

Trend Analysis Report

AI AND ITS PIVOTAL ROLE IN TRANSFORMING OPERATIONS

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The big picture

A year ago, we published our first report on artificial intelligence, *AI: The time is now*. The title reflected the urgency and excitement surrounding the potential of AI, and the report delved into the most obvious application for it: improving customer experience. This year the focus and mood have shifted. Much of the enthusiasm has been replaced by caution and indecision as communications service providers (CSPs) grapple with the many difficulties of applying AI to operations (AIOps). Still, they are beginning to make progress.

In researching this report, we surveyed 65 executives from 37 different global, regional or national CSP operating companies in 25 countries, and 48 suppliers from 33 unique companies. We also conducted in-depth interviews with operators and suppliers.

AI deployment gets underway

Nearly 70% of CSP respondents said they are either deploying AI in some parts of the business or testing it in proofs of concept and trials. Operators are deploying the technology on their own and in

collaboration with suppliers. Either way, the use cases typically focus on improving how CSPs operate now.

However, as networks become more complex, the IT systems supporting them also must evolve to accommodate future demands. Networks and IT must be prepared to accommodate billions of connected devices and waves of new technology, the most prominent being 5G. CSPs recognize that AIOps will be the only way to scale operations and make them sufficiently fast and responsive to profoundly changed networks and businesses as digital transformation progresses.

As José Manuel de Arce, Deputy Director OSS/BSS Infrastructure, WorkSpace and OSS Technology at Telefónica International Wholesale Services, puts it:

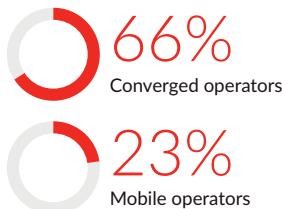
“

AI is about working with data and doing with it what humans would do, without the errors and faster.”

Who are the AIOps survey respondents?

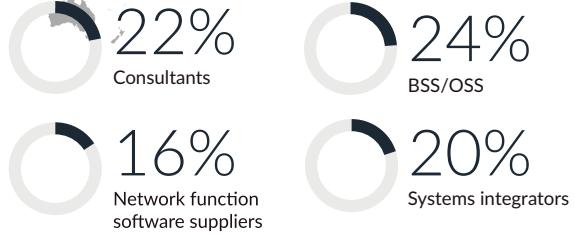
CSPs

65 respondents from 37 unique companies



Suppliers

48 respondents from 33 unique companies



Caution and distrust

Many CSPs seem uncertain about where and how to start with AIOps, and some are not convinced by what's on offer from suppliers. There is considerable tension and distrust between CSPs and established equipment providers in particular, fueled by operators' great fear of losing control of their networks and data if they no longer understand what decisions AI is making (or why) in a supplier's black box. Also, the more processes an AI solution touches, the more valuable and efficient it should become. By the same token though, any faults caused by AI will spread rapidly, so isolating them quickly will be critical. How to do that is adding to CSPs' longer-term concerns.

Our research found that CSPs see having internal AI and analytics expertise as strategically important. Many are working to acquire and develop those skills and knowledge in various ways, yet few appear to have any kind of structured approach either to implementing AI or coordinating their initiatives to avoid duplicating effort and expense, and slowing progress.

Another big issue is that AI needs massive amounts of clean data, but the data CSPs have, which is multiplying all the time, resides in silos and in formats that are not compatible, consistent or easily accessible despite years of grappling with this issue. Lack of standardized data models and other universal approaches are also blocking progress, but CSPs have recognized this, and individual companies and industry bodies are acting to address it.

Go slow to go fast

A lot is happening on many fronts, and while the progress of AIOps seems piecemeal and slow, the approach is arguably a perfect example of Amara's 'Law': Back in the 1960s, Stanford University computer scientist Ray Amara said we tend to overestimate the impact of a new technology in the short run but underestimate it in the long run. Or to quote from a recent presentation by Jerome Katz, Vice President of Service Provider, Customer Experience at Cisco:

“

Go slow to be able to go fast: You need to plan, and [it's] critical to get [AI] aligned with business processes, operational structure, organizational alignment and skills.”

Read this report to understand:

- Which operational changes CSPs are undertaking that require AI
- The types of AI technology operators are using in operations and for what purposes
- How reliant operational transformation is on AI
- The use cases driving AIOps deployment, including which of them operators are implementing today versus in the future
- Issues and gaps CSPs are finding in their attempts to harness AI

Section 1

Analytics, algorithms and operations

There is considerable confusion inside and outside telecommunications about what AI is, why we need it, how to implement it and what impact it will have – never mind how to apply it to CSPs' networks and operational and business support systems (OSS/BSS). We do not have full answers to many of these questions, but understanding what AI is (and is not) as well as why it is becoming essential to operations (AIOps) is a good start in the journey towards reaping the promised benefits.

Analytics and AI

The term 'AI' is often used to mean applying analytics, but the use of analytics alone does not necessarily involve AI, and indeed in many ways this is at the heart of the issue regarding operations. If analytics monitor data looking for pre-defined patterns and anomalies without applying intelligence – that is, without evolving how or what it monitors, or drawing more advanced conclusions from what it has 'learned' – that is not AI. Analytics on their own can contribute to better decision-making, but the decisions must be made and applied by humans.

What is AI – and what's not?

Following are several terms used in this report along with an explanation of how they're related but different:

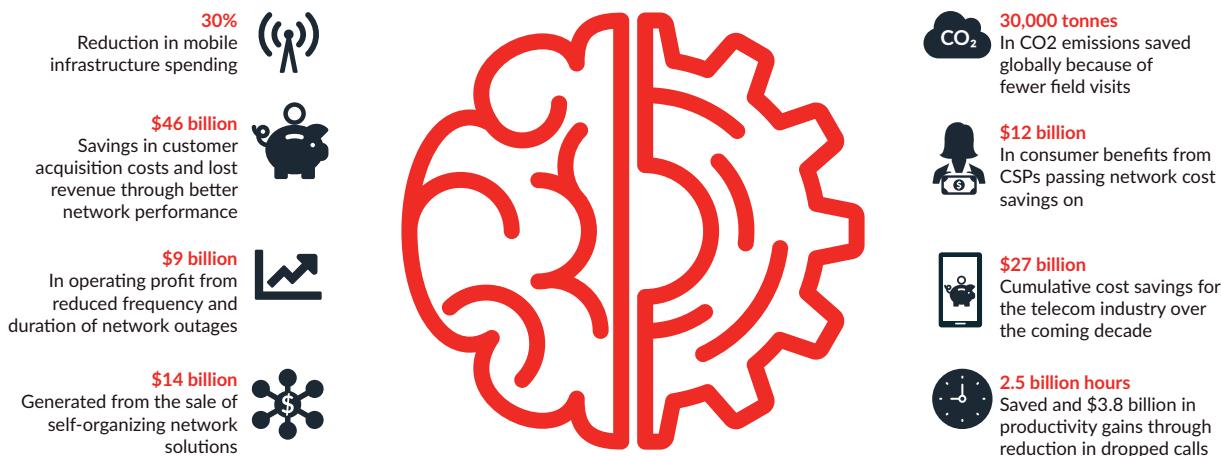
 **Analytics** – monitoring data to look for patterns and anomalies (without applying intelligence) and applying those patterns towards effective decision-making

 **Artificial intelligence (AI)** – the development of computer systems capable of performing tasks that normally require human intelligence; this includes visual perception (such as is required for

self-driving cars), speech recognition (for example, Alexa), decision-making, and translation between languages (think, Google Translate)

 **Automation** – within telecoms this means automation of processes that were previously carried out by people; AI is an enabling technology that may (or may not) help with the process of automation

AI use cases for network and service management



TM Forum, 2018 (source for data: World Economic Forum)

 **Machine learning** – a type of AI that gives machines the ability to learn automatically and improve from experience without being explicitly programmed

 **Deep learning** – takes machine learning further by processing information in layers, where the result or output from one layer becomes the input for the next

 **Cognitive computing** – like AI, cognitive computing is based on the ability of machines to sense, reason, act and adapt based on learned experience, but whereas AI acts on its analysis to complete a task, cognitive computing provides the information to help a person decide

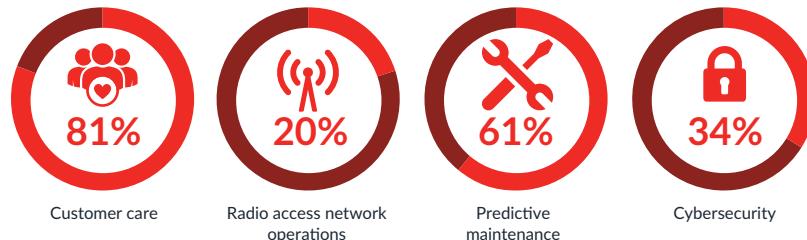
 **Robotic process automation** – a software tool that allows people to configure robots (computer software) to perform rules-based tasks such as accessing programs and systems, performing calculations, creating reports and checking files; within telecoms it can be particularly useful for processes that have predictable and frequent interactions with multiple applications

 **Decision management engine** – runs a process or set of processes to improve and streamline action items in business processes and customer-facing applications

 **Virtual agents** – animated characters (usually in an appealing form) that act as online service representatives and can have ‘intelligent’ conversations with users, answering their questions

 **Self-organizing networks (SON)** – a technology for automating the planning, configuration, management, optimization and healing of mobile radio access networks; it was developed by 3GPP and is sometimes conflated with AI

Where will CSPs use analytics?



TM Forum, 2018

Analytics for operations

We asked CSP survey respondents how they plan to use analytics in operations over the next year, and a large majority said they intend to use them for customer care.

Customer experience is frequently called out by operators as the biggest reason for digital transformation, and customer care is a key aspect. It is also one of the most heavily criticized elements of customers' experiences in dealing with operators, even though it remains primarily call center-based and because of that is extremely expensive. Inexplicably, CSPs often view improving customer care as delivering a better call center experience – when was the last time you called Amazon?

Read this report for more on improving digital customer experience:



CSPs are under pressure to improve customer care while cutting costs, and using analytics to do this is key. Customer experience is also behind the second most likely application for analytics in operations in the next year – predictive maintenance.

