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Navigating the end-to-end service orchestration journey

How communication service providers can evolve into digital service providers for a 5G ecosystem

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Contents

The evolution towards digital

We are standing at the precipice of a new 5G era. Unlike previous generations of mobile telecommunications networks, 5G represents not an incremental step, but a fundamental disruption of today's realities. As the first mobile telecommunications generation to be virtualised from inception, 5G is poised to combine a series of concepts – such as network slicing, open ecosystems, and service-based architecture – to deliver tailored connectivity for a vast universe of use cases.

The implementation of these concepts and use cases, however, cannot be achieved without automation. Indeed, in a 5G world, a communication service provider (CSP) will be expected to dynamically manage and orchestrate services of an unprecedented volume and complexity, all while coordinating a multitude of different data and technical domains. This means that automation will become mandatory – and not optional – as manual human operations alone will never be able to achieve this feat.

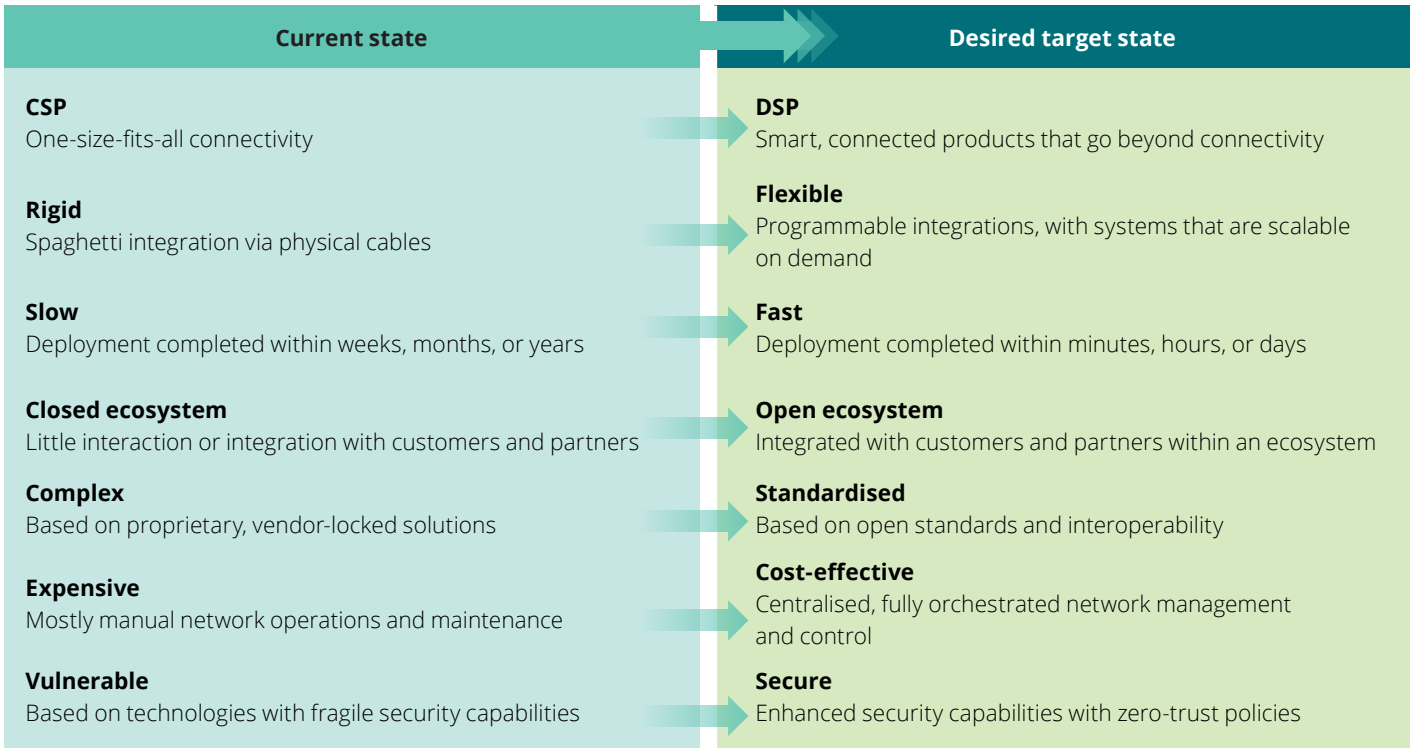
To deliver on these expectations, CSPs must ultimately become digital service providers (DSPs). In other words, they will need to possess networks capable of providing on-demand consumable services that are not only flexible and fast to provision, but also tailored to be compatible with the three main pillars of 5G: enhanced mobile broadband, ultra-reliable low latency, and massive machine type communications.

Central to becoming a DSP, therefore, is end-to-end service orchestration (E2ESO). Specifically, CSPs must evolve their mindsets and operations to manage their end-to-end customer service – and not merely networks. Overall, this transition to the desired target state can be understood as comprising seven key shifts for CSPs (see Figure 1).

In the sections ahead, we will discuss our perspective of the E2ESO journey for CSPs. To begin, we will lay out a vision of the 5G orchestration architecture – and within it, the critical role of E2ESO. Then, we will explore the E2ESO journey through a persona-based view, and consider what mature E2ESO use cases could look like in a 5G ecosystem. Finally, we will examine several success factors for CSPs embarking on the E2ESO journey, and share 10 lessons that we have learnt from our experience supporting CSPs on their automation and virtualisation programs.

We hope that you will find this report insightful as you lead your organisation in the E2ESO journey towards a truly virtualised 5G ecosystem.

Figure 1: Seven key shifts to the desired target state



The 5G orchestration architecture

In our discussions with C-suite executives at CSPs across the globe, three common questions often surface on the topic of E2ESO: How does E2ESO differ from a Network Functions Virtualisation Orchestrator (NFVO)? Which part of the service lifecycle does E2ESO cover? Who should provide the E2ESO solution: a network vendor or an IT solution vendor?

Ultimately, the answers to these questions will determine the design of their 5G orchestration architecture – and with it, their path forward in a 5G ecosystem. It is therefore perhaps worthwhile that we begin by addressing each of these questions in turn:

1 How does E2ESO differ from a Network Functions Virtualisation Orchestrator (NFVO)?

The bottomline is that roles and functionalities differ between E2ESOs and NFVOs. Put simply, E2ESO solutions available on the market today exist in two main forms. There are, firstly, unified solutions with E2ESO capabilities embedded into their NFVO products; and secondly, hierarchical solutions with a digital platform – which in turn includes an E2ESO building block – built on top of their NFVO. According to the 5G Infrastructure Public Private Partnership (5G-PPP), there is currently no standardisation on this matter, and either unified or hierarchical approaches may be adopted.

Based on our observations, however, an approach that favours modularisation will not only enable telecommunications providers to increase their resilience and obtain best-of-breed capabilities for their architecture, but also avoid lock-in. This is an important principle, as E2ESO should fundamentally be agnostic to underlying infrastructure and systems.

