



Research study for Huawei

**Digitalization reshaping operations:  
a new digital operational model for  
the future**

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# 1. Executive summary

Software is disrupting nearly every industry, fundamentally reshaping the business models, changing the competitive landscape, and forever altering customer expectations. Highly successful digital companies owe a major part of the success to their software-driven operations.

Communications service providers (CSPs) are embarking on their own digital transformation to increase service agility and operational efficiency through infrastructure evolutions and operations transformations. Like digital companies, the success of the CSP digital transformations will hinge on a new software-driven operations model that is underpinned by high levels of process automations to the point where predictive autonomous operations becomes a reality, enabling CSPs to automatically pre-empt and tackle service quality issues before they occur.

*“Highly successful digital companies owe a major part of the success to their software-driven operations”*

*“The current operations model severely constrains the CSPs to achieve the benefits of the digital transformation”*

The current operations model, based on rigid software architectures, siloed operations software, high proportion of manual and repetitive tasks/processes, and bureaucratic organisational structures, severely constrain the CSPs to achieve the benefits of the digital transformation. Operations persons are mainly trained to use the software and execute the processes, but are often not expected to- or lack the skills to-

continuously improve operational efficiency. This model which was developed for the physical infrastructure is unsuitable for the emerging hybrid and virtual infrastructures.

CSPs need a future proof software driven operations model that can cater to today’s physical networks but also adapt as the infrastructure transitions to hybrid and virtual networks. Broadly, the new model must be based on:

*“CSPs need a future proof software driven operations model that can cater to today’s physical networks but also adapt as the infrastructure transitions to hybrid and virtual networks”*

- highly automated operational processes to accelerate the transition from rules based automations to machine learning based autonomous operations.
- a horizontal operations software platform based on microservices, powered by analytics and enabled by unified monitoring for IT and telecoms physical, virtual and hybrid infrastructures, and
- an operations workforce with the software skills to continuously enhance operational efficiency by developing automations as part of their daily duties

CSPs must adopt DevOps processes to foster collaboration among its departments such as the engineering and operations to continuously deploy operational enhancements both to the operations platform as well as the processes. CSPs must also develop partner ecosystems with the aim to crowdsource domain expertise and develop innovative applications that can benefit the CSP and the wider ecosystem.

*“A handful of CSPs with the necessary financial backing and risk appetite may take the ‘do it yourself’ approach but a vast majority of CSPs may require support from vendor partners to accomplish the transformation”*

CSPs must explore innovative execution models that are being developed across other industries to transform to software driven operations. Most CSPs will find it challenging to execute such a transformation themselves, and it is going to be even more daunting with new strategic initiatives such as network function virtualisation (NFV), software defined networking (SDN), IoT and 5G expected to introduce more operational complexities. A handful of CSPs with the necessary financial backing and risk appetite may take the ‘do it

yourself’ (DIY) approach but a vast majority of CSPs may require support from vendor partners to accomplish the transformation.

CSPs will need the help from partners on various fronts including consulting and advisory services to conduct the initial assessment of operational maturity and preparedness for transformation, recommending the best transformation strategy, executing the transformation, running the day to day operations and continuous operational enhancements. CSPs can use vendor partners in innovative ways depending on the level of maturity of the vendor offer and the level of control and ownership that the CSP wants to retain in-house. Engagement options such as consultative led operations as a service relies on the partner to deliver the operations based on agreed service level agreements using the partners’ operations platform, supplemented with advisory and implementation services to transition to software driven operations. In addition, traditional vendor engagement options such as outsourced operations, managed services and best of breed models will continue to be viable choices for the CSPs.

*“CSPs can consider emerging vendor engagement options such as consultative led operations-as-a-service, and traditional models such as managed services, outsourced operations and best of breed approaches”*

## 2. CSP digital transformation will fail without a radical overhaul of the operations model

### 2.1 Software driven operations underpin the success of the digital businesses across different industries

*“Software is eating the world”*

*Marc Andreessen, co-founder of venture capital firm, Andreessen Horowitz<sup>1</sup>*

The famous words by Marc Andreessen is true now more than ever. The pace of software disruption has increased multi-fold, and software is transforming every industry. Relatively new software-driven ‘digital’ companies are disrupting well-entrenched companies and forcing them to change.

Figure 2.1 presents some examples of these highly disruptive software-driven digital businesses. At one end of the spectrum, in the automotive sector, Tesla can make over-the-air software updates to its cars deploying new features and functionality, effectively upgrading the car overnight. Tesla, founded in 2003, briefly surpassed 109-year-old General Motors in April 2017 as the most valuable American automaker in terms of market cap.

<sup>1</sup> Refer to Marc Andreessen’s article “Why Software Is Eating The World” in Wall Street Journal: <https://www.wsj.com/articles/SB10001424053111903480904576512250915629460>

At the other end of the spectrum, in the cloud computing sector, Amazon disrupted the computer industry by commoditising the storage and computing through its Amazon Web Services (AWS) business, providing on-demand cloud-based infrastructure, platform and software-as-a-service (SaaS) offers. AWS forever altered the economics of IT, and started a new era of cloud-based service innovation that saw many big companies like Google and Microsoft successfully following suit.

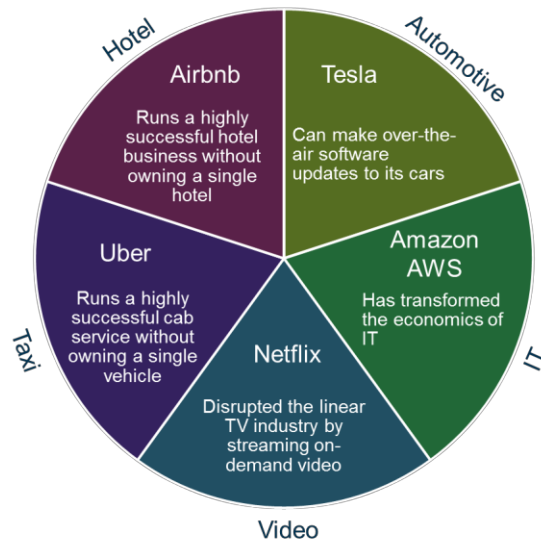


Figure 2.1: Examples of highly disruptive software driven digital companies [Source: Analysys Mason, 2017]

Digital companies owe a large share of their success to the way they run their operations and demonstrate a few common characteristics that are foundational to their digital operations. These are:

- highly automated operational processes,
- operations staff highly skilled in software,
- use of DevOps principles for service design and delivery,
- use microservices-based software architectures,
- application programming interfaces (APIs), and
- cloud infrastructure

Figure 2.2 discusses examples of how some of the digital businesses use software-driven operations to increase operational efficiency and differentiate themselves from the competitors.