As Dave Salam, Director of Core and Data Analytics, BT/EE, was quoted saying in his keynote at a Cambridge Wireless event in the UK in September:

“

When customers are telling you there is a problem, it's already too late.”

With predictive maintenance, the idea is to be able to ‘fix’ network elements before they are broken by knowing when they are due for routine maintenance and updating, rather than responding when customers start to complain. Predictive maintenance can also minimize truck rolls.

Verizon Communications has set up an internal team in its wireline business to deploy analytics, machine learning and other types of AI in the future. Its first priority, though, is to address network problems and reduce customers' complaints.

Matt Tegerdine, Director of Network Performance Analytics, Verizon, pointed out in a recent TM Forum report, *Building a data lake to drive digital transformation*, that the payoffs for that project are multiple: Faster resolution of problems leads to better customer experience, and solving the problem the first time around also reduces costs.

Securing the network

About a third of respondents plan to use analytics for cybersecurity operations. This is an increasingly difficult challenge to address because the 'attack surface' gets bigger as the number of network-connected devices and interdependencies between them grow. For example, 5G will be a network of networks, and operators are keen to push interoperability up the stack to support enterprise applications.

Radio access network (RAN) operations is the next priority for analytics. Again, 5G will make RAN operations more complex because it needs forests of tiny antennas to exploit the very short wavelengths it will run on. 5G coverage and capacity will be provided through tight integration with other kinds of networks such as Wi-Fi and 4G, and increasingly, RAN technology will be deployed that can be configured and updated remotely, with self-organizing and self-healing capabilities.

Dr. Lester Thomas, Chief IT Systems Architect, Vodafone Group, notes that his company is deploying self-organizing networks in 'emerging' markets (the first one was Egypt) where electricity supplies can be unreliable, so sometimes cells go offline then have to optimize themselves. Using big data analytics, the surrounding sites reconfigure themselves to accommodate the changes. Thomas observes, "It's not like static radio planning," adding that Vodafone built the autonomous application itself using open source technology.

Of course, data and analytics are two of the basic ingredients that fuel AI which 'learns' from and builds on processing massive amounts of data,

in real time. Although operators generally have made little progress in harnessing 'big data' and analytics despite all the hype, they are now looking to AI to help them become data-driven organizations, which is a major theme of this report.

Automation and AI

Sometimes the terms 'automation' and 'AI' are used interchangeably, which is misleading. CSPs are automating their networks because as they become increasingly complex, it is beyond humans' capabilities to manage them in terms of scope, scale and speed. EE/BT's Salam explained why EE started investing heavily in automation several years ago:

“

It became apparent that you can't run a network when...people reporting things on Twitter is a much quicker way to spot issues in the network than you can yourself.”

EE's reasons for transforming its operations through automation include:

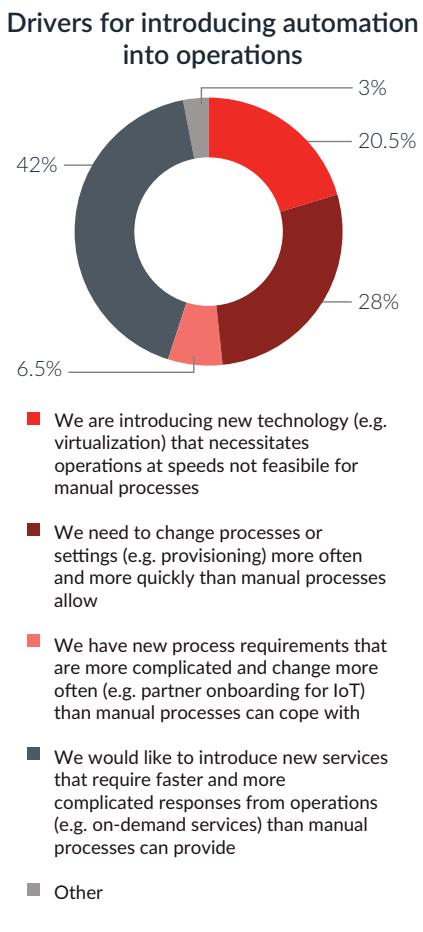
- An exponential rise in the number of devices connected to their networks, driven by IoT
- Need for greater capacity on networks as the number of simultaneous connections in many locations soars
- Requirement for increased speed as use cases such as autonomous vehicles need a return path with a latency of 1 millisecond or less

- Continuing, staggering growth of mobile and video traffic
- Changing traffic patterns, which are demanding more flexible and efficient use of assets and are changing how networks are designed and run (EE is moving to a distributed, cloud-based architecture with more processing happening at the edge of networks to reduce latency and minimize the traffic traversing the network)
- Need to accommodate 5G, a cloud-native technology that will provide seamless coverage through an ecosystem of networks, such as Wi-Fi and 4G, and those of third parties, which creates a far larger number of interdependencies
- More interdependencies make it harder to identify the source of problems and secure the network, the traffic it carries and devices connected to it

In short, the insatiable demand for greater bandwidth capacity, coverage and speed, coupled with the proliferation of new services means networks and the associated IT systems are increasing in complexity. Over the next few years as CSPs move networks and operations to the cloud, the age-old division between network and IT divisions within CSP organizations will disappear as software-controlled, automated operations become the norm.

What's driving automation

The graphic below shows where and why CSP respondents are looking to implement automation over the next year.



With close to half of CSPs picking new services as a driver, it seems likely that the imminent arrival of 5G and the complexities it brings are on operators' minds. Even so, new services like microservices and network slicing are a considerable way off and unlikely to become mainstream for up to five years.

In the near term, 5G will be about boosting fixed wireless connectivity and providing better mobile broadband coverage, speed and capacity.

It's also intriguing that changing processes and settings is the second-place driver by such a margin – slightly more than 14% behind new services. Arguably this should be as pressing as introducing new services, but operators are more used to coping with incremental change.

Slow network transformation

The relatively low percentage of CSPs picking new technology like virtualization as a driver for automation reinforces the results of our latest Digital Transformation Tracker survey, *DTT 3: Why is network transformation so difficult?*, which showed that almost half of CSP respondents and two thirds of supplier respondents believe CSPs have not established a business case for network virtualization.

Network functions virtualization (NFV) and software-defined networking (SDN) have stalled and slipped down CSPs' agendas, although operators know that eventually their infrastructure will become virtualized and cloud-based. Many blame the lack of progress on suppliers that were slow to develop products and solutions to implement NFV, as they saw little benefit in doing so according to their critics, preferring to leverage their existing portfolio. Operators are also aware that unless their networks are automated, the cost of implementing NFV and SDN will be prohibitively expensive.

There is another big factor for operators to take into account too: Automation as they have deployed it so far cannot meet the operational challenges that are hurtling towards them because it cannot scale. Today automation typically relies on static, network operations center-based analytics to manage repetitive tasks, which do the same thing endlessly unless a human makes changes, having of course first worked out what changes are needed – no small feat in such a complex environment. AIOps are far more suited to goal or intent-based management, as we explore in [Section 3](#).

Machine learning is necessary

In order to scale their operations, CSPs must apply machine learning in conjunction with automation. Machine learning is a type of AI, and it is currently the most common type of AI in use, although this is expected to change in the next two years ([see page 14](#)). Where machine learning is in use now and how it will be superseded varies considerably among operations domains.

Machine learning works by 'studying' the algorithms and mathematical models that computer systems use to build and constantly refine how they perform tasks without specific coding for those changes. This and other kinds of AI present an alternative approach to static, rules-based automation because they massively reduce the human effort needed to generate the rules that enable automation and are needed to devise better rules over time.

In particular, as networks and the ecosystems they operate within evolve, AIOps will have a key part to play in helping us understand and manage interdependencies. As EE/BT's Salam, puts it:

“

We need proactive fault management, anomaly detection for real-time network management. As we build in more intelligence, we can optimize it, tune it in real time and ultimately, for 5G and IoT, autonomous control will be essential to underpin, design and run operations...because the level of complexity you will get to will be not understandable by operations now – assistive intelligence is needed.”

The path to making the fullest use of AIOps is not clear. Perhaps the biggest thing to grasp is that applying AI to operations – with the ultimate goal of gaining autonomous control of the network – is not just a question

of applying technology. Implementing AI demands a whole lot of other changes too, which on top of everything else CSPs must address as part of their transformation efforts, is a lot to handle.

In the next section, we'll look at where and how CSPs are deploying AI.

Section 2

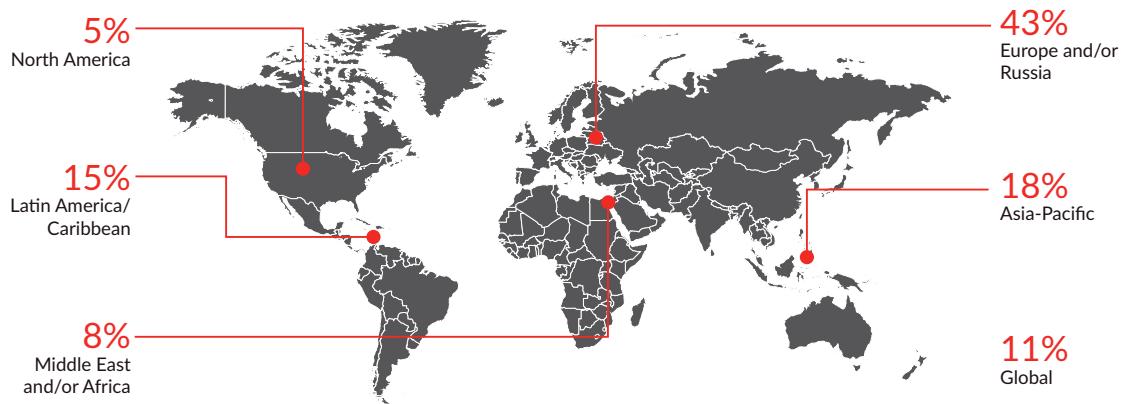
The respondents speak

AIOps and opportunities

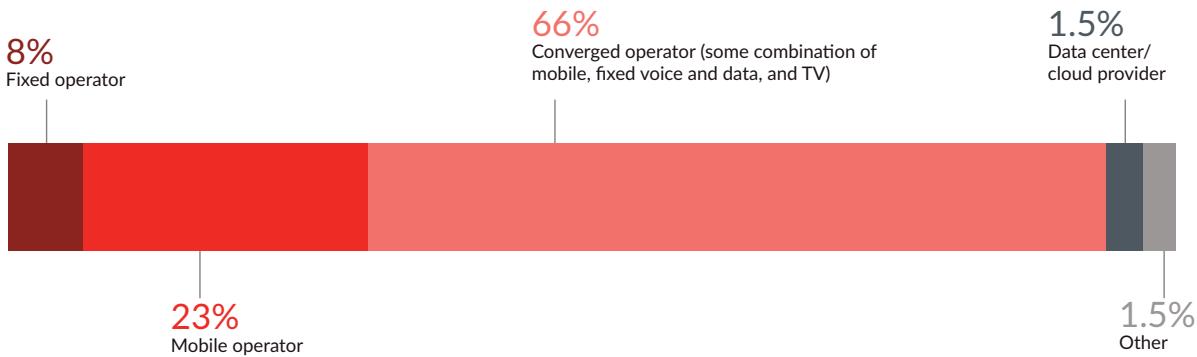
Who?