In addition, the concept of network slicing – or the idea of having an automated, logical cut on the required infrastructure to deliver a service with guaranteed performance – is also a matter of debate. Should the NFVO be responsible for the network slicing? Should the slicing be done above or under the network? Experience tells us that network slicing capabilities are an integral part of NFVO – but they should nevertheless be orchestrated and linked to business requirements through E2ESO.

2 Which part of the service lifecycle does E2ESO cover?

E2ESO is expected to play a key role in the service order fulfilment and service assurance (including quality management) aspects of the service lifecycle. Automating the network and services processes will generate some reduction in operational expenditure, but more importantly, also provide the necessary agility to deliver and guarantee performance to customers. With the introduction of the MEF Lifecycle Service Orchestration (LSO) standard, we can also expect to see E2ESO playing a role in service design, testing, billing, and usage aspects.

3 Who should provide the E2ESO solution: a network vendor or an IT solution vendor?

The virtualisation and orchestration journeys undertaken by CSPs have created a hotbed of competition between network vendors and IT solution vendors. We had started the journey believing that IT vendors will be more likely to possess more mature products due to the programmability nature of the solution – and in this regard, they have surpassed our expectations.

But our observations also suggest that network vendors have an advantage over IT solution vendors when it comes to service assurance capabilities. To deliver service-guaranteed performance, the generation and usage of network counters – comprising the key performance indicators (KPIs) for Quality of Service (QoS) – must be monitored in real-time, and this is a capability that comes naturally for network vendors.

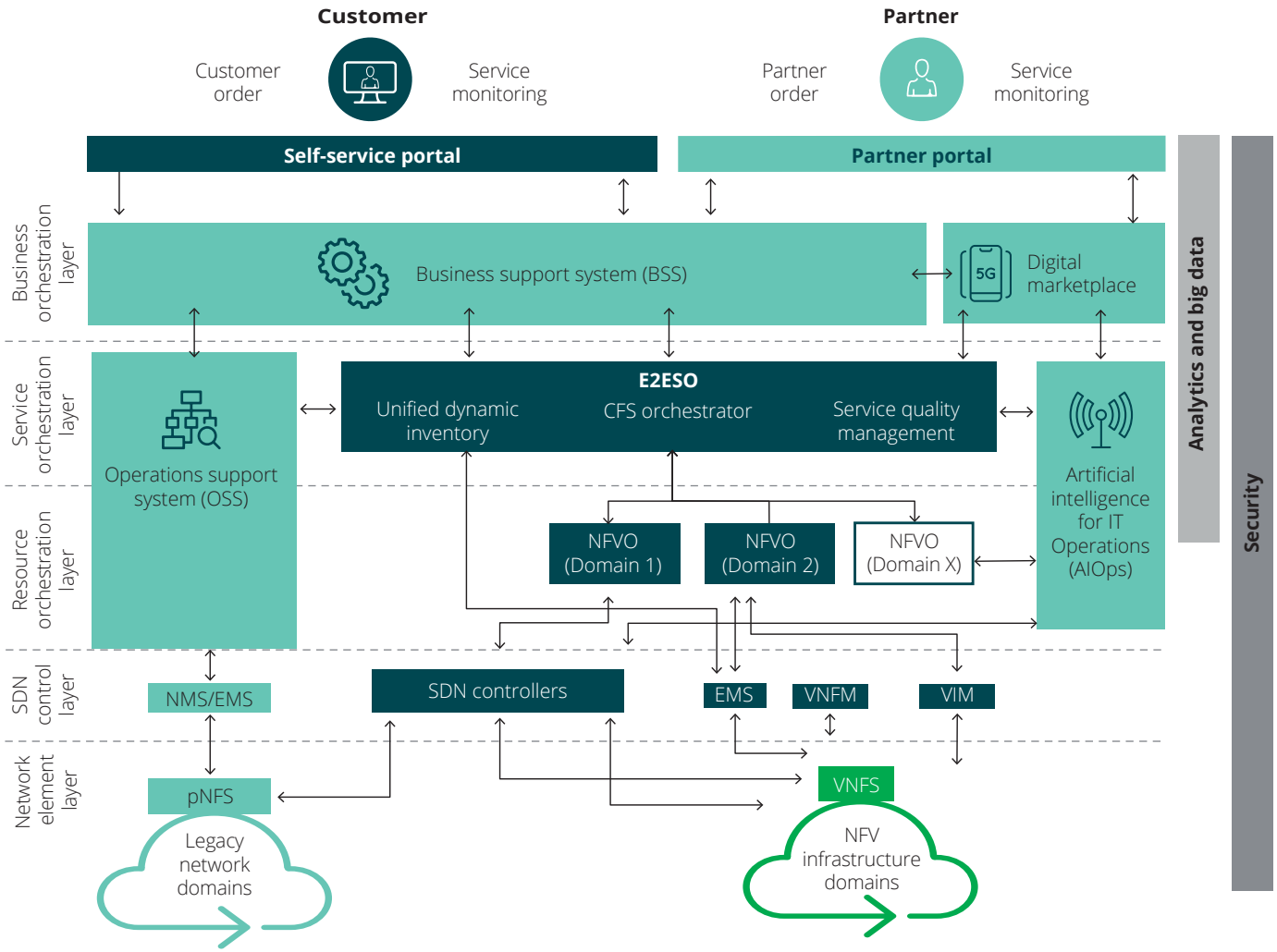
Segregation of roles

Based on the aforementioned experiences and concepts established by different standard bodies – including Zero-touch Orchestration, Operations and Management (ZOOM)[1], Open Digital Architecture (ODA)[2], and ETSI Industry Specification Group (ISG)[3] – one possible option for a 5G orchestration architecture suggests the segregation of roles between network-facing service (NFS) and customer-facing service (CFS) orchestration[4] (see Figure 2).

Briefly, the architecture is a hybrid ecosystem of physical network functions (PNFs) and virtual network functions (VNFs), between which the standards foresee an integration. There are, however, several real challenges surrounding the migration of the technical debt to the new virtualised ecosystem – especially given the fact that the latter is expected to be lean and agile.

To overcome this conundrum, one approach could be to create a digital portfolio to be fulfilled by the new virtualised ecosystem, and place this alongside the legacy ecosystem, which can in turn be used to provide resources to the new ecosystem as though it were an external company – that is, without the integration or merger of the two landscapes.

Figure 2: One possible option for a 5G orchestration architecture



1. "Transformation to an agile and virtualised world". TM Forum. 2016.
2. "Open Digital Architecture". TM Forum. Accessed in May 2022.
3. "ETSI-MANO and LSO – Graphic". MEF Wiki. Accessed in May 2022.
4. "View on 5G Architecture". 5G-PPP. June 2019.

Zero-touch service fulfilment and assurance

Under the new model, it is envisioned that the 5G orchestration architecture will be based on a programmable, virtualised environment designed for automation. For their part, DSPs will be expected to be equipped with the necessary agility and flexibility to implement zero-touch service fulfilment and assurance without human intervention.