Figure 2.2: Software driven operations of digital businesses [Source: Analysys Mason, 2017]

Company	Highlights of digital operations
<b>AWS</b>	<ul style="list-style-type: none"> <li>• Minimises error-prone manual operations by automating the management of its services using APIs to control the key functionality of its operations</li> <li>• Uses automation rules to maintain reliable and predictable performance at scale by decomposing applications into essential building blocks, each with its own management API</li> </ul>
<b>Google</b>	<ul style="list-style-type: none"> <li>• Applies the “Site Reliability Engineering” paradigm which espouses the idea of DevOps to build software products with an operations mindset.</li> <li>• Uses an operations workforce with software skills to automate repetitive manual tasks, thus removing the business risk associated with manual errors during the operations.</li> </ul>
<b>Netflix</b>	<ul style="list-style-type: none"> <li>• Relies on software-driven automated operations underpinned by cloud-based service infrastructure and DevOps processes</li> <li>• Migrated its service delivery components and operations to distributed AWS cloud infrastructure</li> </ul>

Company	Highlights of digital operations
	<p>over a seven years process</p> <ul style="list-style-type: none"> <li>Transformed development processes by introducing DevOps-based tools and methodologies to increase efficiency and automation</li> </ul>
Uber	<ul style="list-style-type: none"> <li>Migrated from a monolithic operational software architecture to a flexible and scalable microservices-based software architecture for rapid, reliable and independent software releases across regions.</li> </ul>

## 2.2 Current telecoms operations model is not suitable for the future digital telco – status quo is not an option

CSPs are playing catch-up in the digital economy, and accept that there is high business risk of not transforming to a software-driven business. They are facing increasing competition from the alternative service providers that offer traditional services for free at a fraction of cost and with more features. CSPs are therefore embarking on their own software-driven transformation initiatives such as evolving to virtual infrastructures and exploring new operational approaches to achieve business, service and operational agility and flexibility. The boldest initiative is the evolution towards NFV and SDN. NFV involves the migration of the networking infrastructure from proprietary hardware based networks to a shared cloud based resource layer running software virtual network functions; and SDN makes the networks programmable and controllable for dynamic traffic management and service optimisation. At the heart of this transformation is the goal to achieve business and service agility by increasing the speed of service development and delivery, increase operational agility and flexibility through software driven operations automation, and reduce the costs of delivering services.

However, the current operational model is not entirely compatible with these strategic initiatives, which means that this model is not a viable option for software-driven telco operations. Characteristics of the prevalent current operational model include:

- The operational processes around these software systems are developed by stitching together the fractured systems, resulting in poor automation and high mean time to resolve resource and service faults. Ultimately, this leads to poor service quality and inferior customer experience.
- Operations support software is designed based on rigid closed software architectures. These architectures are deployed in domain-based operational siloes that create a scattered IT estate, which extends software change cycles beyond control, increasing the time to market of new services.
- The operations engineers are trained to use the software systems to perform their daily tasks. They do not necessarily have the skills to enhance the software to suit changing needs. They may also be constrained by the functional boundaries of the software that disallows customisation.
- The operations organisation is tiered and bureaucratic. For example, there are usually three tiers of customer care and network operations, often reflecting the siloed software and process siloes, with high levels of manual handoffs between tiers.
- Operations persons lose motivation due to the mundane and repetitive nature of the manual operational processes. This causes high levels of employee attrition.

Collectively, these characteristics of the current operational model are the antithesis of the vision of the next-generation telco, and may prevent the CSPs from achieving the business benefits of digital transformation. A business-as-usual approach would lead to more operational silos and highly unmanageable workflow processes,



higher operational costs, and a real prospect of a failing to achieve the objectives of digital transformation. CSPs must overhaul the current operations model and make it fit for purpose for the software-driven digital telco.

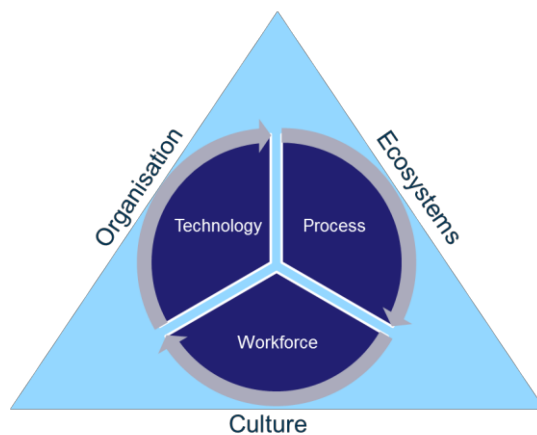
## 3. CSPs must adopt a multi-pronged transformative approach to all aspects of operations

### 3.1 The success of the future digital telco will depend on a new operations model

CSPs must embrace a new operations model to achieve the objectives of the network virtualisation, such as service agility and autonomous operations. The new model must offer a certain level of flexibility to not only support the legacy physical networks, but also the emerging converged IT and networks infrastructure that is being driven by the introduction of NFV. This will enable seamless onboarding of new software and enabling infrastructure components pertaining to 5G, IoT and other future business partners.

At the service layer, the model must support traditional communication services. It must be able to automatically onboard new digital services and offer a flexible framework to quickly develop the associated automations to monitor and assure those services, and the associated infrastructure components. Furthermore, the new model must foster a culture of collaboration and constant innovation both within the CSP organisation and externally through partners and ecosystems]. These external parties can both contribute to – and benefit from – the automations and innovations.

CSPs must execute a multi-faceted operations transformation to implement the new operations model. Figure 3.1 depicts the key tenets of this operations transformation to achieve the future mode of operations.



*Figure 3.1: Key tenets of software driven operational transformation [Source: Analysys Mason, 2017]*

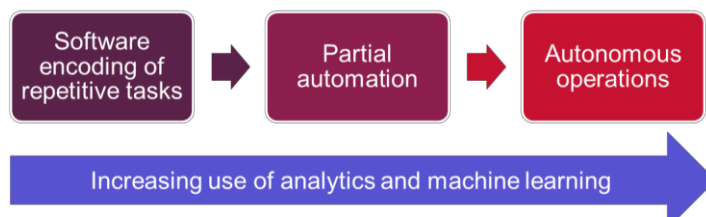
CSPs require a shift in mindset to achieve this vision and acceptance that this edition of operations transformation is going to be fundamentally different to all the past transformations, both in terms of scale and scope. CSPs must embrace new ideas in all aspects of operations, as will be explained in the rest of the report.



## 3.2 Process transformation – autonomous operations is the goal with manual intervention deployed only as an exception, but this will not happen overnight

### 3.2.1 CSPs can realise the true benefits of the transformation by achieving high levels of automation

While the goal is autonomous operations, however, the evolution will be gradual, and will only be possible by taking an incremental approach to automation, and by strengthening operational trust along the way. As part of the process transformation, CSPs should constantly pursue opportunities to automate. They should work on the principle that everything that can be automated should be automated. Figure 3.2 illustrates the CSPs' evolution to automated autonomous operations.



*Figure 3.2: Evolution to autonomous operations*  
[Source: Analysys Mason, 2017]

### 3.2.2 Manual process tasks must be coded into reusable software components

CSP operations departments rely heavily on repetitive manual processes for service delivery and day-to-day operational tasks. Such manual processes are usually available in the form of written runbook manuals but it is also likely that they are private knowledge of operations persons. In many cases, the processes require the operations persons to access multiple infrastructure components or IT systems to troubleshoot issues. Despite detailed instructions and experienced operations people, manual processes are prone to errors. The risk of performing inaccurate analysis or making an incorrect configuration change is high. This may lead to service disruption, lost revenue and customer churn. It is therefore vital that the tasks are completed accurately and consistently every time. Runbooks and repetitive manual processes are most conducive for software automation, and the goal should be to package the software routines as reusable components so they can be programmatically triggered and executed based on data-driven decision points and rules.

The component-based software engineering approach enables the identification of repeatable manual tasks at the most granular level. This approach codifies them into reusable software components forming the smallest unit of automation. Performing deep analysis of the tasks will provide answers to questions such as:

- which tasks must be performed sequentially
- which tasks can be performed in parallel
- what the decision points may be
- what data points drive the decisions etc. that informs the business logic of the software components.

Finally, packaging the components with APIs allows the components to be programmatically triggered based on policies and rules, and executed as part of automated process workflows.

### 3.2.3 Partial guided automation is necessary to develop operational trust

Operations persons need to develop trust in the automations to a point where they can completely relinquish control and let the automations drive operations. This will, however, be a gradual process. Not all codified automations and operations process workflows are going to be executed in fully autonomous mode from day one. CSPs must employ partial automation to ease the operations persons into automation and create a flexible

automation framework that allows varying degrees of programmatic control and manual decision checkpoints in the process.