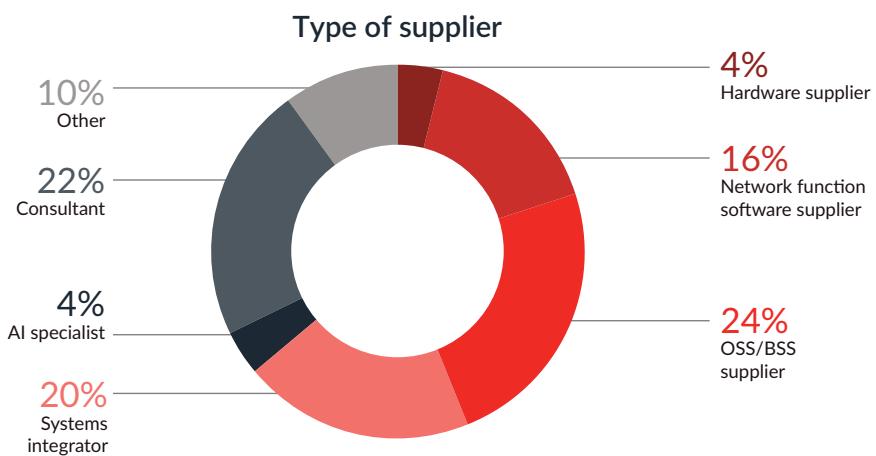
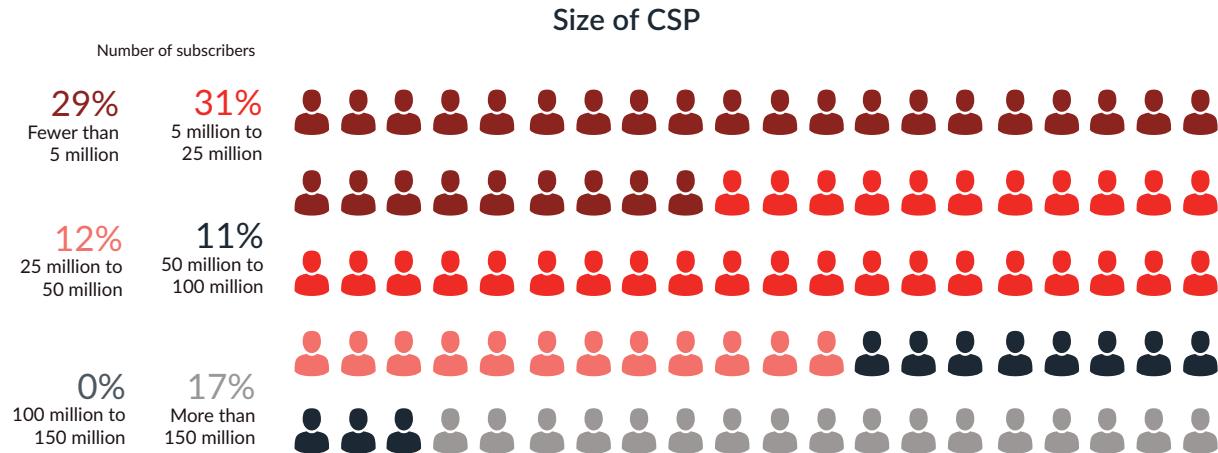
For this report we surveyed 65 executives from 37 different global, regional or national CSP operating companies in 25 countries, and 48 executives from 33 supplier companies. We also conducted in-depth interviews with operators and suppliers.

Location of CSP



Type of CSP





Gauging deployment

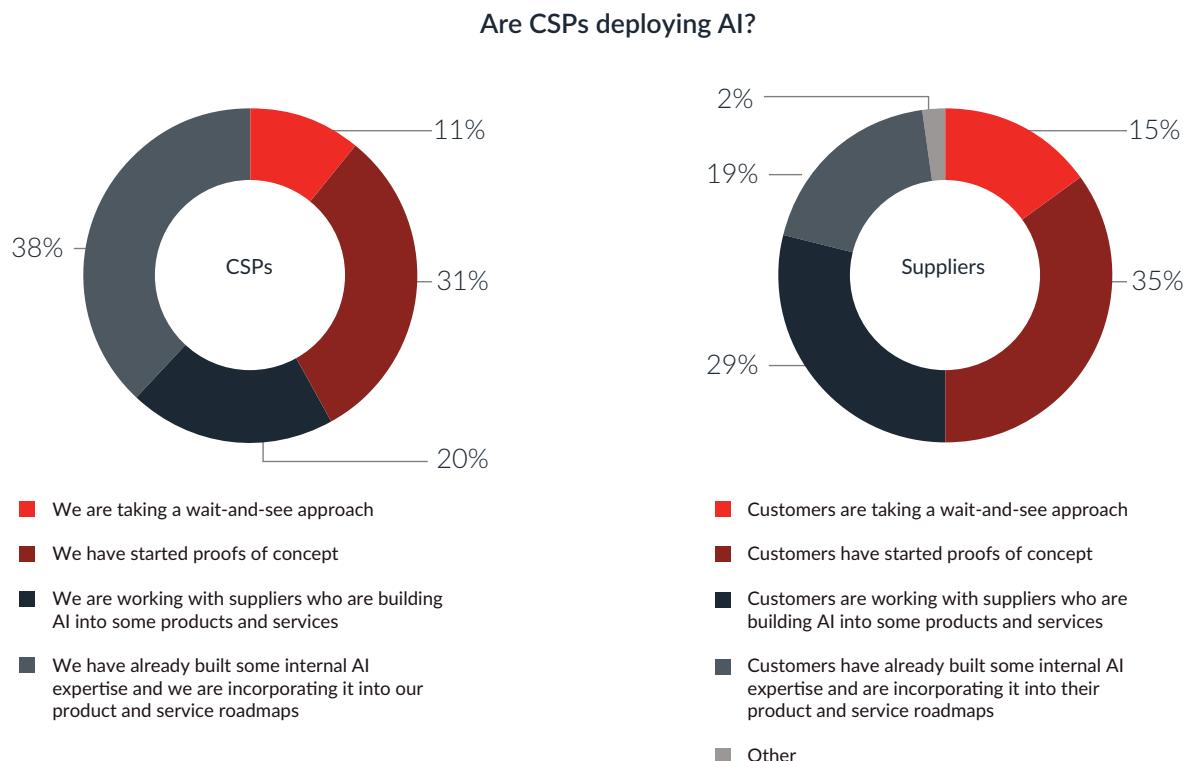
We began our survey by asking communications service providers (CSPs) if they are deploying AI, and by asking suppliers for their view of their customers' activity – or lack of it. There are some notable discrepancies between their responses, especially when it comes to how operators are deploying AI, but it is at least encouraging to see that a majority of

CSPs have embarked on some AIOps activities.

Vendors' perception is that almost 50% more CSPs are waiting to deploy AI than the CSPs' answers indicated, although admittedly the percentage in question is low. What's more interesting is that vendors' answers suggest that about 30% more CSPs are working with them to build AI and products and services than the CSPs'

responses showed. CSPs' replies concerning how many of them are developing internal AI expertise is more than double the number provided by the vendors.

We probed this further in interviews and uncovered something of a chasm between vendors and their CSPs' customers regarding AI, which clearly is having a profound effect on the rate of deployment (see Section 4).



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Where is AIOps needed?

It is perhaps not surprising that improving customer experience is the biggest driver for AIOps (see graphic below). Interestingly, two thirds of CSPs' explanations in the 'other' category were indirectly about better customer service while the remainder concerned cleaning databases. But even without adding those responses into the original totals, delivering better customer experience is the clear winner by more than 15%.

Given the diverse range of drivers for AIOps mentioned by CSP respondents, we delved deeper into the numbers to see if their priorities are influenced by their size. Delivering the best customer experience is a top priority among respondents from the group of largest operators (which

have more than 150 million subscribers), with more than 91% of them choosing it. This is 11% ahead of the next nearest groups which are from at the other end of the scale regarding size – those with fewer than 5 million customers (79%) and those with 5 million to 25 million (80%).