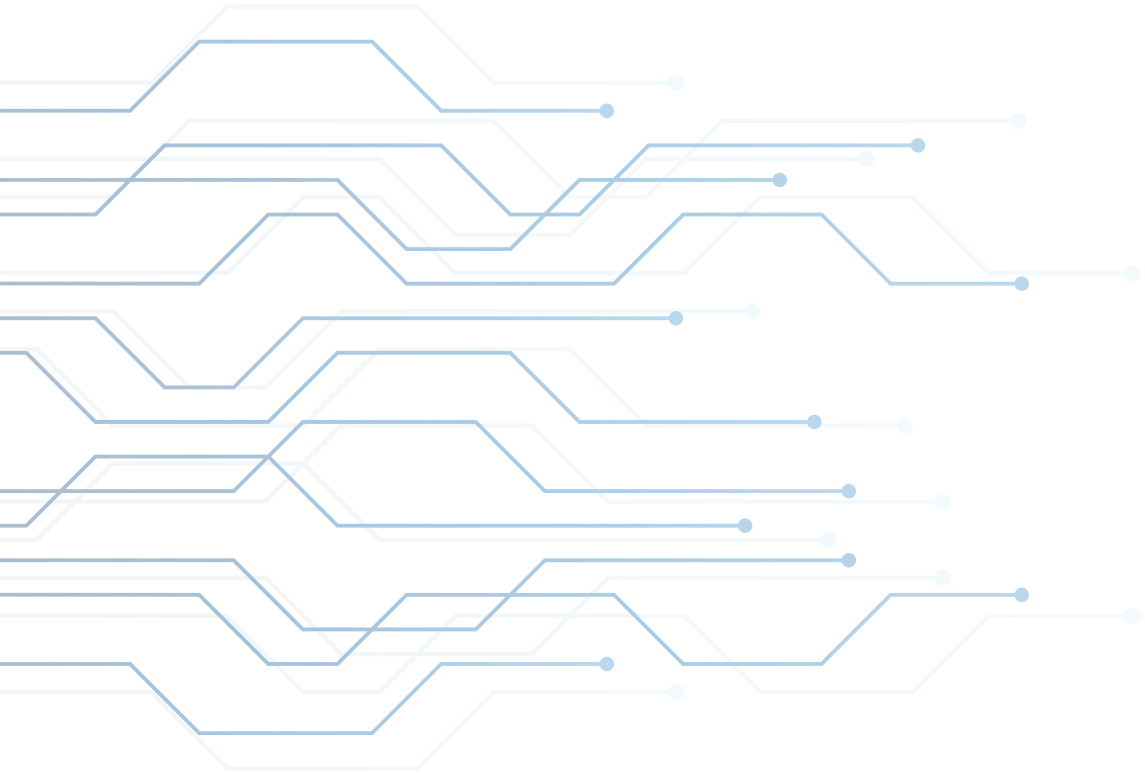
Specifically, these self-service portals will be placed within business support systems (BSS) to capture customised service orders. Then, business rules will be applied to address the different aspects of the customer order – including order management, quotation, terms and conditions, contract e-signature, billing and charging, amongst others – in a seamless and automated manner, for example, by leveraging robotic process automation (RPA).

Once the customer order has been successfully placed through the BSS, the E2ESO takes over at this critical juncture. Briefly, this is achieved by the decomposition of the customer order into various atomic NFS configurations, such as Layer 3 VPNs (L3VPN) followed by a resource feasibility or inventory snapshot check executed with the support of a unified dynamic inventory system.

In the absence of any jeopardy paths, the customer order is then passed onto the respective NFVO to be provisioned at the underlying infrastructure level, which is typically a private cloud ecosystem or Network Functions Virtualisation Infrastructure (NFVI).

By leveraging the same mechanism to ensure that all specifications of a customer's order – including latency, bit error rate, jitter, and bandwidth – have been fulfilled according to contractual obligations, E2ESO also enables closed loop assurance.

Specifically, E2ESO will enable the instructions to be passed on to the NFVO for the parameters to be provisioned, and allow the service quality management component to conduct constant monitoring of end-to-end service KPIs to ensure that they are in line with what was contracted. If a breach or violation is detected, the E2ESO will trigger the NFVO to provision the service into different parameters (or different slices) to provide the customer with the exact configurations that they had requested.



Navigating the E2ESO journey

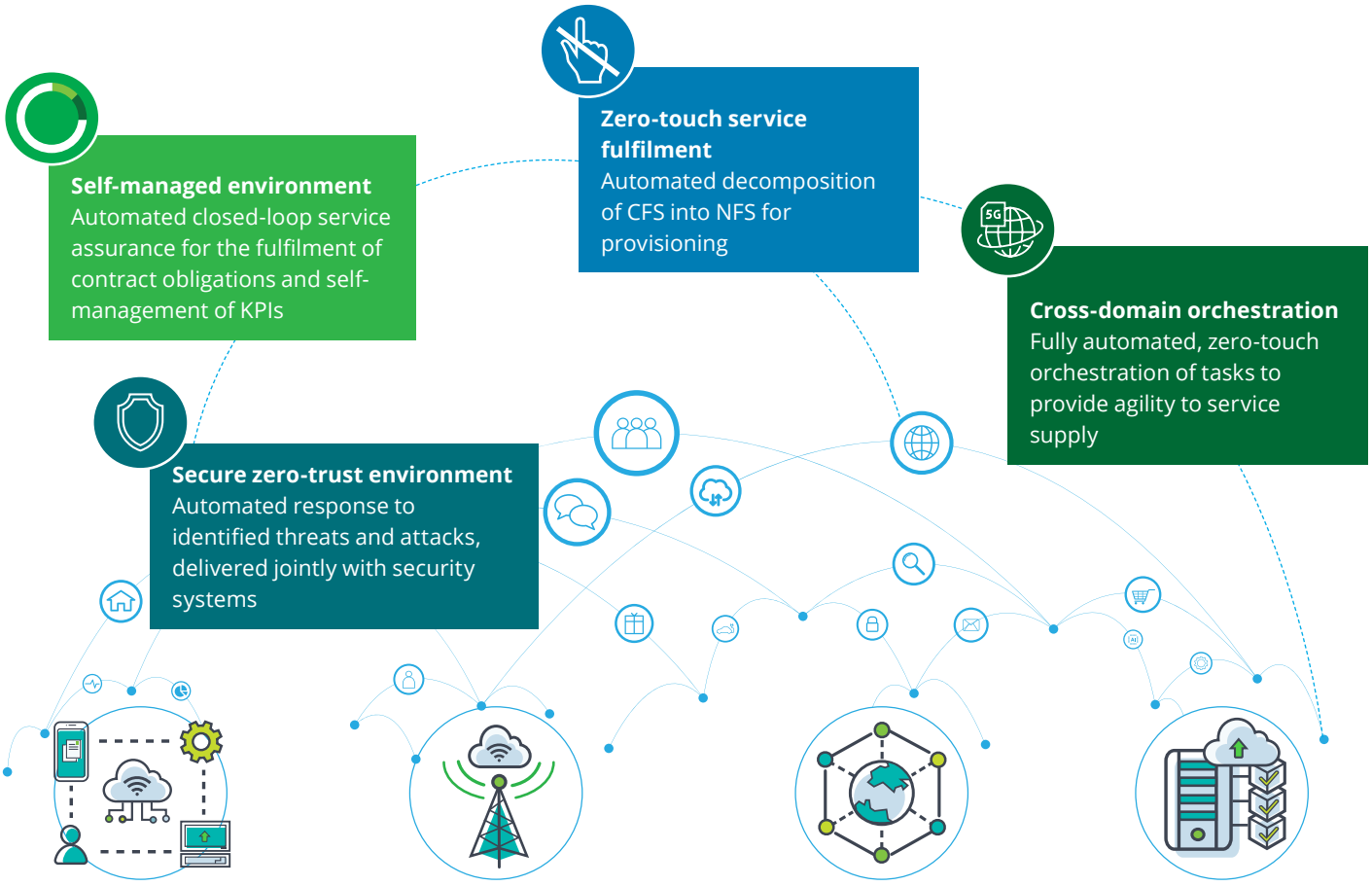
Broadly, a CSP's journey to E2ESO can be understood as somewhat analogous to the experience of global cloud providers in the evolution of their operating models. In both instances, the digital-first experience begins with a user-friendly web interface, and a service portfolio that is automatically provisioned within minutes on demand. At the same time, both models also offer assurance, reliability, scalability, and security as built-in capabilities that are chargeable based on usage.