Using this framework, partial automation workflows can be designed to allow operations persons to assess the status, perform the analysis and make decisions on the next best action at key decision points in the workflow path. Upon gaining sufficient confidence in this stage, CSPs can apply analytics models and machine learning to make the decisions on behalf of the operations persons, and employing manual intervention only for approving or rejecting the decisions.

### **3.2.4 Analytics and machine learning driven process workflows prepare the ground for full automation**

Analytics is going to play an even bigger role in helping the CSPs make the leap from partial automation to full operational automation. The analytics models, together with the derived contextual insights, will act as the control centre that will drive the decisions during the process runtime. However, to be fully effective, the analytics models must constantly develop intelligence and learn from the environment to make better decisions when presented with the same operational context in the future, much like the human brain. This is where machine learning's pivotal role in operations automation becomes clear.

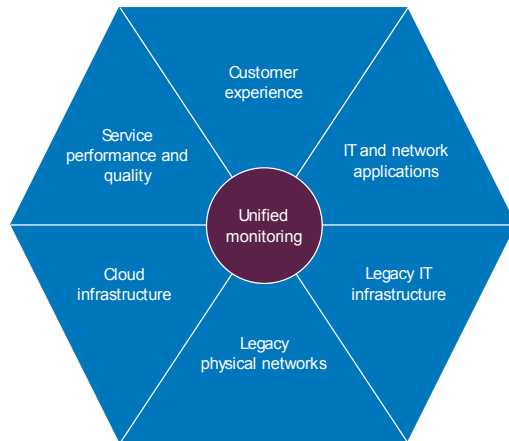
Machine learning augments the analytics models with learning abilities, and provides the basic mechanisms for continuously enhancing the intelligence of the model. For example, applying machine-learning-based analytics models, even to partially automated processes, offers excellent opportunities to calibrate the models. Using supervised and reinforced machine learning approaches, the operations persons can tune the analytics models as they make decisions while executing the workflow. This allows for an accurate recording of the decisions and the associated environmental context in which the decisions were made. The models can then replay the decisions when the same environmental contexts manifest again during future executions of the operational workflow.

As confidence grows in machine-learning-led automations, unsupervised machine learning models can be gradually introduced to work with automated workflows, taking CSPs into the realm of AI-led operations. The self-learning and self-calibrating nature of unsupervised learning models constantly tune themselves to increase the accuracy of the operational decisions. The goal of the new operations model must be to realise autonomous operations, with operations persons on standby to deal with exceptions.

## **3.3 Technology transformation - from vertical tool siloes to a horizontal operations platform**

### **3.3.1 Consider unified end-to-end monitoring of the hybrid physical and virtual infrastructure to deliver superior customer experience**

The complexity of today's networks poses a significant management challenge for CSPs. This is primarily because a new generation of networking technologies is introduced without retiring the old, resulting in a complex mesh of coexisting legacy and new networks. The operations systems, such as monitoring and assurance, associated with the legacy networks also perpetually coexist with the new management systems. The introduction of NFV will magnify the scale of problem further. In addition, CSPs operate numerous data centres hosting a large estate of business-critical IT applications which require separate monitoring and assurance. Consequently, because of the plethora of fractured vertical monitoring tools and systems, CSPs struggle to gain a true end-to-end view of the network and infrastructure performance, network service quality and customer experience, resulting in dissatisfied customers and high churn rates.



**Figure 3.3: The scope of unified end to end monitoring [Source: Analysys Mason, 2017]**

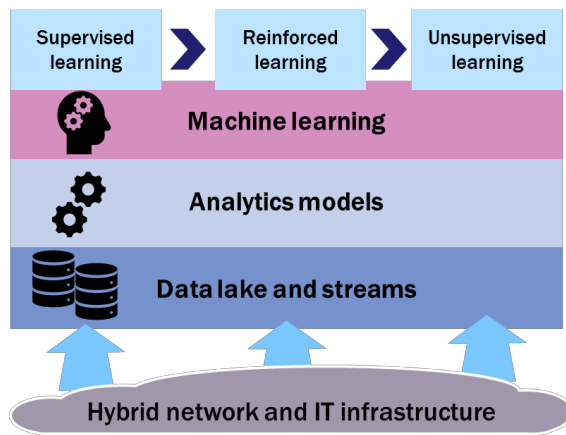
To tackle this problem, CSPs must transition to a horizontal unified monitoring capability encompassing all aspects of the networks and IT infrastructure, including existing legacy networks, emerging hybrid and virtual network infrastructure, as well as the data centre and cloud IT infrastructure. The heterogenous infrastructure layer, including the legacy physical infrastructures, must be abstracted with a common set of APIs to normalise data acquisition. Sensor data generated from IoT devices embedded in the telecoms passive equipment can add a unique and powerful dimension to monitoring. Using this data, CSPs can automate the detection of equipment malfunction and service impacts, significantly reducing the time to analyze and restore equipment and service faults. Figure 3.3 illustrates the scope of unified monitoring in the new operations model.

To make the model future proof, the monitoring solution must enable seamless onboarding of new infrastructure components and domains such as NFV, IoT and 5G. Most critically, the monitoring solution should also provide ‘out-of-the-box’ capabilities to measure and monitor the true indicators of customer experience (such as end-to-end network service quality) with the additional ability to customise the service models and algorithms to suit CSP requirements.

**3.3.2 Implement a data lake powered by analytics and machine learning to enable real time and predictive operations**

As part of the evolution towards horizontal operations, CSPs must complement the unified monitoring approach with a data lake and streams architecture with the ability to record, process and aggregate every data point originating from the infrastructure and the network and IT application layers, such as log files, network counters, transaction data and network telemetry data. While the data lake forms the crux of the data acquisition layer, the data models and analytics algorithms provide the mechanisms to generate actionable insights from the raw data and act as the core engine to drive automation. To achieve the high levels of operations automation, CSPs will need the analytics models to drive closed loop assurance and orchestration processes, shrinking the ‘time to action’ to a matter of seconds, or even near real time.

Figure 3.4 provides an illustrative framework of how CSPs can apply various analytics and machine learning techniques such as supervised, reinforced and unsupervised learning techniques to bolster operational impact.



*Figure 3.4: Data lake and analytics for real time predictive operations [Source: Analysys Mason, 2017]*

Using reams of historical operations data, supervised machine-learning algorithms can be trained to spot patterns (e.g. degrading network performance) and trigger remediation routines (e.g. supplement network capacity). Continuous calibration of the algorithms can increase the accuracy of pattern matching and decisioning, to a point where there is sufficient confidence to establish predictive operations. In a predictive operations context, the models predict network or service issues, hours, days or even weeks in advance, allowing sufficient time to take remediation action. On the other hand, unsupervised learning algorithms have not had prior training on how to classify or label patterns, but would employ grouping or clustering to organise data to understand potential structures and patterns before predicting outcomes. Reinforcement learning is when the machine-learning algorithm makes a single action and receives a notification on how good the decision was, and calibrates its next move based on the feedback. Of the three machine-learning paradigms, supervised machine learning is the most widely used technique, and requires the skills of data scientists to set up and continuously calibrate the algorithms. All three machine-learning techniques are expected to play a critical role in achieving the vision of full operations automation.