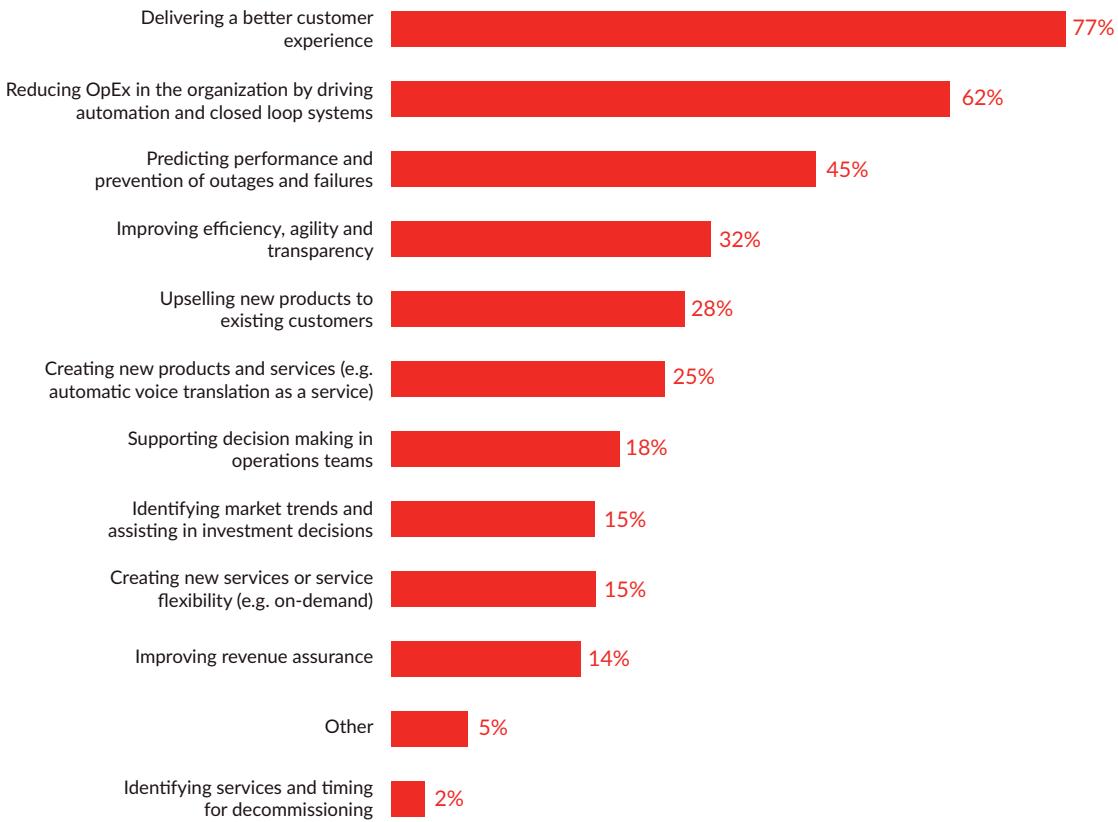
The second most popular driver, reducing OpEx by using automation and closed loop systems, scored most highly among respondents from small to mid-sized operators (those with 5-25 million and 25-50 million customers). About 75% chose it as the top driver. Interestingly, this was the least popular driver for large operators, with only 55% choosing it as a top driver.

Preventing failures and outages is a

priority for operators with 25-50 million subscribers, with half of them choosing it. The lowest percentage (36%) was among the largest operators, which perhaps indicates that they believe they have built more resilience into their networks.

However, as we were completing this report, there were serious outages on the O2 UK network and SoftBank's in Japan due to software being decommissioned. Interestingly, only one operator chose the option of identifying services and timing for decommissioning as a top driver for AIOps in our survey, and none of the vendor respondents cited it. Given the level of change that will be taking place in networks over the next couple of years and beyond, they might do well to revise their view.

Primary drivers for AI



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Which AI use cases?

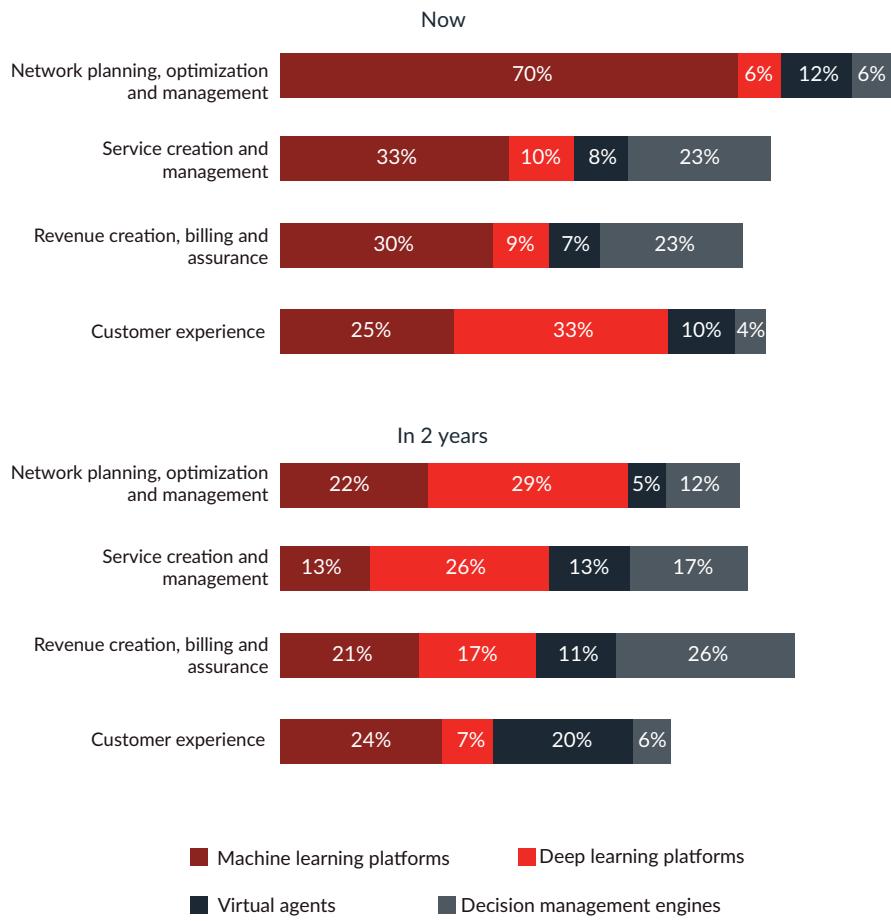
We asked CSP respondents which AI technologies they have already deployed and in which operational domains, and which they intend to deploy in the next two years. We ranked the top four responses, which account for the majority of activities. Use of machine learning in network planning and optimization is the biggest use case today by far, but that will change over time.

As noted in [Section 1](#), machine learning is currently the most commonly used type of AI overall, with a strong presence across the board. It is interesting to note though, that CSP respondents expect it largely to be replaced by deep learning, which didn't make it into the top four AI technologies already deployed. In two years' time CSPs expect robotic process automation to diminish, replaced in the top four by deep learning.

Use of machine learning is also expected to decline in revenue creation and billing and assurance, as well as in service creation and management. The most dramatic change predicted is the decline of machine learning for planning, optimization and management, from 70% of AI tech deployed today to 22% in two years' time and the rise of deep learning. This is a reflection of operators needing more sophisticated tools and insights as 5G and IoT deployments proliferate.

The other notable predicted change is the increasing use of decision

Top uses of AI in operations now and in 2 years



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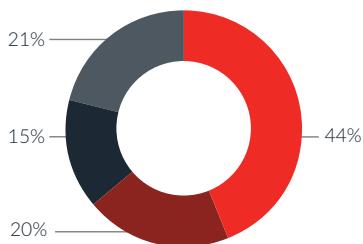
management engines. While its prominence falls in customer experience and remains stable in network planning, optimization and management, it more than doubles in service creation and management, and more than triples in revenue creation, billing and assurance. This is because decision management

systems are designed to automate interactions with customers, employees and suppliers. They are increasingly popular in many sectors to speed response times and make decisions based on huge amounts of information resulting from analysis of historical behavioral data, previous decisions and their outcomes.

Automating operations

We also wanted to know how CSPs are using AI to automate operations. Almost half of respondents are automating one process within a single domain or business unit, a finding reinforced by our interviews.

How are CSPs automating AIOps?



- Automating a single process within a single domain or business unit
- Automating multiple processes within a single domain or business unit
- Automating a single process across multiple domains or business unit
- Automating multiple processes across multiple domains or business units

TM Forum, 2018

The beauty of using AI to automate a single process is that it is a good learning experience but with limited ramifications if it doesn't go well. It's easy to measure how successful it is and helps operators build confidence in the technology and approach, but many small projects contribute to mainstream ops. Still, over a fifth of respondents told us they have ventured into automating multiple processes across multiple domains or business units, and 20% have tackled multiple processes within a single domain or business unit.

Among operators, both multiple process approaches are more popular than applying AI to a single process in multiple domains or business units, which suggests a certain level of confidence and experimentation. After all, the greatest benefits will be

reaped by applying AI in operations from end to end, and indeed will be necessary to reach the end-goal of having an autonomously controlled network. Nevertheless, fear of AI faults spreading and resulting in undesired and unforeseen consequences is reasonable.

Using AI for end-to-end management

When CSPs were asked to name the areas where they are tapping analytics, customer care headed the pack by a big margin. This is encouraging because customer experience, of which customer care is a key part, is the biggest driver of digital transformation. But CSPs must also slash costs, which necessitates using AI to improve network and service management.

We asked CSP respondents which management use cases are a top priority for deploying AI, and perhaps not surprisingly, using it to handle big data and detect patterns within it, ranked highest. (see graphic below).

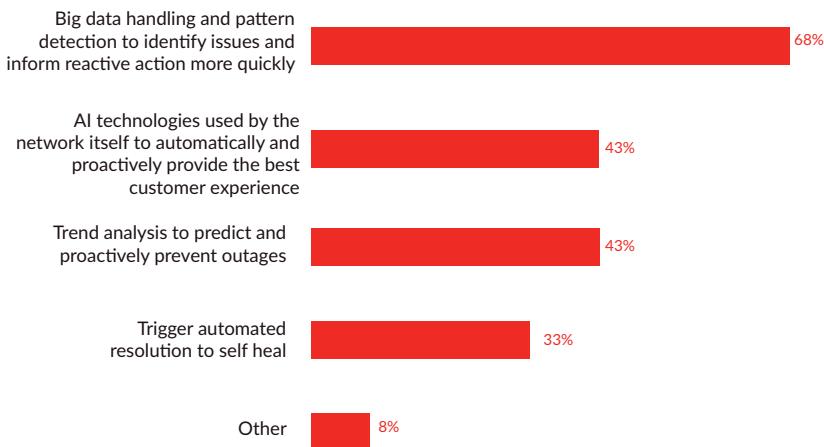
So far, CSPs have not been able to make good use of their enormous quantities of data with analytics alone, and the volume of data will increase by an order of magnitude due to 5G and

IoT applications in the near and distant future. Combining analytics, automation and AI can transform operations, giving operators increasing levels of autonomous control, but deploying AI technologies will be difficult in static, rules-based systems – they are far better suited to working with systems that are organized around goals or intent, which looks at the network in terms of what users want to achieve through services ([see Section 4](#)).