For a CSP, this operating model will likely be enabled by 5G technologies, which are by design virtualised and secure to enable automation. The challenge, however, is that while CSPs have ample experience in virtualising their network domains and automating their business processes, these activities are often conducted in silos with little or no link between them[5].

Therein lies the real value of E2ESO: by precisely automating business processes across both domains, it enables CSPs to better integrate their business realms and network resource realms. Through the use of application programming interfaces (APIs), E2ESO also helps CSPs to stitch together a standardised, multi-vendor virtualised ecosystem, and bridge the business systems to the network infrastructure layer.

The end result is a system with the following four important features: self-managed environment; zero-touch service fulfilment; secure zero-trust environment; and cross-domain orchestration (see Figure 3).

Figure 3: Four important features of E2ESO



5. "Economic benefits of network automation". ACG Research. 2020.

A persona-based view of E2ESO

With the implementation of E2ESO use cases, a CSP's ways of working will undergo significant transformation. Specific changes, however, will likely differ by persona, depending on whether the individual is a customer, account manager, or network operator. Indeed, we fully expect the higher level of automation enabled by E2ESO to benefit these three key personas in particular (see Figure 4).

Figure 4: Benefits of E2ESO for three key personas

Customer

Improvement of customer experience, by empowering the customer to customise their own bespoke product or service to be fulfilled in real-time and on-demand

Account manager

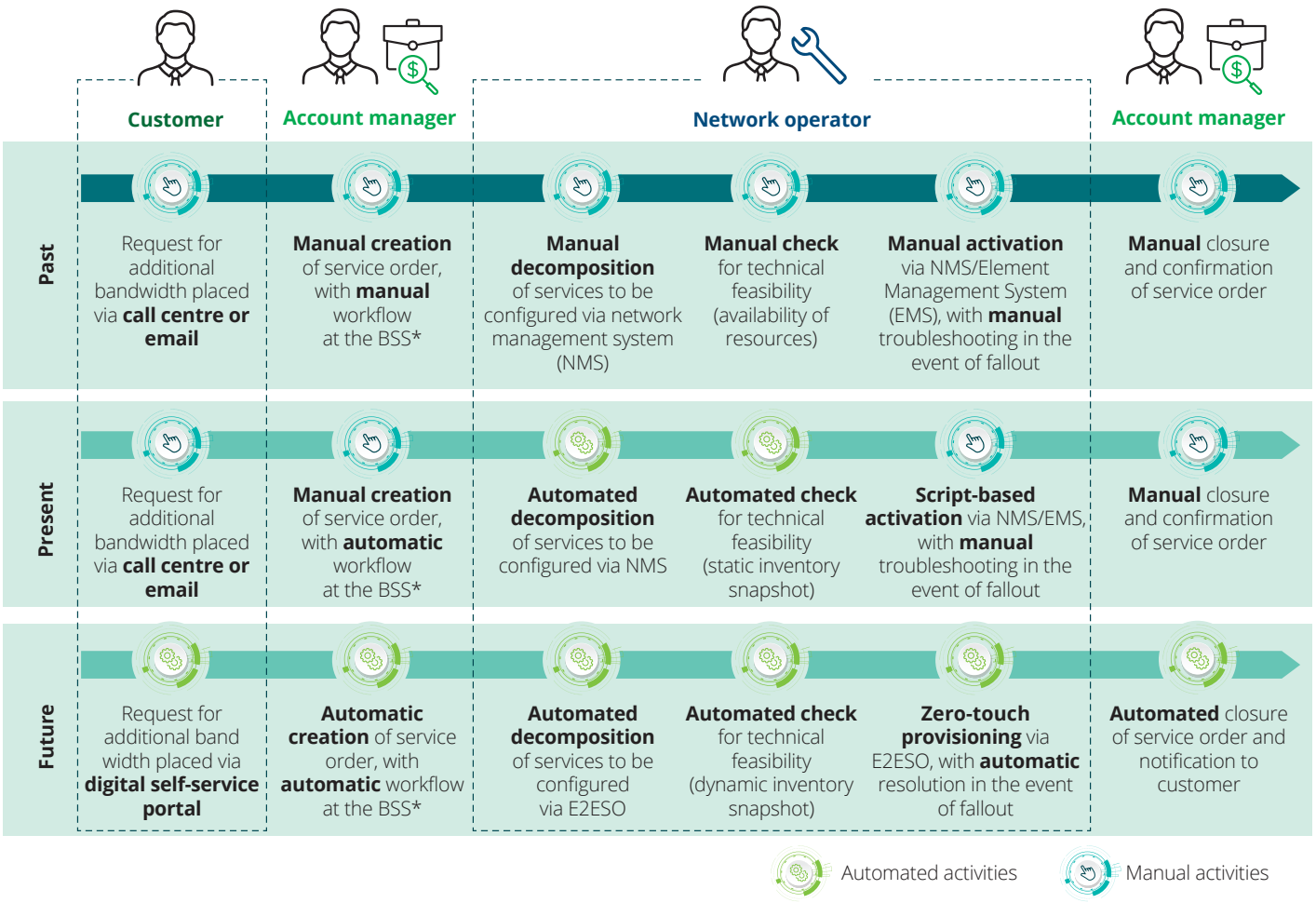
Reduction in administrative work, which frees up more time to focus on customer acquisition, upselling, cross-selling, and relationship-building activities

Network operator

Elimination of repetitive tasks, which frees up more time to focus on network improvement activities, acquisition of new skills, implementation of new use cases, and management of E2ESO policies

As an illustration, consider the example of a connectivity request from an enterprise customer for the upgrading of bandwidth – and how this process has evolved from the past to the present, and will continue to evolve into the future with the implementation of E2ESO (see Figure 5).