### 3.3.3 Embrace microservices architecture for rapidly composable and scalable operations

New service introductions require changes to operations systems and processes. In legacy monolithic software architectures, these changes often take months to complete. An operations platform based on microservices architecture enables CSPs to become more agile and responsive to changing business needs. Using a microservices architecture in conjunction with DevOps software engineering principles, CSPs can significantly reduce the time to apply changes. This means that they can quickly onboard new services and reduce the time to launch these services. Furthermore, the microservices architecture is most conducive to develop applications in the cloud, which paves the way for CSPs to implement a cloud-based operations platform.

Microservices architecture enables the creation of small and highly granular functional software modules (e.g. performance analysis, log analysis, reporting) that can be used to compose applications (e.g. service quality monitors, engineer dispatch applications). A microservice is self-contained and highly available, enabling it to be configured, scaled, enhanced and replaced independently without affecting the availability and reliability of the cloud native applications it is part of. Figure 3.5 illustrates an example of the microservices architecture.

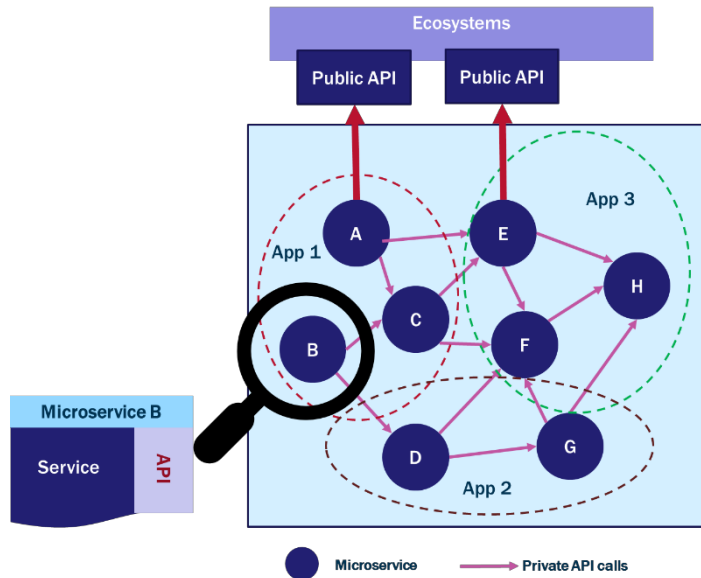


Figure 3.5: Microservices architecture [Source: Analysys Mason, 2017]

However, for the effective functioning of such an architecture, the microservices must interlink and communicate with each other using APIs. APIs are one of the most powerful features of microservices, which enable them to be dynamically called during runtime by other microservices as part of a larger application.

### 3.3.4 Support open APIs for rapid open innovation

Open APIs allow external software applications to access exposed platform capabilities, creating infinite possibilities for open innovation through authorised ecosystem partners. It enables CSPs to harness the power of the broader digital ecosystem, creating a win-win proposition for both the CSP and the ecosystem partners. We would suggest that the platform supports the REST API architecture as it is the most commonly used API standard across the IT world. Using REST will ensure that the platform can integrate with existing applications that already use this API architecture.

### 3.3.5 Harden the operations platform to provide highest levels of security

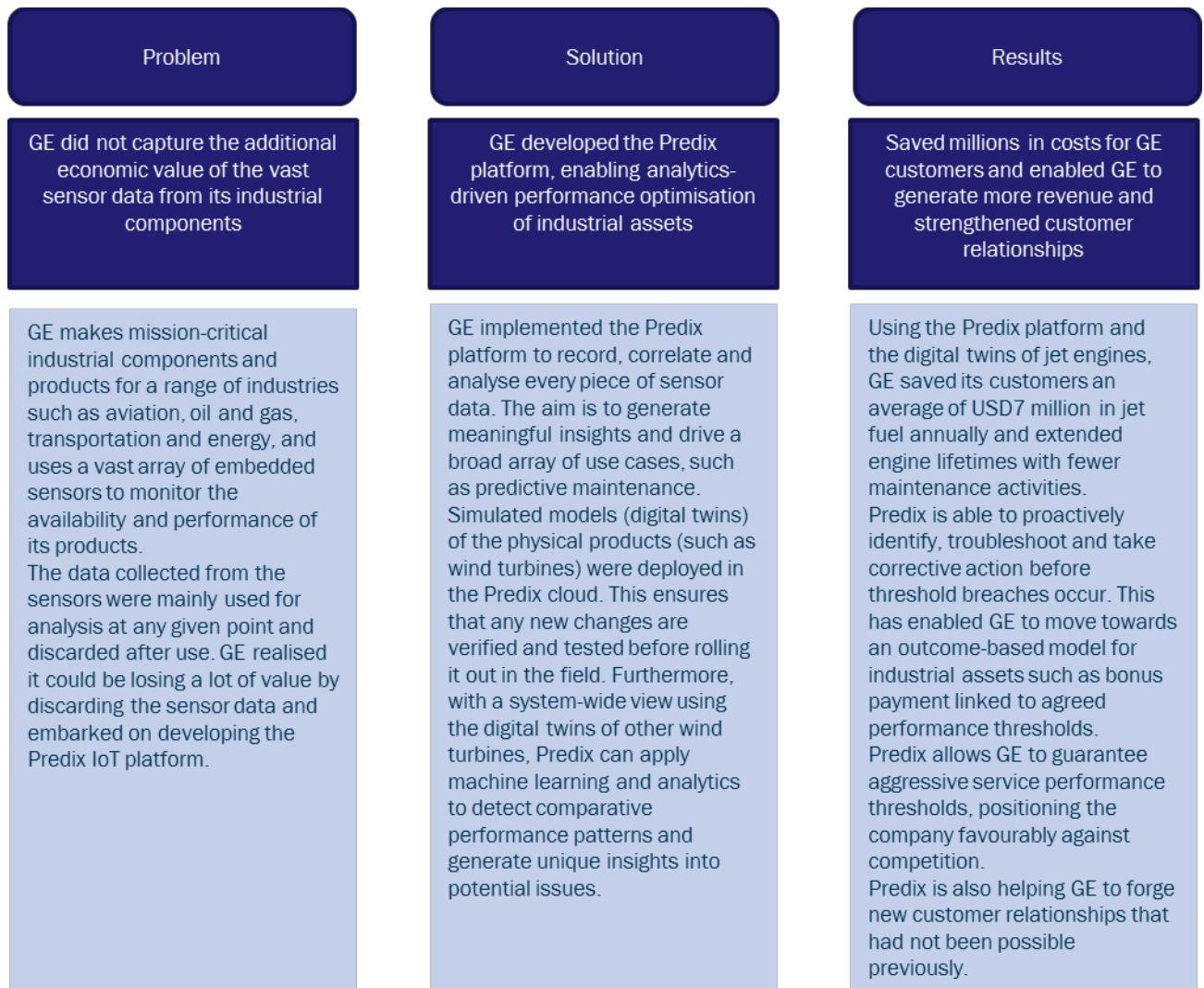
Increased use of software and APIs exposes the operations platform to security vulnerabilities such as viruses, malwares, intrusions and unauthorised access control. In 2017, ransomware attacks such as WannaCry and Petya caused significant business disruption at large enterprises and government agencies worldwide, wiping out millions of dollars of revenue and severely impacting day-to-day operations. Not all attacks can be prevented but to reduce the success rate of attacks, it is imperative that security is integrated into the platform development process from day one. This should be coupled with the ability to quickly and continuously make patch updates for latest security threats. Security teams must be fully equipped with the tools and expertise to rapidly handle any security incidents.