Operators need clean, valid data sets, standard data formats and a universal data model to fuel AI, plus AI models for specific use cases and affordable, pragmatic ways, to work alongside legacy systems ([see Section 3](#) for more on data-handling standards and models).

Tied for second place are: using AI to predict and prevent networks outages, and to proactively improve customer experience. As networks become more complex, the fear of outages rises because it is harder to understand cause and effect in such environments – indeed, it is one of the reasons a number of operators are making great strides in dealing with the tens of thousands of alarms they deal with daily in their network operations centers ([see page 16](#)).

AI use cases for network and service management



TM Forum, 2018

Outages can cause financial losses and reputational damage, regardless of who or what is responsible. For example, an O2 UK outage in early December affected 30 million individual customers, which is nearly half of the entire population of the UK. While 25 million of the customers affected were O2 customers, 5 million were customers of MVNOs Tesco Mobile, Sky Mobile, GiffGaff and Lycamobile whose businesses have suffered too. In addition, O2 UK has many large corporate customers such as Transport for London, for which it provides live location data for 8,500 buses in the city.

Using AI to proactively maintain customer experience is also key. As BT/EE's Dave Salam so eloquently noted in his comment about finding out about network problems on Twitter ([see page 7](#)), CSPs' current alarms, metrics and key performance indicators fail to provide an accurate picture of how customers are experiencing services at any given time because they are, by design, network-centric not service-centric.

Automated resolution to self-heal networks also will be essential because with so many dispersed elements, there will be no other viable or affordable way of fixing failures in the network. As noted, truck rolls must be avoided because they are expensive and slow.

Early adopters' success

Several CSPs have made substantial progress in applying AI in network operations centers (NOCs), which typically receive up to 90,000 alarms every day. Although only perhaps 1% to 2% indicate significant incidents or faults, it is difficult to pick them out from all that noise coming off the network.

According to intelligent automation supplier Cortex, it has enabled a European CSP operating company to close down three NOCs and reassign

Deutsche Telekom uses AI for fiber deployment

In October Deutsche Telekom announced a pilot scheme using AI to streamline fiber-optic rollout in Bornheim, Germany. Walter Goldenits, Head of Technology at Telekom Deutschland, said in a statement, "The shortest route to the customer is not always the most economical... The new software-based technology evaluates using digitally-collected environmental data. Where would cobblestones have to be dug up and laid again? Where is there a risk of damaging tree roots?"

A measuring vehicle was sent out in Bornheim (near Bonn) this summer, equipped with 360° cameras and laser scanners. It collects about 5GB of surface data per kilometer. Says Prof. Dr. Alexander Reiterer, who heads the project at the Fraunhofer Institute for Physical Measurement Techniques (IPM):

"Such huge amounts of data are both a blessing and a curse. We need as many details as possible. At the same time, the whole endeavor is only efficient if you can avoid laboriously combing through the data to find the information

the 250 skilled technicians who worked in them to more valuable tasks.

Similarly, a large North American cable operator has used Guavus Alarm IQ analytics to silence unimportant alarm noise. It applies machine learning and AI to alarm streams to classify which alarms will result in problems for customers, which are associated with open tickets and which can be discarded, with a claimed accuracy level of 99.2%.

This leaves staff free to escalate alarms that indicate genuine troubles and gain greater insight into how issues that

you need. For the planning process to be efficient the evaluation of these enormous amounts of data must be automated."

Fraunhofer IPM has developed software that automatically recognizes, localizes and classifies relevant objects in the measurement data. The neural network used for this recognizes a total of approximately 30 different categories through deep learning algorithms. This includes trees, street lights, asphalt and cobblestones, right down to the smallest detail: Do the pavements feature large pavement slabs or small cobblestones? Are the trees deciduous or coniferous? The trees' root structure also has a decisive impact on civil engineering decisions.

Once the data has been collected, a specially-trained AI is used to make all vehicles and individuals unidentifiable. The automated preparation phase then follows in a number of stages. The existing infrastructure is assessed to determine the optimal route. A Deutsche Telekom planner then double-checks and approves it.

impact customers develop on the network.

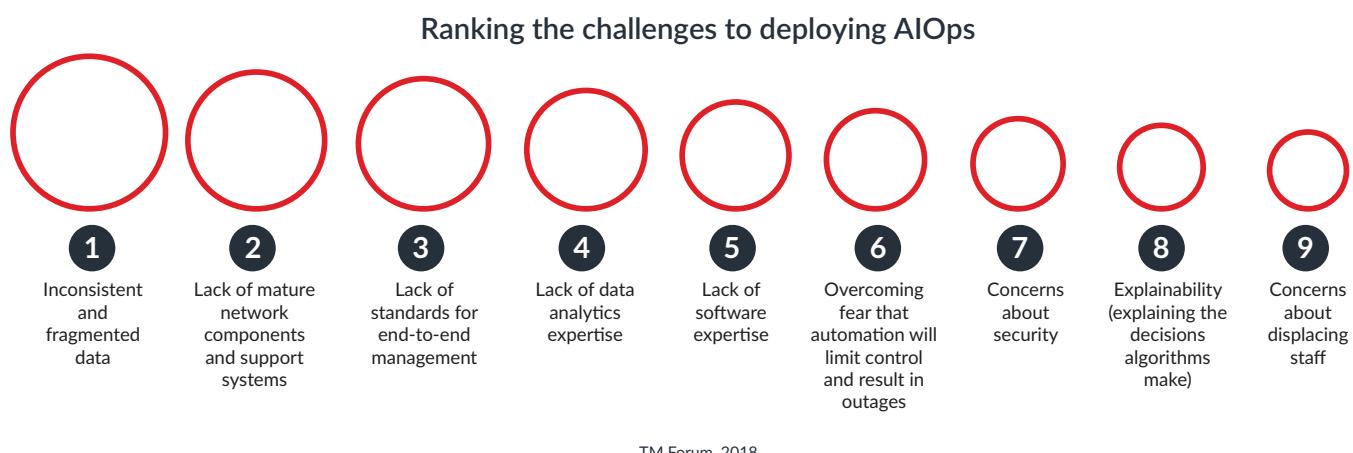
So-called silent failures that affect customers but don't trigger network alarms are notoriously difficult to identify and address – NTT DoCoMo used to employ 8,000 to handle the task. Now it uses AI to classify data traffic within cells as 'normal' or 'deviant', with the latter causing silent failures. This has greatly cut costs and improved workforce productivity while improving customer experience.

In the next section, we'll look at the challenges CSPs face in deploying AIOps.

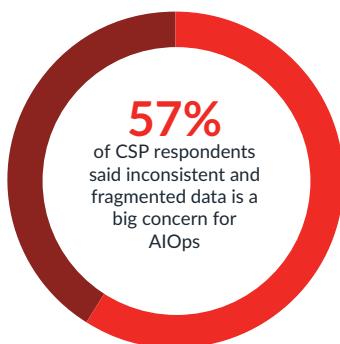
Section 3

What are the challenges to implementing AIOps?

While CSPs know they need to embrace AIOps, implementing it can be difficult for many reasons ranging from a lack of software and analytics expertise and cultural fear of automation, to a lack of mature network components, support systems and standards. We asked operators to rate the challenges they are facing. The graphic below shows how they rank based on the percentage of CSPs who put the specified challenge in their top three concerns.



Inconsistent and fragmented data



TM Forum, 2018

It is no surprise to see inconsistent and fragmented data as the top challenge. No readily accessible, usable data means no AIOps, and that has significant repercussions: Without AIOps, CSPs cannot virtualize and cloudify their infrastructure, which impacts 5G because it is cloud-native and IoT because operations will not be able to scale to handle millions of devices and the concomitant traffic.

The issue of data is so fundamental that it demands CSPs rethink how they run their businesses and operations. Dr. Lester Thomas, Chief IT Systems Architect, Vodafone Group, comments:

“

Telcos [unlike internet companies] haven't come from a background of data for its own sake and seeing it as an asset in its own right, but you need that approach to say, 'How can you optimize and improve what you do?'

Some operators are striving to emulate webscale providers' data-driven *modus operandi* by adopting a 'future operations mode', which Vodafone, among others, is collaborating on within TM Forum.

"This is a cloud-like way of building your organization, not just the IT, with small domains that offer what they do as a service to other parts of the organization and to third parties," Thomas explains. "Smaller domains are very important, they cover the aspects in autonomous units not one humungous one. This is a microservices culture with the agile method of operation based on data, that you continually optimize as it matures, rather than measure, to achieve digital transformation."

In parallel, Vodafone and a number of other operators are working towards intent-based network management, which abstracts the complexity of the network at a high level and then uses a customer's intent along with analytics and policy to manage it. Thomas explains:

“

Instead of modeling the network, we model the customer's communications needs. That way, you can continuously change and improve the implementation. This is the process the big cloud providers use.”

The level of interest in and commitment to this intent-based approach was underlined by an award-winning proof-of-concept Catalyst project in Kuala Lumpur in

November. The [Mindreader project](#) developed a prototype for how operators can predict customers' intent to serve them better and faster, through improved personalization. CSPs have always captured intent and episode data, but they haven't been able to track or utilize it efficiently because it tends to get lost in interaction notes or call detail records.

The project was led by Telstra with participants CloudSense, Infosys and Nokia Australia.

Watch the Catalyst team discuss the Mindreader project:

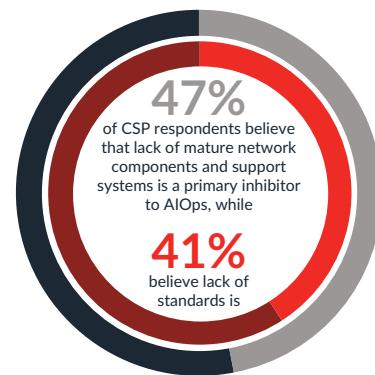


Steven Guggenheimer, Corporate Vice President – AI & ISV Engagement at Microsoft, urges, "You have to think about the data estate first: If your data estate is not in order, or you don't have a data pipeline for the future then those early bespoke implementations are not going to be sustainable for the long term. Honestly, we should talk about BI [business intelligence] before AI if you're not using data to drive insights, it's likely too early to be trying to drive intelligence (AI)...if you are driving insight then we can talk about AI.