Figure 5: Illustrative example of a connectivity request from an enterprise customer for the upgrading of bandwidth



*The BSS workflow refers to the automated service lifecycle – which includes the product catalogue; Configure, Price and Quote (CPQ); customer relationship management (CRM); order management; and billing and charging processes – that is integral to the orchestration of E2ESO. An in-depth consideration of these capabilities, however, is beyond the scope of this report.

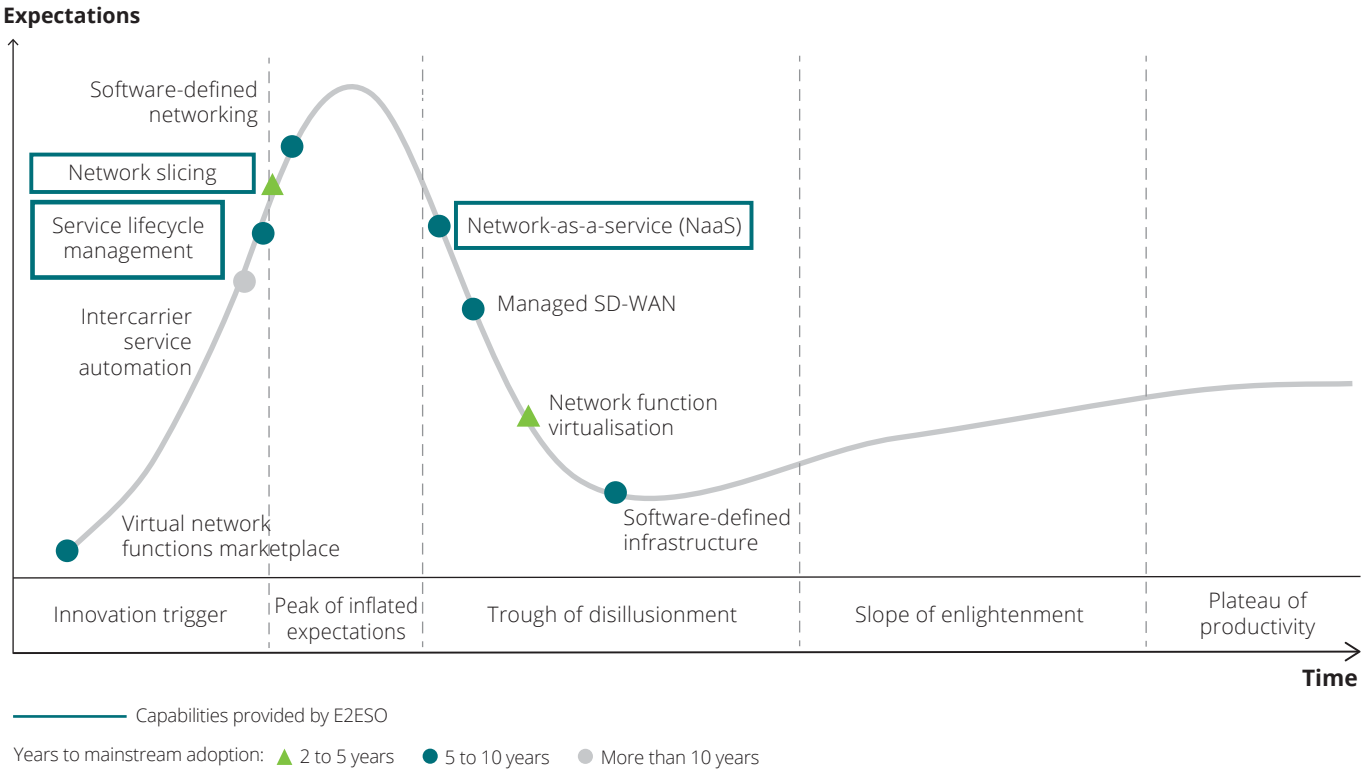
Use cases for E2ESO

As the success of any emerging technology depends on its potential for monetisation, CSPs will need to consider the implementation of new E2ESO use cases in the context of their potential for commercialisation by various business units. Central to supporting and managing these use cases is the rollout of 5G – and the ultra-high speeds, superior reliability, and ultra-low latency capabilities afforded by these technologies.

Under the 3rd Generation Partnership Project (3GPP)'s Release 16 of 5G standards, for example, we have already observed elements of slices for vehicle-to-everything (V2X), industrial Internet of Things (IoT), and ultra-reliable low-latency communication (URLLC) use cases[6]. By stitching together a multi-domain virtualised ecosystem, and bridging business systems with the infrastructure layer, E2ESO will be a mandatory building block for the fulfilment of these use cases, which are likely to continue to mature in tandem with the technology based on 3GPP's Release 16 and 17[7].

In terms of the timeline, the transition to a fully virtualised ecosystem is expected to take place sometime within the next eight to 12 years, as this is the average lifespan of the PNFs that are still being acquired today. E2ESO, however, is likely to become mainstream much earlier, with some estimates suggesting that this will happen around 2024, on the back of the recent introduction of network slicing capabilities[7] (see Figure 6).

Figure 6: Mainstream adoption of E2ESO capabilities



6. "The 5G evolution: 3GPP Releases 16-17". 5G Americas. 2020.
7. "Hype Cycle for Communication Service Providers". Gartner. 2019.