### 3.3.6 Case study: GE's Predix Industrial IoT analytics platform – using insights to improve operations and strengthen customer engagement

General Electric (GE), a 125-year-old conglomerate with an annual revenue of USD120 billion, is embracing cloud based technologies to transform towards a modern digital business. It has setup a separate business subsidiary called GE Digital to drive innovations, particularly in the industrial IoT domain. The company has created a cloud based IoT platform called Predix, which was originally developed to drive the digital transformation within GE's own businesses across industries such as aviation and utilities. In FY 2016, the revenue of GE Digital grew by 16% to USD3.6 billion, and GE expects Predix related business to reach USD 1 billion in 2017. Following significant success

of Predix at GE, other companies across the world are adopting the platform. Figure 3.6 explains how GE used Predix to achieve cost savings and strengthened customer relationships.

Figure 3.6: GE Predix case study [Source: Analysys Mason, 2017]



### 3.4 Workforce transformation – operations teams must learn new skills and acquire a software programming mindset

*Every new GE recruit will learn to code. We don't expect them all to write software, but they must understand the 'art of the possible' in a digital future.*

*Jeffrey R. Immelt, CEO of GE<sup>2</sup>*

#### 3.4.1 'Programmable' operations require new skills

Most revolutionary changes in technology require an accompanying profound organisational change, which is driven by the need to attain the skills and cultural shifts demanded by the new technologies. The transition to

<sup>2</sup> GE Annual Report 2016. Available at [http://www.ge.com/ar2016/assets/pdf/GE\\_AR16\\_Integrated\\_Summary\\_Report.pdf](http://www.ge.com/ar2016/assets/pdf/GE_AR16_Integrated_Summary_Report.pdf)



software-driven operations requires a transformation in telcos’ workforce: a change in both skill set and mentality.

A key success factor of the new operations model is its ability to quickly adapt to changing business and operational needs. In other words, the new model must allow rapid addition, modification and composition of relevant automation components and workflow processes for service changes or new service introductions. These combinational characteristics of agility and programmability are what makes the new operations model unique. To realise this vision, CSPs will need to augment their staff with a whole new set of skills. Figure 3.7 provides some examples of these new skills.

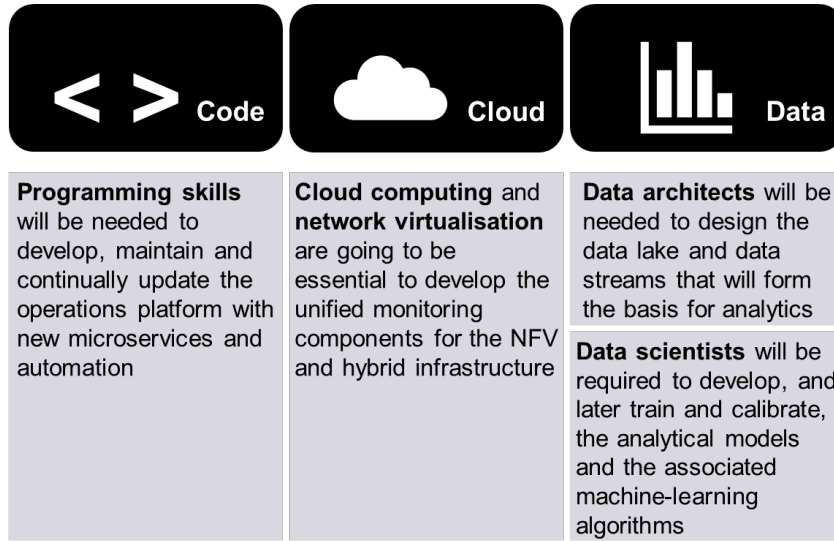


Figure 3.7: New skills required for 'programmable' operations [Source: Analysys Mason, 2017]

**3.4.2 Reskilling programmes must be supplemented with 'new blood' to achieve the mindset shift**

CSP HR departments are faced with a significant challenge: large existing headcounts (i.e. costs to the business) that do not fulfil new business needs. This challenge assumes different forms in different types of CSPs, but all CSPs need to make a key strategic decision: whether to **hire or reskill or do both**. Figure 3.8 summarises the pros and cons of these approaches.

Figure 3.8: Key advantages and disadvantages of hiring v. reskilling [Source: Analysys Mason, 2017]

	Advantages	Disadvantages
<b>Hire</b>	<ul style="list-style-type: none"> <li><b>Quality</b> – hire the person with skillsets that are an exact match to the CSP needs.</li> <li><b>New mindset needs new 'blood'</b> – new hires will likely come without much legacy, cultural baggage i.e. with the right software programming mindset</li> </ul>	<ul style="list-style-type: none"> <li><b>Supply is low</b> – skills that CSPs need are in high demand across almost all industries</li> <li><b>Cost is high</b> – software engineers and data scientists are highly paid and replacing existing staff would be very expensive</li> <li><b>Telcos have low appeal to high-quality hires</b> – the most talented software engineers prefer to work for webscale companies and start-ups</li> </ul>
<b>Reskill</b>	<ul style="list-style-type: none"> <li><b>More popular option</b> - avoid massive and unpopular layoffs of the existing workforce</li> <li><b>Reinforces loyalty</b> – allows the CSP to retain the most loyal people</li> </ul>	<ul style="list-style-type: none"> <li><b>Regulatory environment can be prohibitive</b>– many countries have restrictive regulatory environments i.e. layoffs may not be an option</li> <li><b>Cost is moderate/high</b> – large scale training programmes can be very costly for the organisation</li> <li><b>Uncertainty of outcome is high</b> – not everyone will be willing to undergo training and/or capable of</li> </ul>



Advantages	Disadvantages
	learning completely new skills. While people can be reskilled through training programmes, it is unlikely that these programmes will change the mindset/culture entirely
<b>Overall</b> Neither solution on its own is ideal; most CSPs will find that a combination of the two is best.	

### 3.4.3 Case study: AT&T's "Workforce 2020" programme

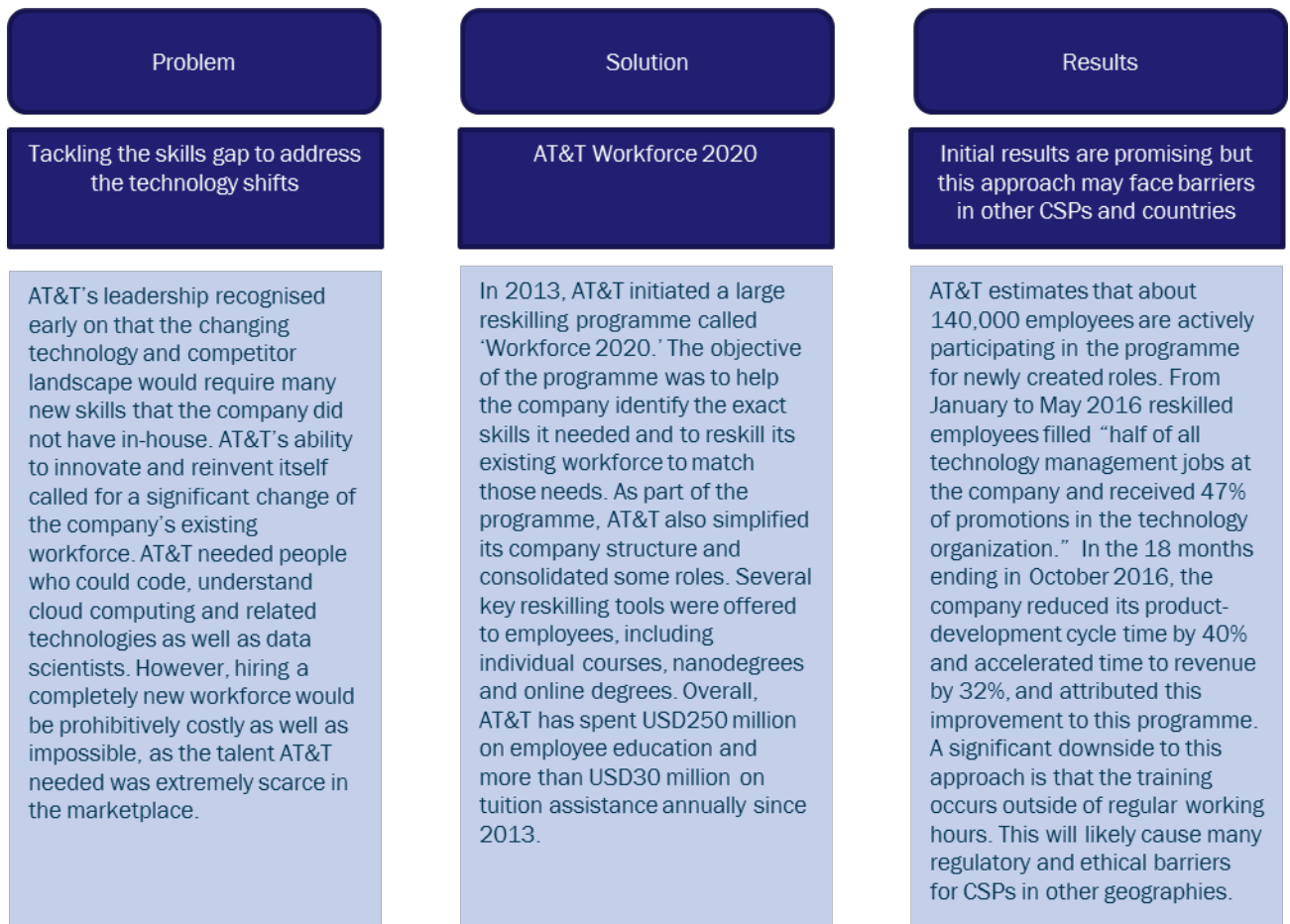
*"You can go out to the street and hire for the skills, but we all know that the supply of technical talent is limited, and everybody is going after it. Or you can do your best to step up and reskill your existing workforce to fill the gap."*<sup>3</sup>