"Beyond the BI to AI transition, we should talk about SaaS and where it fits in – spending energy building AI into a line of business tools (e.g. like a customer care system, or a sales system) that are already in use might not be the best place to expend energy," he adds. "You have to assume that SaaS vendors over time will add AI capabilities into their offerings that you can leverage, versus building everything yourself. It's best to

consider applying your scarce AI resources to areas that drive real differentiation..... [Consider] network operations management, or price and sales optimization – there are other places where you do have unique data and assets and where you do want to do things yourself, as opposed to assuming it will come along as an SaaS."

Lack of mature components and standards

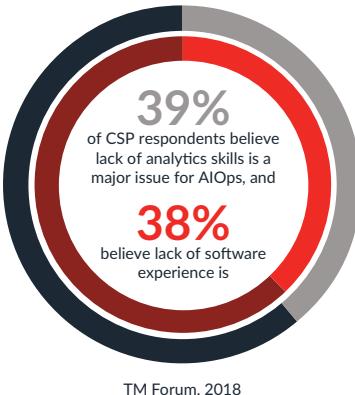


TM Forum, 2018

intent-based management needs training data sets, but it is difficult to extract usable data from differently structured data stored in diverse, siloed, incompatible sources. Hence, data availability combined with the rapid pace of change in the network are factors in the No. 2 and No. 3 AIOps challenges: Lack of mature network components and support systems and lack of standards.

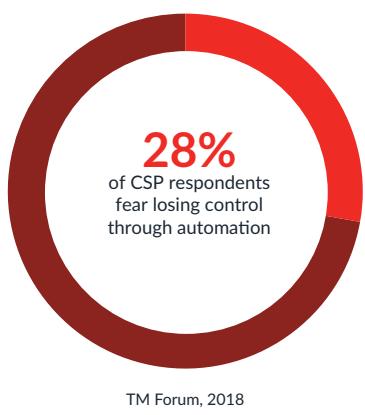
These issues are closely linked to a lack of standards for end-to-end management and are drivers of the [TM Forum Open API initiative](#), instigated early in 2016 by Vodafone, Orange and BT. The aim is "delivering a practical approach to seamless end-to-end management of complex digital services" by enabling operators to plug incompatible systems together to make them interoperable for specific, defined tasks.

Lack of skills



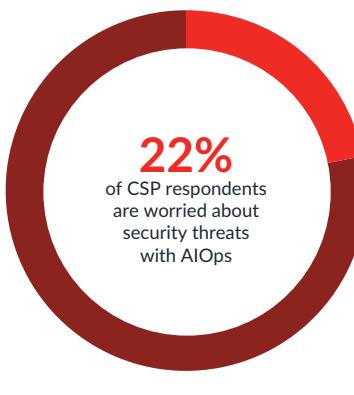
Lack of in-house data analytics expertise and software experience are also key challenges. Many CSPs see having software, analytics and AI skills in-house as strategically critical if they want to maintain control of operations, and therefore their key asset – the network. We'll look how operators are addressing skills in the next section.

Fear of losing control



The skills issue is linked to the considerable fear CSPs have about losing control of the network as AIOps become increasingly prevalent, which CSP respondents chose as the sixth biggest challenge they face in implementing AIOps. Again, see [Section 4](#) for a more detailed discussion about this issue.

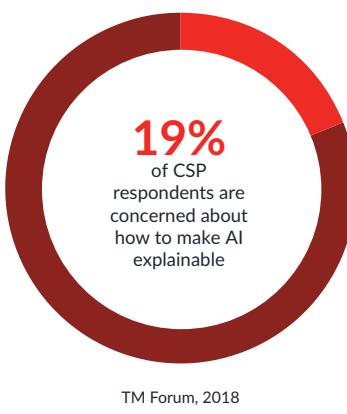
Concerns about security



Worries about security are also linked to the fears about losing control and visibility, in parallel with the imminent arrival of 5G. The issue is not so much about the next generation of wireless technology, rather it's about the network of networks designed to massively increase capacity, coverage and speed over the next few years.

This greatly increases the number of interdependencies increasing potential weaknesses for hackers and other criminals to exploit, as well making it difficult to figure out the implications of those dependencies in every set of circumstances.

Making AI explainable



'Explainability' is relatively low on the list of challenges for now, but it too is closely linked to worries about losing control and about AIOps leading to

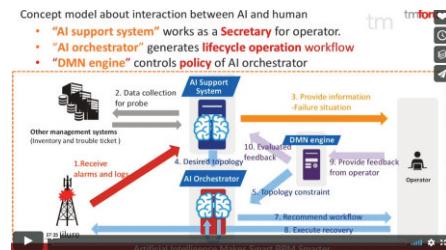
outages. A CSP's engineers need to understand and be able to explain how AI systems – whether developed internally or bought from a vendor – make their decisions so that they can be checked to ensure they comply with the organization's goals and policies. A 'by-product' of this is that the line between operations and engineering will blur.

Also, operators would do well to heed mathematician and author Cathy O'Neil's warning that algorithms are "opinions embedded in code", or they could unconsciously or otherwise reflect the opinions of the coder. While there are clearly deep ethical and possibly legal and regulatory ramifications, it would not serve operators well in their development of intent-based approaches which involves a large degree of judgment and interpretation.

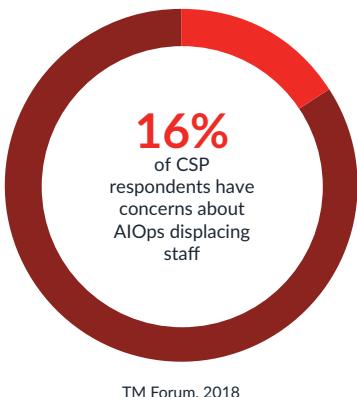
Another recent TM Forum Catalyst project called [Artificial intelligence makes smart BPM smarter](#) looked at how to incorporate AI-based decision modeling and explainable AI (XAI) into telecom business processes such as provisioning, fault management, assurance and customer management. The team used standard [decision modeling and notation \(DMN\)](#) to create a layer of XAI, or what amounts to an AI support system.

TM Forum members also are working on an AI reference architecture and interface definitions ([see page 26](#)).

Watch the Catalyst team discuss the project:



Fear of displacing staff



"Anxiety about staff being displaced by AIOps is inevitable, but as we've mentioned briefly above and explore further in Section 4, many operators are busy retraining as well as recruiting staff and the 'right' graduates to gain expertise in analytics, automation and AI. Many of the migrations underway – for example, the move to distributed models like edge computing plus cloud-based architectures and virtualization in parallel with adopting AIOps – are likely to require more, not fewer, staff during the transition."

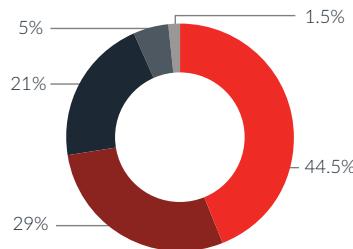
Greatest data barrier

To implement AIOps, CSPs must expose the operational data needed for network automation and efficiency, but this too comes with challenges. Microsoft's Guggenheimer notes, "Most telcos have so much data, the question becomes 'Of what you have, what do you want to use?' Then, 'Of what you have, what do you want to try and make usable?', and 'Of what you have what do you not want to try and make usable, so let's start over and try to collect it in a better way?' This is the dialog, and we are seeing [telcos] trying to implement that, but right now they are busy because there is so much they can use and they are still doing a bunch of that work".

The graphic in the next column shows which barriers CSPs feel are most difficult to overcome. By a considerable margin (almost 16%)

they indicated that being unable to access data spread across operational silos is the most significant barrier to the effective exposure of operational data.

Chief barriers to exposing operational data



- Inability to access the data needed across operational silos
- The lack of clear standards for exposing data streams
- The lack of relevant APIs for exposing data streams (e.g. open event streaming integration APIs)
- Lack of provisions for/concerns about security
- Other

TM Forum, 2018

This issue has dogged CSPs for years, and they are taking various approaches to addressing it. Korea's SK Telecom, for example, collapsed 150 OSS platforms into one to help it unify data formats.

Two years ago, Telefónica created its data and AI unit LUCA by pulling its expertise into one unit. It is now integrating the Stratio Data Centric platform: The combination will deliver what the company calls a Big Data Platform as a Service (PaaS) solution. It is designed to speed up corporate customers' digital transformation of their operations. Telefónica said it will start deploying the new solution in some Latin America markets "soon".

The operator claims that its new platform differs from others on the market because it can work with multiple data sources, at large scale. It says the multitenant platform "revolutionizes the application-centric model through a unique interface that guarantees data consistency and

provides a unified vision and advanced intelligence for myriad use cases. Stratio Data Centric brings together the analytical and operational capabilities of the enterprise, enabling data intelligence for real-time operations."

LUCA has relationships with more than 150 corporate customers in over 20 countries and is working on 200 projects. Advertising and media, financial services, retail, tourism and transport sectors are its key markets. The unit was positioned as a market leader in a report published by Forrester Research in October.

Diving into data lakes

An increasingly popular approach to gaining access to usable data is to extract it in its native form and store it in a data lake, often using architectures like Hadoop because of its massive storage capacity, extensibility and scalability. Data lakes, which allow for data to be left in its original format making them more flexible and less expensive than other options such as data warehousing, should be a key part of any AIOps strategy.