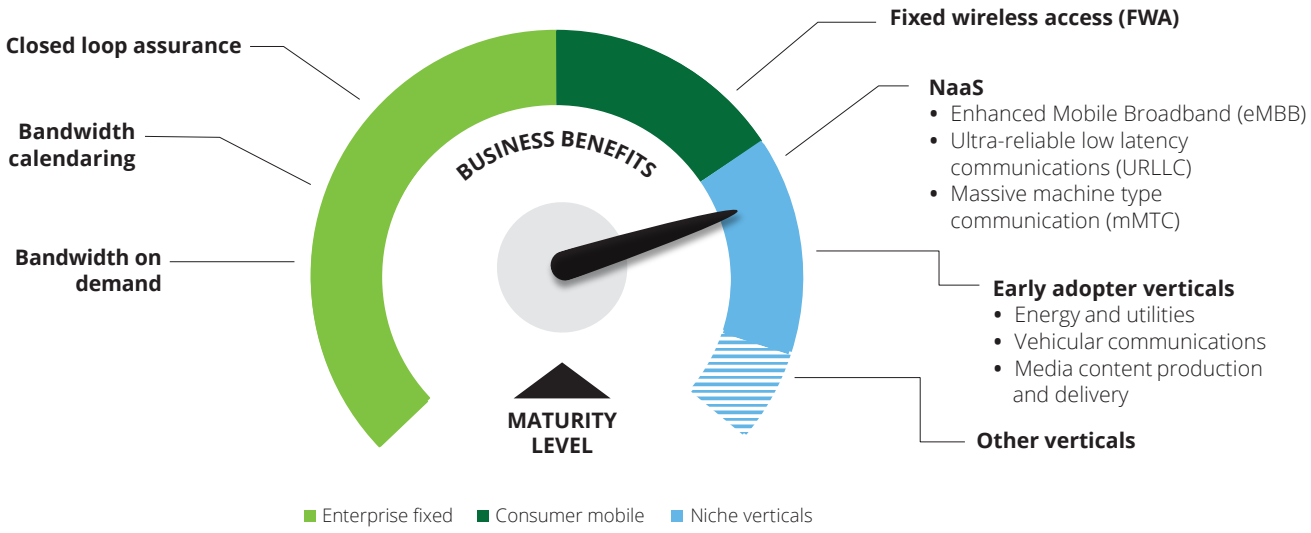
Niche verticals as early adopters

What these developments mean for CSPs is that they must quickly reframe their perspective around cloud and virtualisation for a future 5G ecosystem, where PNFs gradually fade away and VNFs become more mainstream. Specifically, they will need to shift from a mindset that is primarily focused on savings in operational expenditure, to one that is more focused on customer needs, and how these can be addressed with more innovative products and agile delivery.

Indeed, a focus on the latter could also benefit the former: in the long run, the adoption of an automated, virtualised, and scalable approach could also enable CSPs to improve revenues, and benefit from savings in operational expenditure.

In contrast to the current consumer-focused and one-size-fits-all approach adopted by CSPs, however, winning 5G use cases are likely to lie within specific needs in niche verticals. Examples of such verticals with the potential to become early adopters of 5G network slices include, for instance, energy and utilities; vehicular communications, as well as media content production and delivery[8] (see Figure 7).

Figure 7: 5G use cases across the maturity level spectrum



8. "View on 5G architecture". 5G PPP. June 2019.

Success factors for a 5G orchestration program

Around the globe, CSPs are considering the timeline and speed with which they should deploy their 5G orchestration programs. In particular, they are weighing the trade-offs of becoming a first-mover – and thereby obtaining a head-start on the future 5G race – against that of being a smart follower, where they can benefit from the experience of other players and markets in deploying proven strategies.

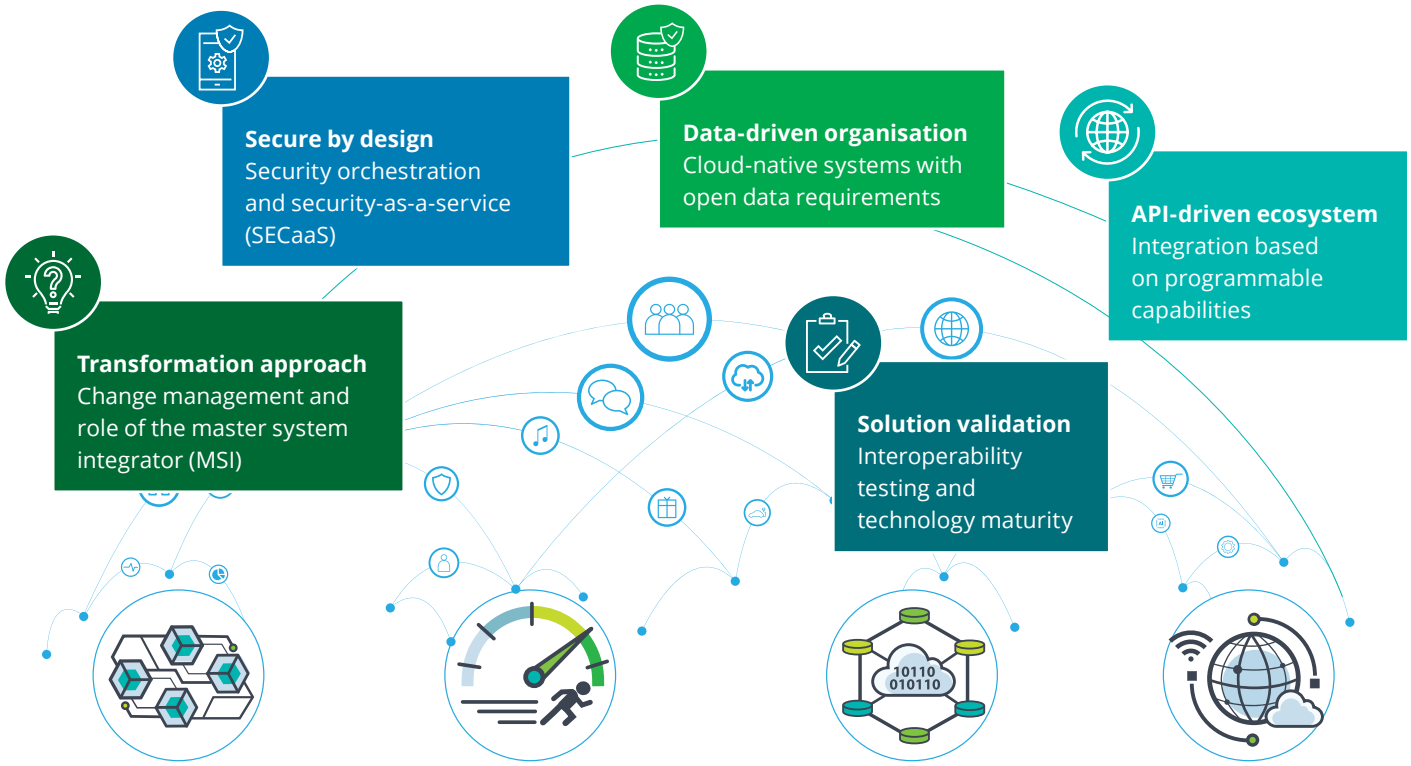
Our view, however, is that speed is relative. In other words, a CSP does not need to be the fastest in order to win the race – it only needs to be faster than its competitors. Indeed, based on our market observations of 5G use cases, we have noted that once a CSP has launched a viable use case and gained significant market share in a particular segment, it becomes extremely difficult for its competitors to make inroads.

In order reap the benefits of the learning curve, however, CSPs must first invest in learning the concepts relating to the operationalisation of E2ESO, as well as its associated enabling technologies and business models. To this end, CSPs could consider the introduction of a "skunkworks" team, one responsible for implementing and operationalising E2ESO on a small scale for niche, early adopter verticals. In doing so, they would have embarked on the learning curve, and would be on their way to developing the necessary capabilities to implement, operationalise, and scale E2ESO within their specific environments.

It is worth noting that the overall picture is also made more complex by other forms of disruption, such as the entry of new players that are now competing with CSPs on the connectivity side. In European and US markets, for example, cloud providers are offering on-demand connectivity services – and already, they are reshaping customer expectations on what 'good' should look like in terms of agility, responsiveness, and ability to customise products to their customers' specific needs.

In summary, there are five success factors that CSPs will need to pay attention to as they embark on their 5G orchestration programs, each with the potential to affect the benefit realisation of the overall program (see Figure 8). In the section ahead, we will elaborate on some of the related considerations, and actions that CSPs can take to increase their chances of success.