**Scott Smith, AT&T's senior vice president of human resources operations**

Since 2013, AT&T has been executing on its 'Workforce 2020' talent overhaul programme to reorient itself towards a software driven organisation. Figure 3.9 discusses AT&T's workforce transformation in more detail.

<sup>3</sup> Harvard Business Review (USA, 2016), AT&T'S TALENT OVERHAUL. Available at <https://hbr.org/2016/10/atts-talent-overhaul>

Figure 3.9: AT&T’s “Workforce 2020” programme [Source: Analysys Mason, 2017]



**3.4.4 Workforce transformation is the hardest to execute**

Telco digital transformation cannot succeed without a long lasting organisational and cultural change. Organisational culture, which is the common set of shared beliefs and values governing the people, is one of the key defining attributes of a company, and the hardest transformation to execute because people are generally resistant to change. Companies that embark on organisation wide change require sponsorship, commitment and direct governance from one or more of the C-level executives. Executive-led initiatives enables CSPs to align the transformation effort and business objectives, and critical decisions are made in a timely manner. All round 360-degree stakeholder management is necessary to keep all the stakeholders informed, especially those who are affected by the transformation.

Digital transformation initiatives such as the transition to software driven operations must go beyond teams or a single department to cover all the relevant groups in the organisation. Team or departmental transformation provides limited benefit because of the high probability that bottlenecks may occur in other parts of the organisation, which will ultimately render the transformation ineffective. AT&T’s workforce transformation is a rare example of an organisational change of this scale in the telecoms industry, and provides a glimpse of what it takes for CSPs to execute the transformation themselves.

Indeed, every CSP is different, and the specifics of the approach to transformation will depend on the CSP characteristics – a multi-national CSP with many operating companies would be constrained by the sheer size of the workforce, organisational bureaucracy and the complexity of the transformation as opposed to a small agile CSP that can make swift decisions and execute the transformation at a much faster pace. Nevertheless, the

importance of transforming mindsets and skillsets, the associated challenges and the complexity of the transformation cannot be underestimated.

## 4. CSPs can differentiate through continuous innovation, ecosystems and lean operations

### 4.1 DevOps is the underpinning process framework to execute the new operations model

A key characteristic of digital businesses is the use of the DevOps-based approach to deliver software and services. DevOps is as much about the organisational culture as it is about the processes and tools that are used. A DevOps approach demands deep collaboration between the software development and the operations organisations to rapidly deliver enhancements into the production environment in a continuous fashion, resulting in less room for error. It nurtures a culture of rapid innovation by frequently delivering small chunks of incremental functionality using DevOps processes such as continuous integration (CI) and continuous delivery (CD). CI and CD processes mandate regular code delivery followed by automated build, test and deployment of the code into a test environment. This is then followed by the release to the production environment.

Microservices architecture, discussed in detail in Section 3.3.3, lends itself to the DevOps philosophy. Each microservice can be independently developed and, if required, use completely different programming languages. Using DevOps processes in conjunction with a microservices architecture, CSPs can rapidly and continuously deploy and deploy enhancements to the operations platform, as well as create new applications and workflow automations. Using DevOps, CSPs can aspire to achieve the required operational agility that is so vital for the success of the new operations model. From a security standpoint, DevOps also provides the vital mechanism to quickly apply patches to protect against any emerging threats.

### 4.2 Ecosystems increase the scale and pace of innovation

In the emerging digital economy, increasing collaboration between businesses raises the pace of innovation and delivers services faster. In the context of the new operations model, ecosystems are becoming an important adjunct capability that can bolster operations and further increase service agility. By opening the operations platform to its trusted network of business partners and vendors, a CSP can harness the power of a larger community of experts, 'crowdsource' innovations, and quickly adopt the most relevant applications. Multi-national group CSPs can explore opportunities to cascade the applications across their operating companies for rapid adoption. Where relevant, CSPs can also consider monetising the applications by selling them on to their business customers or offering the applications for free to earn goodwill.

Carefully developed ecosystems with a large base of reputable companies can create a 'network effect' for CSPs, increasing the value for both the CSP and the ecosystem participants as the users increase. Successful ecosystems are extremely influential in creating unique competitive differentiation. These ecosystems also have the potential to increase end customer loyalty because the customers benefit from the collective power of innovation offered by the ecosystem participants. In the telecoms industry, some leading CSPs along with industry bodies are spearheading efforts at creating open source ecosystems to address the challenges around NFV operations in which automation of NFV and SDN management and network orchestration are key drivers. Examples include Linux Foundation's Open Network Automation Platform (ONAP) promoted by AT&T with

more than 50 members, ETSI's Open Source MANO (OSM) led by Telefonica with 38 members and Open Network Operating System (ONOS) with 18 members.

In other industries, GE Digital, the business unit running Predix, launched a global alliance programme in 2016. The aim of the programme was to create a digital industrial ecosystem across systems integrators, independent software vendors, telecoms service providers and technology providers. The ecosystem comprises some of the top businesses in the world, including Accenture, AT&T, Cisco, SoftBank and Vodafone, Capgemini, Intel, Infosys, Genpact, TCS, Deloitte Digital, Softek and Wipro Limited. In 2016, Predix had notched up more than 400 partners. Notably, TCS has developed more than 50 Predix-based applications that are available in its store.

### 4.3 CSPs must consider lean organisational structures to enhance customer experience

The new operations model presents CSPs with a tremendous opportunity to take a fresh look at their own organisation structures. To realise the benefits of software-driven operations, CSPs must move away from the prevalent bureaucratic organisation structures and align themselves with the principles of lean and agile operations and delivering enhanced customer experience.

