanied by initiatives to encourage a 'continuous learning culture' based on both soft/enterprise and technical skills. Learning and development can also be a useful strategy to retain talent and ensure continued engagement as a company transitions its work practices to cloud-native approaches. There is evidence that the most successful digital business leaders also place the most emphasis on a high training budget. The research also suggests that revenue growth for those organizations that spend more on training remains four times higher than for those that do not, demonstrating again the importance of technical skills across a workforce. The main lesson for their learning and development is that a robust training approach is particularly vital to a pre-existing daily operation, even more so than a greenfield start-up operation.

2.8. Conclusion

In this chapter, we have studied the ability to handle the journey and transition into a cloud-native environment of next-generation telecommunications. Over the last 140 pages of this book, the reader has gained an understanding of the advantages and challenges of such a transition. Phrased in coaching terminology, to enable speed and agility, 5G or otherwise, it is no longer business as usual in telecommunications. Are we just organizing ourselves in an operational framework, knowing we have to shift into cloud-native and are quite advanced there, or are we in a completely different world, i.e., do we have to execute a deep operational transformation top-down, culture included?

Telecommunication companies should start to find their own strategic and acceptable answer to the question: is a cloud-native environment disruptive to the telecommunication operational and product world? Therefore, running network services is not just an implementation matter—it has an organizational and operational significance as well and is the precondition for systematically exploiting the benefits of building a platform. Moreover, the operators share the vision of a future state of telecom operators where all their services run in a digital cloud with a software-driven operation—a cloud-native approach that enables an end-to-end zero-touch operational framework. The solution design involves a new way of thinking, as it is designed from a cloud and automation integration to ensure end-to-end connectivity and services, not via classic interconnect architecture. Instead of a vertical organization around specific functions, the operators are creating cross-functional entities that follow, roughly speaking, the chain of work corresponding to the various software products they provide. There is a need for both a basic technology shift, such as cloud-native technology, and an appropriate organization and culture shift. There are no fine lines of demarcation between the different groups. All efforts will have to work as a group to achieve the functionality and services needed. Each of them has to deliver functionality and services to others in a cloud-native approach. These two are the dynamic and systemic nature that is the way to enable organizational and operational efficiency.

Future research should continue to explore the use of other technologies besides cloud-native to provide insights into the usage of emerging trends and changes in global business market discussions. A deeper dive into cultural change management and the examination of sources of dissonance among incumbent participants would be useful. There's also an opportunity to further explore the network technology infrastructure questions—especially concerning edge computing. The concept of cloud has proven critical to the dynamic scalability of telecommunications, but there is more to it. Cloud-native services are designed and delivered to the next level in the telecommunications service value proposition. Are you ready? Do you have the right operational mindset, structure, and culture to embrace continuous change? Let's find out! Thus, we hope this study guide has been able to help describe the cloud-native phenomenon in telecommunications as it is today.

2.8.1. Final Thoughts and Future Directions

In the preceding chapters, we have made a strong case for the reasons why the transition to cloud-native telecom environments will be necessary for many businesses, and why it will remain pivotal for all businesses in terms of adapting to changes. The initial experience gained from the first operators' endeavors in various cloud-native domains indicates the general validity of such predictions. Our brief comparison of the benefits of the ongoing cloud-native telecomification exposes that these benefits derive from the cloud-native infrastructure itself. This may provide a few strategic conclusions: the continued development of these strategies and related implementations offers real benefits, but also includes an element of risk. To share and mitigate such risks, stakeholders are encouraged to get involved in the evolution with the end goal of helping to shape ongoing efforts.

Fig 2 . 3 : Telco Cloudification Unveiled

There remain several untold stories that would be important avenues for future investigation. The use of mobile edge computing and network slicing in many of the more recent developments suggests some potential pointers. To what extent do such solutions orient themselves around this new paradigm? What is the stance on the use of initiatives that are not 'new', to cut a quick or easy path to the final destination? It is overly simplistic to assume that virtualization-based solutions do not offer intrinsic value, though they may face similar, if not identical, shortcomings to cloud-native ones if they do not allow for an adaptable service environment. Nonetheless, we hope that the modest, incremental improvements we have witnessed in cloud-native environments provide a motivating force for organizations to seek further perfection and innovate with new releases of solutions.

References

Cziva, R., & Pezaros, D. P. (2017). Container-Based Network Function Virtualization for Software-Defined Networks. IEEE Transactions on Network and Service Management, 14(4), 946–960. https://doi.org/10.1109/TNSM.2017.2766066

Mijumbi, R., Serrat, J., Gorricho, J. L., Bouten, N., De Turck, F., & Davy, A. (2016). Network Function Virtualization: State-of-the-Art and Research Challenges. IEEE Communications Surveys & Tutorials, 18(1), 236–262. https://doi.org/10.1109/COMST.2015.2477041

Bhamare, D., Samaka, M., Erbad, A., Jain, R., & Gupta, L. (2017). A Survey on Service Function Chaining. Journal of Network and Computer Applications, 75, 138–155. https://doi.org/10.1016/j.jnca.2016.09.001

Sabella, D., Vaillant, A., De Foy, X., Kuklinski, S., & Rauschenbach, U. (2016). Mobile-Edge Computing Architecture: The Role of MEC in the Internet of Things. IEEE Consumer Electronics Magazine, 5(4), 84–91. https://doi.org/10.1109/MCE.2016.2590118

Taboada, I., González-Castaño, F. J., López-Bravo, C., & Ramos, S. (2020). Towards a Cloud-Native 5G Network Architecture: Design Principles and Challenges. Future Generation Computer Systems, 109, 505–514. https://doi.org/10.1016/j.future.2020.03.037