Having extracted data from their multifarious systems, some large CSPs have taken it upon themselves to address the thorny matter of making their data fit for purpose. Verizon's Matt Tegerdine pointed out that once his team started investigating data produced by Verizon's network systems, they realized:

“

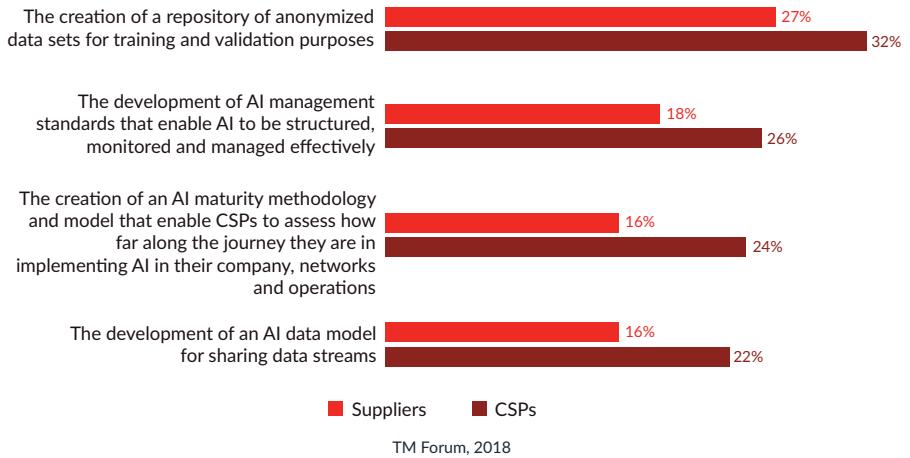
The data was really primarily being tapped by vendor systems, so essentially we're paying vendors to go out and mine our resources then sell them back to us.”

In addition, Verizon cannot find a suitable AI solution on the market to use the data and help the operator gain greater autonomous control of the network. Consequently, along with others, such as international operator Telia Carrier, it is looking to develop its own solution. We look further into the vexed issue of operators' somewhat fraught relationships with equipment providers in [Section 4](#).

Is collaboration the answer?

Lack of standards again rears its head in CSPs' answers to the question about exposing operational data, with almost a third identifying the lack of clear standards as the biggest barrier, followed closely by lack of the right APIs. Given these concerns, we asked CSPs and suppliers how useful or necessary they feel collaboration on standards and APIs is. We asked them to rate the need for collaboration in four areas as either essential, very useful, moderately useful, slightly useful or not useful at all. The graphic below compares the percentage of CSPs and vendors who said collaboration is essential.

Percentage of respondents who believe collaborating on AI is essential



Perhaps not surprisingly, CSPs are more enthusiastic than suppliers about collaboration, which reflects the strategic importance operators are attaching to developing expertise and skills in-house and the fear of being overly reliant on suppliers (again, we'll cover this relationship in more detail in the next section.)

The growing industry consensus is that operators need common data models and a phased standardization of how data is classified, collected, distributed, managed and used to drive decisions. [TM Forum's](#)

Information Framework data model (previously known as the SID – see page 43) is used by most CSPs around the world, and indeed has been developed and refined by the operators themselves and their supplier partners over many years. The Forum is now working on a functional AI data model, starting by packaging all the relevant entities, then identifying the gaps and building extensions to address them.

Section 4

Developing and finding AIOps expertise and solutions

Survey responses and interviews about finding AIOps expertise, and the relationships between CSPs and suppliers, turned out to be some of the most intriguing information we collected. At best the relationship between CSPs and vendors can be characterized as mismatched expectations, but at worst it could signal deep-rooted distrust on the part of CSPs, which is creating an impasse. One thing seems certain: Although operators know AIOps will be critical, they are determined to move at their own pace and ‘not break things’, and this means not getting tied to vendors’ roadmaps.

We asked CSPs about how they are developing solutions for AIOps. It is striking that more than half of them, 54%, said they are primarily relying on their own internal resources to develop their AI solutions (see graphic below). This begs big questions. First, is building AIOps solutions what CSPs want to be pouring their resources and time into, as opposed to running their operations and businesses with 5G, IoT and so much more that is imminent? As Utpal Mangla, Vice President & Partner, Global Leader – Watson AI, IoT & Blockchain at IBM, puts it: “Their core competency is telecoms, not being an AI product company.”

Where to find the skills?

A second question is: Where will the internal expertise come from as these skills are in short supply the world over? Huawei has recognized this opportunity and is offering to train operators' staff, and this trend could spread to other suppliers and systems integrators. Some CSPs are addressing skills shortages in creative ways, from retraining/reskilling staff (such as those displaced when network operations centers are disbanded) to graduate recruitment policies.

Our impression is that smaller companies generally are more decisive

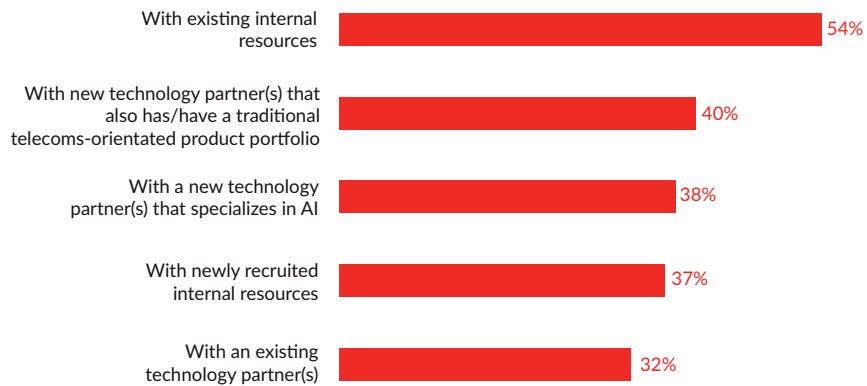
and active on the AIOps front, including building up internal expertise. Christian Yde, Lean Agile IT leader at Danish operator TDC Group, says that top management at his company has “bought into AI” and created a specialist division with a team of 70 – a mixture of data scientists, mathematicians, statisticians, developers, graduates and consultants.

The line of command here is interesting too: The unit is run by the VP of AI and Robotics, who reports to the Chief Digital Officer, who in turn is answerable to the CEO of the OpCo. Note that TDC Group is a joint venture between the OpCo and the NetCo,

which owns the infrastructure. The two became separate legal entities in June. BT, Telefónica and TIM have all either separated their operations and network, or are exploring the option.

This approach is gaining traction with European telecom regulators in particular as, despite years of what many view as heavy-handed regional regulation, they have failed to curtail the market dominance of the former incumbents and/or oversee the creation of competing national infrastructures. Instead, they have ended up with many competing networks in densely populated areas and little alternative infrastructure elsewhere.

How are CSPs developing AI solutions?



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The benefits of creating separate legal entities between operations/business and the network is that building and running infrastructure has much longer investment and return cycles, with initial high costs, in sharp contrast to the much shorter cycles of retail businesses.

Yde explains the new division's sole purpose is to build and spread AI across the organization, although so far, the only thing that has gone into production is next-best-thing offers to support call center staff.

Gorazd Hribar Rajterič, Telecoms OSS Expert, Telekom Slovenije, observes that larger operator groups "have greater resources to invest in AI and grow competition in AI and employ specialists, but smaller ops need to spend money carefully, yet don't want to be at the mercy of vendors, so we have to find some middle ground." His company is working with universities and TM Forum to get to know the technology. Telekom Slovenije also hosts students who bring fresh knowledge, defines projects to be studied at university and has joined a number of European Union AI projects.

Who's more experienced?

A third issue is experience with AI. As Sholom Weglein, Product Manager with Amdocs, points out: "CSPs haven't got the experience we have as the result of working with many of the world's largest service providers.

You need the expertise to build data models, and to know which tools are best suited to each task and which areas to focus on."

Internal expertise aside, on the subject of working with new suppliers, a senior executive from one such vendor comments:

“

Operators talk and talk about bringing in new vendors and using open source, but when it comes to the writing the check, they lose their [courage].”

Rajterič doesn't see it quite like that. "Operators are ready to let go of the comfort blanket of the big vendors, but while in our core network operations we have been working towards open source, our network is Ericsson-based and there is no sudden escape from that," he says.

Working with vendors

Telefónica International Wholesale Services (TIWS) is a good example of a telco working on AIOps with an established equipment provider. The company is just starting to replace the entire national infrastructure of Brazil and will run an AIOPs testbed in

parallel, looking at the performance of the network between cities, according to Jose Manuel de Arce, Deputy Director OSS & BSS Infrastructure, WorkSpace, OSS Technology. TIWS will be deploying Juniper Networks' NorthStar Controller in the core to help it automate operations, which is designed to balance traffic and service delivery intelligently.

Or as de Arce puts it: "We are moving from SNMP and REST to telemetry; for the first time we'll have information in real time, as things happen, not when we retrieve them – you could say we are moving to push instead of pull." The company also will be deploying Hadoop for a big data approach in 2019, but stressed that his company would maintain control of the data at all times.

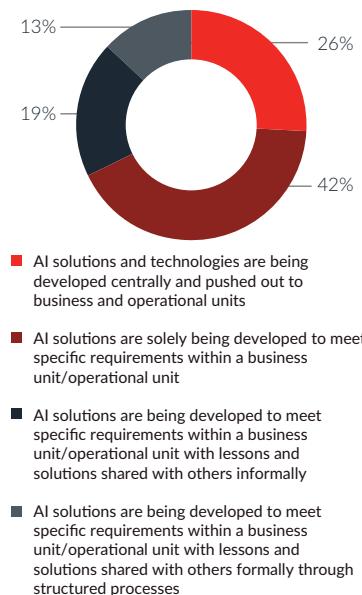
Vodafone is working in open source groups, but in an effort to complement what its vendors are doing, not replace them. Says Dr. Lester Thomas, Chief IT Systems Architect at Vodafone Group: "We have never attempted to build solutions ourselves, we rely on vendors, but it's constant negotiation and evolution – for example, we have joined ONAP but not to build an open source alternative, but to buy from different commercial suppliers and orchestrate their solutions, asking them to follow ONAP standards and mechanisms. We have the vision, but it takes as long as it takes."

Improving processes

Arnold Buddenberg, Enterprise Business & IT Digital Transformation Architect, Orange Group, notes that it's important for CSPs to improve processes as part of their march toward AIOps. He says: "All the vendors talk about AI as much as 5G, so it's hard to know the right starting point... The industry is not used to thinking in process terms, and you need loops and processes for AI – and you have to really understand and be able to describe that process, particularly in the network. If it's in a black box, you don't understand it. We need to improve processes... Do we either wait for vendors to come and tell us how to do it with a black box or I understand my processes and have a white box that I own?"