The increased use of software in operations is expected to significantly increase the efficiency of the operations persons. Utilising their new skills in software, operations persons will be empowered to rapidly develop and deliver operational enhancements into operations, becoming a higher valued staff directly contributing to the success of the overall business. Most of the operations persons' time will be spent on handling automation exceptions and enhancing the operations processes rather than on day-to-day, repetitive activities. Furthermore, by exposing the automations directly to the front office customer care departments, CSPs can make the care agents much more effective and responsive in dealing with customer demands. The resulting highly 'intelligent' software-driven customer care and operations departments allow CSPs to deliver a superior customer experience. These departments also offer avenues to create a flatter operations department, with a further possibility of merging the customer care and operations departments into a highly agile converged operations department.

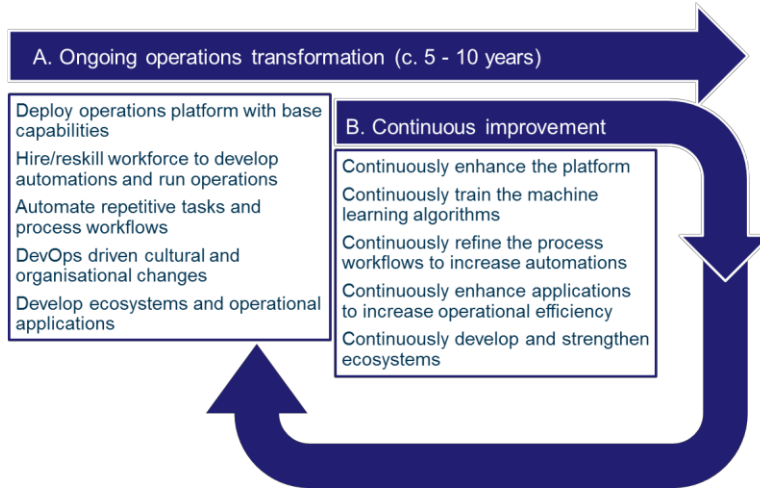
## 5. The journey has just begun - can CSPs execute the transformation on their own?

Most transformation projects are considered high risk. High failure rates are caused by budget and time overruns, and an inability to meet CSP expectations. However, many leading CSPs accept that the risk of not transforming to a software-driven digital business is significantly high. More and more CSPs are concluding that the potential benefits of transformation, such as service agility, substantially outweigh the risks. Having crossed that important psychological barrier, CSPs must now initiate and execute the transformation process.

### 5.1 Dual track transformation strategy

The software driven operations transformation can be viewed as two broad tracks, as illustrated in Figure 5.1. Track A is the main transformation thread that will be ongoing for the foreseeable future. However, the immediate aim is to deploy the base capabilities of the operations platform, identify the most favourable manual

tasks and process workflows for automation, prepare the development and operations organisation, and develop and deploy the automations using DevOps methodologies. As the initial set of automations reach steady state, Track B, the second track of continuous improvements, can begin. In the meantime, Track A can progress by developing new automations. Track B is the continuous improvement track, and will focus on constantly enhancing the platform, processes, applications and the ecosystems, with the ultimate aim of achieving autonomous operations.



**Figure 5.1: Dual track operations transformation strategy**  
 [Source: Analysys Mason, 2017]

Typical of any transformation, CSPs must execute the operations transformation while also running their current operations. In this particular case, the balance between transformation and current operations must be maintained while also evolving the infrastructure to NFV and SDN, which makes the job even more complex and risky. To mitigate some of the risks, it can be argued that certain elements of the transformation (such as the operations platform development, runbook automation and workflow automation) can start immediately while CSPs finalise the strategy and budgets for NFV and hybrid infrastructures operations. The automations will be reusable and the benefits will be immediate, which will bolster the business case for the new operations model.

## 5.2 CSPs have many strategic choices to execute the transformation

Given the complex nature of the transformation journey, CSPs face the key question of how to go about executing the transformation. A major decision will be whether they should they take the DIY approach or engage with a strategic partner, or partners.

Not all strategic options are suitable for all CSPs. The CSP’s level of operational maturity, its track record in executing large transformations, its regulatory and data privacy requirements, and its clarity and understanding of the objectives of its future software-driven operations are all factors to consider when choosing a strategy. Furthermore, there are a wide variety of CSP types (Tiers 1 to 4) that can be characterised based on revenue, types of services offered (mobile, fixed, converged, MVNO), single country or multi-country group CSPs, regions of operation (developed or emerging markets). Various permutations and combinations of these parameters lead to variations in CSP characteristics and behaviour. A combination of these CSP characteristics will dictate the suitability of the execution option.

The DIY approach may be most suited to large Tier 1 and Tier 2 CSPs that have the financial appetite and significant R&D budget to conduct extensive R&D, and own all aspects of the transformation. At the other end of the spectrum are the small but highly agile niche CSPs who can rely on internal capabilities to transform with

minimum business inertia. However, the operations transformation will demand extensive change on multiple fronts, and the amount of change can be overwhelming.

Most CSPs may lack the full set of knowledge, experience, skills and the financial backing needed to execute the transformation. For example, they may not necessarily have the full understanding of the context and extent of the transformation. CSPs with limited knowledge may feel confident enough to engage in the operations transformation but may not focus on the most crucial elements of the transformation. CSPs may need to supplement their capabilities with external support and engage with a partner or a combination of partners to execute the transformation journey successfully. Figure 5.2 below provides illustrative examples of some of the potential strategic choices such as DIY, consultative-led operations-as-a-service, managed services, outsourced operations and best of breed models, although this is not an exhaustive list.

Figure 5.2: Options for transformation execution [Source: Analysys Mason, 2017]<sup>4</sup>

Option	Description	Advantages	Drawbacks
DIY	CSPs take end-to-end responsibility for the transformation	Retains full control of the transformation	Incur high costs and own all the risks.
Consultative-led operations-as-a-service	CSPs partner with a vendor based on a consultative-led, operations-as-a-service engagement. Uses a multi-tenanted cloud-based instance (SaaS) of the platform that resides in the vendor environment. Vendor provides advisory services recommending the transformation strategy, offers continuous consulting to improve operational efficiency and runs the day-to-day operations.	Vendor shares the risk and costs of running the platform Less disruptive to current operations Opex based predictable recurring costs for the service Exploit the partner's deep understanding of the telco operations through numerous implementations Vendor fully responsible for disaster recovery, security and regulatory compliance of the data.	CSPs have little control over the features and the lifecycle of the platform. Same instance of the platform used for multiple CSPs so there is limited technology differentiation. CSP faces a vendor lock-in scenario.
Managed services	The vendor partner develops and owns the platform which resides in the vendor's environment, and runs the operations for the CSPs. The vendor may take on the CSP workforce as part of the engagement.	CSPs can focus on the core business of service innovation and delivery while the vendor delivers on the contracted service level agreements.	CSPs have little control over the features and the lifecycle of the platform.
Outsourced operations	CSPs own the platform, which resides in the CSP environment, and uses a vendor partner to run the day-to-day operations.	CSPs control the platform lifecycle and automations, enabling them to prioritise automations. Opportunity to differentiate based on the platform, and monetise the platform by 'renting' it out to other enterprises.	CSPs incur the costs of owning and maintaining the platform, and making continuous improvements.
Best of breed	CSPs procure the platform	CSPs optimally use the specialist	CSPs are responsible for

<sup>4</sup> Variants of the operations as service and other engagement models are possible. For example, the CSP may prefer to access a hosted platform in a SaaS mode and perform the operations and continuous improvements themselves, but use the vendor partner's ecosystems and applications.

Option	Description	Advantages	Drawbacks
	based on a perpetual licensing model from a vendor partner, and use other vendor partners for day-to-day operations and process improvements.	partner expertise where most appropriate.	partner management overheads due to a complex procurement strategy. CSPs have some influence over the features and the lifecycle of the platform.