Figure 8: Five success factors for a 5G orchestration program



Building a data-driven ecosystem

Essentially, the 5G ecosystem is designed to be open and data-driven, with every single building block constantly consuming, producing, or sharing data. To leverage the full capabilities of such a system, CSPs must develop an in-depth understanding of the necessary data requirements, and be careful not to replicate a siloed system into their virtualised environment.

Nevertheless, we have observed that in the current market, several vendors continue to push for solutions in standalone verticals, where interoperability standards are not yet mature. This not only contradicts the fundamental principle of avoiding vendor lock-in, but also prevents data from flowing as intended between virtualised domains and integration points to support end-to-end use cases.

In addition, CSPs also need to examine their traditional business and operational support systems – including but not limited to network inventories, charging and billing systems, and customer relationship management (CRM) – to ensure that they are fit for purpose in a 5G ecosystem. Specifically, these systems will need to evolve to become cloud-native, that is, container orchestration systems with loosely coupled microservices suitable for deployment in scalable private or public cloud infrastructure.

On the service orchestration front, the implementation of zero-touch service fulfilment and assurance will also present several data requirements. In particular, the mechanism requires that an object in a predefined data format reaches the orchestrator according to its defined policies, where it will then generate an output in the form of a certain action that in turn produces a change at the network infrastructure parameter level.

As CSPs look to leverage virtualised networks for software programmability, further complications also exist in the exchange of data between the various systems, given that multiple integrations will be required for the system to be configured with different protocols (e.g. TCP, HTTP, REST, and FTP) and data models (e.g. JSON, CSV, binary, and AVRO).

For the OSS truly become cloud-native, one of the pre-requisites should include flexible support for programmable interfaces via the use of APIs. This will help to avoid the emergence of a spaghetti architecture that is complex to operate and maintain. In this context, possible solutions could include the Apache Kafka – an open-source project that aims to decouple data flow from the various systems and its dependencies[9] – or E2ESO systems and other OSS building blocks with ready adaptors for integration.

Data requirements

To exploit the full benefits of 5G, data must fulfil seven requirements in a 5G ecosystem:

1. Centralised or decentralised, depending on the specific use case
2. Personalised and dynamically updated
3. Governed with a defined open model
4. Converged end-to-end across silos
5. Processed in high volumes in a closed loop
6. Processed in real-time (10 ms per transaction)
7. Configured to support new types of assets (such as VNFs)

9. "Kafka 3.1 documentation". Apache Kafka. Accessed in May 2022.

Mitigating technology uncertainties during the procurement process

As virtualised solutions are highly tailored to a CSP's ecosystem, the procurement exercise is typically highly collaborative, and entails the involvement of multiple vendor interactions for the development of a unique solution. To mitigate technology uncertainties, it is important that the CSP purchases its solution from vendors that not only possess a defined 5G vision and roadmap, but are also capable of enabling the rollout of immediate use cases.

One important milestone of this process is also the solution validation phase, which is intended to enable the CSP to assess whether it should go ahead with the contracting. This phase differs from both the activation acceptance test, which is meant to be exhaustive, as well as the proof-of-concept phase, which usually requires a generic lab setup. In the solution validation phase, the CSP may choose several use cases to test the core capabilities of the E2ESO solution under the same conditions that they expect to face in production.

Here, the CSP will need to be conscious not to replicate the complexity of their PNFs into the software-defined environment of the multi-layered ecosystem, and adhere to the principle that the architecture should not have more layers than is absolutely required between its CFS and NFS (see Figure 9).

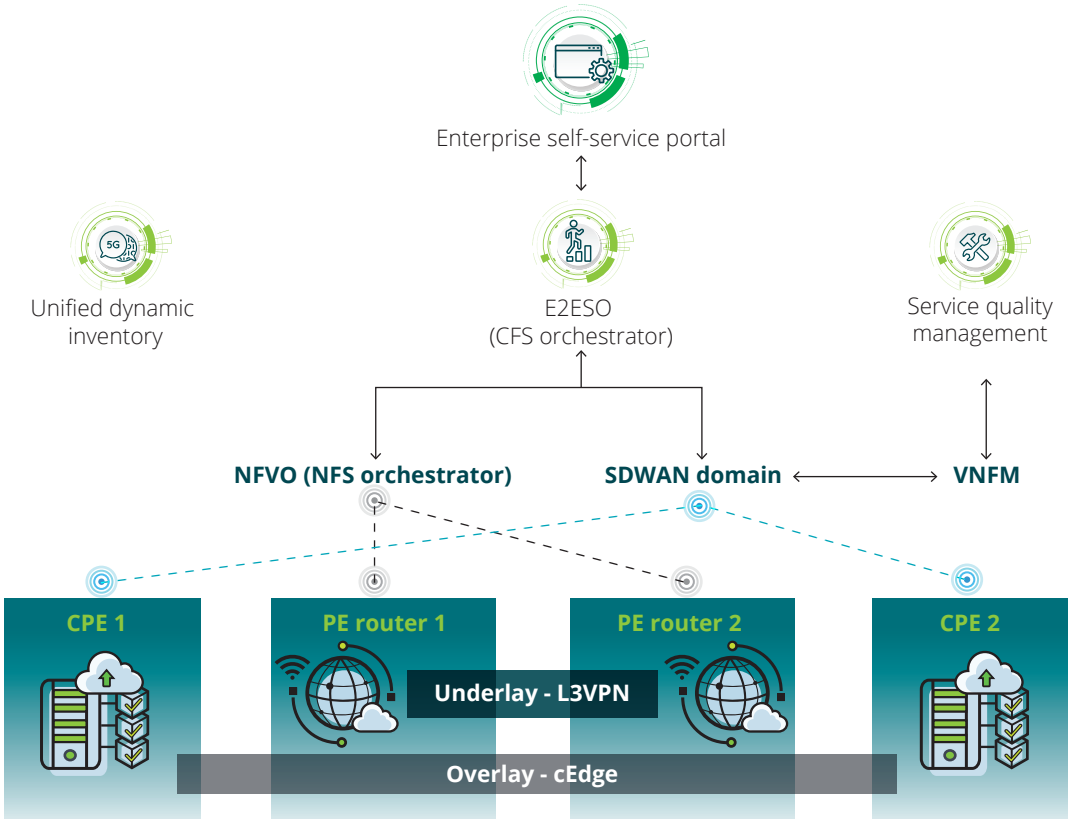
Typically, validating the solution with a mature use case (for example, bandwidth calendaring or bandwidth on demand) requires at least two virtualised – and preferably, multi-vendor domains – for interoperability testing. The results of this validation test can then be used to drive the decision-making process and comparison of shortlisted vendors based on indisputable facts.