The vendor ecosystem must further develop the range of engagement models to suit specific types of CSPs and provide CSPs with a wide range of implementation options. For example, vendors can further enhance the value of their offers by providing the solution in a hosted environment, such as platform as a service (PaaS) or SaaS.

CSPs are expected to increase the adoption of the as-a-service models over the next five 5 years. Analysys Mason estimates that by 2021 (see Figure 5.3), the market for SaaS in the key operational areas of assurance and fulfilment will be worth about USD 1.5 billion, accounting for about 9% of the overall market, growing at compounded annual growth rate of about 17%.

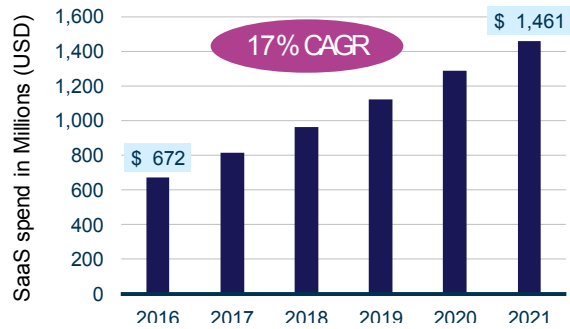


Figure 5.3: Spending on SaaS on operations (assurance and fulfilment) [Source: Analysys Mason, 2017]



## 6. Conclusions

The telecoms industry is at an inflection point. The future success of CSPs will depend on their ability to transform into a software driven business based on a new operations model. To achieve this, CSPs must move away from siloed operations with high levels of repetitive manual processes to autonomous operations enabled by a software driven operations model. This model should be underpinned by an operational workforce with software skills capable of creating and continuously automating operational processes using an operations platform powered by unified monitoring, analytics and machine learning. The operations model must not only support the existing physical infrastructures and the services, but also continuously adapt as CSPs implement new strategic initiatives such as NFV, IoT and 5G. CSPs must embrace a DevOps based approach to continuously develop and deploy improvements to the processes and the platform. A lean and intelligent software driven operations increases service agility, provides CSPs with a strong basis for competitive differentiation and enables CSPs to accelerate the journey of digital transformation. However, this transformation will require a significant shift in mindset coupled with organisational changes. CSPs will need to consider ways to embed a strong culture of continuous innovation and collaboration between operations, the wider organisation, as well as partner ecosystems.

With the increasing use of software across industries, companies will need more software professionals, which is expected to create talent crunch. Digital companies such as Amazon or Google have always attracted top software talent, and this is a significant industry challenge that all stakeholders must collectively address. Training and reskilling of existing workforce can alleviate this problem to some extent but this is not a panacea. CSPs and vendors must attach the highest importance to all aspects of security while developing the new operations model. In cases where CSPs engage with partners, the security requirements must extend to the partner environment, including the cloud environment if the operations platform is hosted there. Data privacy is another important consideration arising from the legal requirement to comply with the regulatory laws of the land and the need to safeguard customer's data.

CSPs have many options to execute the transformation, such as the DIY approach and a range of vendor engagement options. Considering the scale and scope of the transformation, it is expected that only a few CSPs with the necessary financial backing and high appetite for business risk will consider executing the transformation themselves. A vast majority of CSPs will require continuous support from vendors and partners on multiple fronts including consulting and advisory, process reengineering, technical expertise in software programming, cloud computing and virtualisation, big data architecture, data science and machine learning. Some of the vendor engagement options include consultative-led operations-as-a-service with a cloud based operations platform, managed services, outsourced operations and a best of breed approaches.

## 7. Recommendations

### 7.1 Recommendations for CSPs

- **Learn from other industries:** successful digital companies such as Amazon and Netflix are powered by software-driven operations that automate the complete lifecycle and management of the infrastructure and services. Even highly entrenched industrial companies such as GE are making a dramatic shift to software, which is evidenced by the success of its Predix platform. CSPs must learn from these successful companies and embrace ideas that have contributed to the success of these companies, such as DevOps, high levels of process automation, continuous innovation, operations workforce skilled in software, and so forth.
- **Envision a future state of automated operations and take incremental steps towards achieving it:** the end state of automated operations will not be achieved overnight. However, CSPs can identify and implement continuous incremental automations to achieve immediate benefits that can contribute to the broader transformation programme. The process of identifying and automating repetitive tasks need not be delayed in order to occur concurrently with virtualisation evolution and can be initiated immediately. As confidence grows, the scale of the automation effort can progressively increase, gradually building a strong foundation for the new operations approach.
- **Choose a partner for the transformation journey:** the operations transformation is going to be complex, time consuming and fraught with significant business risks. Some CSPs with sufficient financial backing and high risk appetite may choose to execute the transformation themselves. Most CSPs will need a partner to help them navigate the transformation journey.

### 7.2 Recommendations for vendors

- **Provide a migration path to software-driven operations:** it is crucial to assess and understand the current state of CSPs' businesses in terms of their infrastructure evolution plans and the maturity of their operational technology, processes and workforce skills. Every CSP has a unique set of circumstances and a different starting point for transformation. Vendors must develop capabilities to conduct this initial assessment of the CSPs, provide strategic planning and recommend an evolution path for CSPs to achieve software-driven operations.
- **Offer innovative engagement models:** vendors must provide innovative ways to partner with CSPs. This could include a consultative-led operations as a service model where the partner shares some of the CSPs' transformation and operational risks related to moving to software-driven operations. It could also include providing deep software engineering and telecoms domain knowledge essential to transformation success.
- **Demonstrate robust internal and external vision of software-driven operations:** vendors who want to partner with CSPs must demonstrate a credible vision and ability to execute the transformation. Vendors can gain CSP confidence if they can prove that they are themselves transforming to a software-driven business and can demonstrate a comprehensive appreciation of the challenges that CSPs face in transforming to software-driven operations.

## About the author



**Anil Rao** (Senior Analyst) is the lead analyst for Analysys Mason’s Service Assurance research programme. He produces market share, forecast and research collateral for the programme and focuses on industry topics including NFV/SDN and their impact on service assurance, and the importance of service assurance in reducing churn and improving customer experience. He has also published research on IP probes, real-time network analytics and unified service assurance. He holds a BEng in Computer Science from the University of Mysore and an MBA from Lancaster University Management School, UK.

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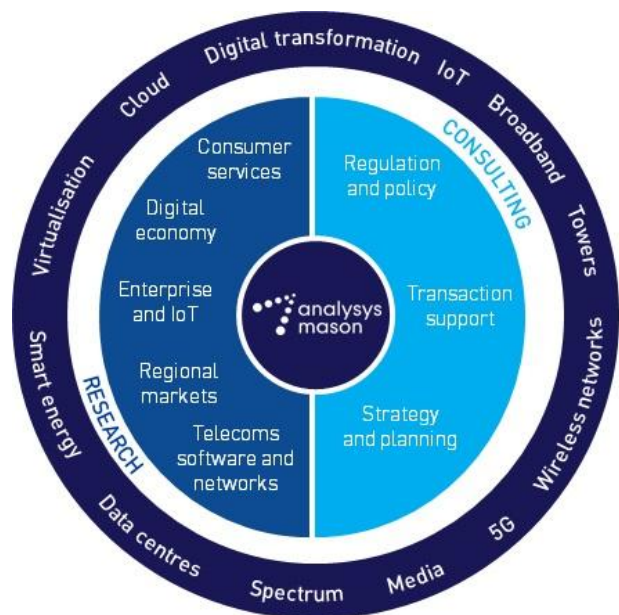
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