Elements of a typical E2ESO procurement process

Based on our experience, a typical procurement process for an E2ESO program comprises the following elements:

- **Tailored requirements:** About 20% of all requirements – including business, technical, transformation, security, data management, and privacy requirements – will require tailored adjustments to meet the CSP's needs
- **Collaboration across different teams:** Request for proposal (RFP) development and evaluation of vendors' solutions will require collaboration across different teams, spanning the areas of NetOps, network and IT planning, and security, amongst others
- **Focus on use cases:** Strong focus on the definition of use cases, with the mapping out of clear and measurable business outcomes
- **Partnerships:** About 50% of procurement efforts are spent on interactive and collaborative interactions with vendors in face-to-face sessions

Figure 9: Illustrative example of an enterprise self-service portal E2ESO architecture for solution validation



Process transformation in a multi-vendor, multi-technology environment

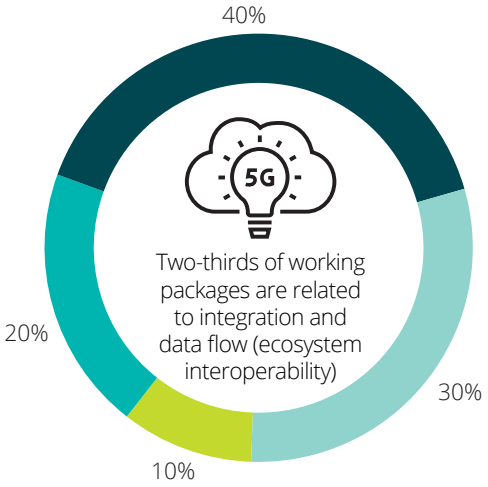
In a multi-vendor, multi-technology environment, a master system integrator (MSI) can play a critical role in ensuring a program's success. As an E2ESO solution requires integration across various IT and network systems, interoperability is key. But a CSP should not put itself into the position of mediating endless integration discussions between two or more of its vendors.

Instead, the CSP should work with an E2ESO solution provider to identify integration points upfront, and nominate and empower it as an MSI to conduct this work on its behalf. In that way, accountability and risks for the integration will lie with the vendors, and not with the CSP.

Other considerations for the process transformation of specific use cases also include the redesign of to-be processes and redefinition of to-be KPIs and service-level agreements (SLAs) to align with automation under the E2ESO, and a defined cut-through where all customer orders will be routed through the E2ESO and not the legacy system – as well as how each of these will impact roles, functions, and data flows.

Overall, our experience suggests that three working packages in an E2ESO program – payload attribute configuration; systems integration testing; and use case testing – collectively account for about 80% of the total effort required for deployment and orchestration (see Figure 10).

Figure 10: Three working packages account for 80% of deployment and orchestration workload



Payload attribute configuration
Aligning payload at integration points across building blocks

System integration testing
Block-by-block testing to verify if attributes are being received accordingly

Use case testing
End-to-end testing of use cases to ensure that an order triggers a defined set of automated tasks to generate an expected outcome

Other activities
All other activities and deliverables required for deployment and orchestration

New ways of working

The adoption of E2ESO and other emerging technologies requires not only technical solutions, but also new ways of working. As CSPs make the transition to software-defined networks, virtualised functions, and orchestrated ecosystems, they will also need to invest in employee upskilling to drive business value and regain sovereignty of their enterprise architecture – rather than give the keys to the business to their vendors.

Equally important for the success of a virtualisation and orchestration program is bold leadership. The tone from the top is critical to avoiding the traps of organisational silos and aligning the technology with their expected business outcomes.

Overall, to execute an effective change management program, a CSP will need to consider the impact of specific use cases on its technology, people, and processes. Some broad steps that it should take in this process include a change management assessment, workforce transition process, learning and competency training, as well as organisational design.

Skills enablement

As E2ESO introduces new ways of working, CSPs will need to consider the following aspects of skills enablement for their talent:

1. **Identify** the new skills that need to be in place for the CSP to sustainably deploy and operate E2ESO
2. **Upskill** talent through skills development, performance tracking, and continuous improvement
3. **Enable** talent by creating an ecosystem of partners for them to access skills beyond their current capabilities

Key takeaways

Although E2ESO remains some distance away from mass adoption, it is clear that it will have wide-ranging impacts on the operating models of CSPs as they stand today. To summarise our perspective, we have distilled the learnings from our experience supporting CSPs on their automation and virtualisation programs into 10 key lessons that, if not sufficiently addressed, will impair the overall success of their E2ESO journeys – and subsequently, the ability of CSPs to transform into DSPs.

1

Adopt an innovation-focused lens

Rather than approach E2ESO with a traditional mindset focused on the optimisation of operational expenditure, CSPs should consider adopting an innovation-focused lens. This is because succeeding in the new, virtualised environment will require a customer-centric orientation, with innovative products and agile delivery to meet customer needs.

2

Speed is relative

While being first-to-market has its advantages in enabling a CSP to dominate a segment, speed is relative. When it comes to E2ESO deployment, a CSP does not need to be the fastest; rather, it should learn from the lessons of first-movers in order to deploy more quickly than the relevant competition in its specific market or region.

3

Avoid vendor lock-in

Openness is a critical factor for the successful, long-term deployment of E2ESO. CSPs should strive to avoid vendor lock-in – a common pitfall when players implement solutions in standalone verticals without interoperability.

4

Refrain from replicating siloed landscapes into virtualised environments

Given that the value of E2ESO lies in enabling the implementation of end-to-use use cases and unbroken flow of data, CSPs should refrain from replicating their siloed landscapes into their new virtualised environments. This requires an unwavering, sustained focus on orchestration to bridge the different processes together.

5

Build resiliency by segmenting orchestrators

To build a resilient environment, CSPs should follow the hierarchical orchestration architecture recommended by 5GPP for segmentation, and architect a service layer orchestration (CFS) on top of a network layer orchestrator (NFS).

6

Focus on eliminating technical debt

Legacy PNFs are laden with technical debt, and this should not be carried over to the new VNFs which are intended to be lean and agile. Rather, a hybrid ecosystem could be designed for the legacy PNF and new VNF to function in parallel for the fulfilment of different types of services.

7

Bold leadership is required

As with all change, the tone from the top is instrumental. In an E2ESO context, bold leadership within a CSP is essential to not only driving the transformation program, but also avoiding the traps of organisational silos, and enhancing the links between the technology and its expected business outcomes.

8

Configure standard software blocks and functionalities to meet a CSP's unique needs

To deliver superior outcomes, standard software blocks and functionalities must be configured to meet the unique needs of a CSP. Accordingly, the procurement process should also be a highly collaborative one, with the involved participation of both the CSP and its vendors as they work together on crafting a unique solution.

9

People are the ultimate drivers of value

At the end of the day, technology is only an enabler of value: the true drivers of value lie with the CSP's talent. Obtaining their buy-in to the transformation program will therefore be paramount.

10

Do not give the keys to the vendors

Finally, as a word of caution, CSPs should be wary of giving the keys to their business to their vendors. This means that they must ensure that knowledge of their proprietary ecosystems remains within their organisation, and invest in the continual upskilling and reskilling of employees to ensure that they can excel in their new roles.

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