Amdocs' Weglein advocates building open solutions so operators can integrate their own preferences with no pressure to change the way they operate at the beginning. Instead the idea is to help identify issues and deal

Which organizational approaches are CSPs using to AIOps?



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with them much faster as the first baby step. Then introduce AI to help with the solution while the operator is still in control, only moving to full automation once the operator is comfortable and confident.

"AIOps is so broad and affects so much that it can help improve operations now and then play a role in IoT business models [or anything else]," he adds.

Differing organizational approaches

We also asked CSPs about the organizational approaches they're using to develop AIOps solutions. With hindsight, it seems it may have been too soon to ask this question because most operators are not sufficiently advanced in deploying AIOps to answer it. As Orange's Buddenberg comments:

“

For now there is a lot of thinking, not deployment – although the feeling is [AIOps] will become critical.”

Although 42% of CSP respondents said they are developing solutions to meet specific needs in a particular business unit, it's a concern that only 13% have a structured, centralized mechanism for sharing experience and knowledge. This was also borne out in our interviews.

Encouragingly, a quarter of operators are developing solutions centrally to push out to other business and operational units, although the risk here is that one AI size does not fit all purposes and situations. Nevertheless, this is a good way to experiment and build expertise.

Vodafone Group's Thomas, explains that although his company's strategy is centralized around the future mode of operations (see page 18 and there is guidance on all design, "The general culture is to leave them to it...using the central blueprint of what we think AIOps should be. We use open source and recommend certain vendors for certain things." The teams also have access to centralized resources such as Hadoop and some tooling.

Vodafone is encouraging its operating companies to set up communities to pull experience and knowledge from deployments, but Thomas acknowledges that each company has its own priorities based on its particular B2B2X model. He also points out that different teams need different AI expertise. Vodafone has set up a central team of about 10 AI experts to look after the technological aspects of AI, while another team of the same size focuses on the commercial elements.

Risks of informal sharing

The 19% of respondents who said their companies are relying on informal means of sharing what they learn, risk failing to pool expertise and experience, and building on it. This could result in CSPs duplicating effort and spending more time and money than they need to, as well as running the risk of ending up with incompatible systems and approaches – the opposite of end-to-end control.

This situation could prove expensive, in every sense, in the longer term. As IBM's Mangla puts it: "Fine on day one, not so much on day three."

Section 5

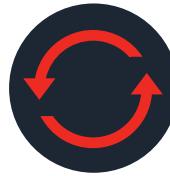
Make it happen

Strategies for implementing AIOps



Go slow to go faster later

Although it feels as if the level of enthusiasm for AI has dipped compared with our research last year, implementing AI in operations is a major undertaking by any measure. Hence progress might appear slow, but CSPs are determined to be cautious and not risk the integrity of the network, because getting AIOps right is critical to the future of their operations and businesses.



Automate, automate, automate

Network functions virtualization (NFV) and software-defined networking (SDN) have slipped down operators' agendas for the time being, although they are inevitable. The big takeaway from their slow progress is that unless the network is automated, NFV and SDN will likely increase, not diminish, operational costs.



Lead from the top

While experimentation and running small specific AIOps projects are a great start, CSPs need leaders with a vision about how to reach the end-game of achieving autonomous control of the network. While this will inform use cases and progress, and ensure they are aligned with corporate strategies, it does not preclude experimentation in pockets or making decisions now about the ultimate centralization of AI across the organization in these early days. But we do urge CSPs to centrally coordinate the areas that are key to AI such as data management and governance, warehousing and data lakes, and commonality of AI and analytical capabilities.



Sharing is essential

In our research for this report, we found that operators typically have little formal structure concerning the sharing of AIOps expertise and experience internally, which risks much reinventing of wheels, unnecessary expenditure and slower progress. Operators recognize that AI expertise and skills are an important strategic asset if they are to control the network by autonomous means rather than have control of their networks wrested from them. In the short term at least, AIOps are likely to require more rather than fewer people at least through the transition phase, and developing talent internally will be necessary.



AI is integral to data strategy

All kinds of AI are fueled by data, and lots of it, so AI need to be foundational to every organization's data strategy. To provide the required fuel, CSPs needs to natively expose data, remove it from silos then create data lakes and make the data stored there accessible to the entire company via open APIs. Simple to say, less easy to achieve.

The most likely candidates for leading the corporate AI charge are the CIO or Chief Data Officer, or the CTIO, as network and IT merge. It matters less which position they hold than being given the authority to carry the strategy through – read more about this in the recently published TM Forum report, [Redefining the CTIO: Essentials for the digital age](#).



Collaborate and standardize

AI is so integral to every CSPs' success, it is a prime candidate for cross-industry collaboration to create standards, models and best practices by sharing knowledge, skills and experience. As we have learned from our survey results, operators tend to be keener on this than their suppliers, but it is up to operators to encourage their participation. TM Forum, ETSI, and the Telecom Infrastructure Project (TIP) initiated by Facebook are all working on AI initiatives.



Join a TM Forum Catalyst project

Another option for collaboration is participation in a ground-breaking proof-of-concept [Catalyst project](#). A recent award-winning project called [Artificial Intelligence for IT Operations](#), which was demonstrated at Digital Transformation Asia, scored a number of firsts. This includes China Mobile, China Telecom and China Unicom collaborating to see how they could improve users' mobile internet experience by optimizing networks and IT operations. They used AI and big data analytics to examine faults and route around them, predict incidents and look at usage profiles to gain continuous insights across IT operations management. They were supported by participants BoCo Inter-Telecom, Huawei and SI-TECH.

Watch the team discuss the project:



Join the effort to develop AI management standards

TM Forum members are working on an AI reference architecture, which includes developing standard interfaces for operational AI models and standard component structures that define the architectural components used to develop and manage AI models, such as feature databases, model databases, deployment servers and registration databases. The idea is to show how real examples of AI components could be usefully developed and managed.

A new information guide entitled Service management standards for

AI, which will be published in February, discusses the motivation and drivers for AI management and examines the lifecycle of an AI model from development through to decommissioning a service, presenting best practices in each stage of the lifecycle. It also defines a high-level model for AI management as well as a reference architecture.

The guide drills down into two specific use cases: churn analysis and chatbots, discussing provocative scenarios and looking at challenges and gaps in the

current systems and what needs to be updated and supported using AI. The team notes that traditional software development lifecycle methodologies often fall short when it comes to managing AI models. This means it is critical that CSPs and their suppliers develop an agreed-upon framework now for managing the lifecycle of AI models in business applications.

To learn more or to join TM Forum's AI collaboration project, please contact Aaron Boasman-Patel via aboasman@tmforum.org.

Additional features and resources

- 28** | [Driving an enhanced customer experience with artificial intelligence](#)
- 32** | [The reality of Artificial Intelligence and Intelligent Machines](#)
- 34** | [Succeeding with big data, AI and analytics – Real-world examples](#)
- 37** | [The promise of AI is holistic transformation](#)

Driving an enhanced customer experience with Artificial Intelligence

Artificial intelligence (AI) has a key role to play in the smooth operations of any business today. And by enhancing the customer experience through improved service quality and speed of problem resolution, well-run operations bring business value and company growth.

As we can see from the TM Forum's study, service providers who have started implementing AI-driven operations have seen an increase in customer satisfaction, a vital tool in the battle against customer churn. Now that communications service providers are transforming into digital service providers, they are obligated to take a fresh look at their operations and focus on how they can leverage AI in their operations to advance their digital business.

And they do: **over 75% of operators cited better customer experience as the driver for intelligent automation, while another 45% (multiple choices were enabled) cited the ability to predict and prevent outages, which has a direct impact on customer experience, as the main rationale and driver for implementing AI.**

At the same time, AI is being used to drive new revenues and services. New digital services require faster processing, and with a dramatic increase in the number of transactions, automation is a must. When asked what is driving automation in operations, customers cited new services (42%) and frequent changes to processes and settings (28%), highlighting the need for automation in the faster-paced digital world. This is the demand

today, even before the implementation of 5G, which will significantly increase demands on operating systems.

Another aspect mentioned is the ability of automation and AI to reduce costs. Over 60% of respondents mentioned OPEX reduction as one of the three main drivers for implementing AI and automation.

The impact of operations on customer experience

Customer experience is far more than the services offered or the way customers communicate with the service provider. Even if a new app uses the latest design, and the service provided is in great demand, customer experience can still be poor if operations do not maintain service quality. This is what encourages customers to implement AI-driven solutions that impact customer experience. The top two responses, when asked where they are investing, relate to experience, with 80% citing customer care, and another 60% focused on predictive maintenance (multiple choice question).

The importance of a good customer experience is even more pronounced in today's environment, given the growth of media services and partner-

based solutions. Customers expect seamless, error-free service, regardless of the type of service or who is providing the solution. Operations need to be fast, accurate and must cover the complete ecosystem. Operations can impact the customer experience through:

Service quality – in many aspects service quality is more important than the application it is supporting. If you launch a cool new self-service app, but the billing system is down for maintenance, the customer experience will suffer. Similarly, if there are any errors in the systems impacting the successful resolution of processes like payment, customers will become annoyed, and start looking elsewhere. Such issues can be prevented through good operations.

Speed of operations – the amount of time it takes for a service provider to resolve an issue, or simply how long it takes to complete routine transactions, such as new service activation or payment, can often be another source of customer frustration.

Bottom line – the faster and more accurately operations take place, the more satisfied the end user, and the more value operations can drive.

Improving speed and quality through AI

To enhance customer experience, operations can leverage various AI capabilities, in several different use cases, improving both the quality and the speed of operations.

Preemptive issue identification and resolution – advanced monitoring and analytics can help discover issues before they impact customers. Trends are analyzed, comparing actual data to previous “normal” behavior, looking for anomalies that indicate a potential issue, and taking measures to prevent the “glitch” before the customer experience is impacted. The system basically heals itself before malfunction.

Automated operations – the use of robotic process automation across all operations, whether planned, such as bill processing, or unplanned activities (for example ticket resolution), helps drive faster and more accurate operations.

Auto-ticket handling – with natural language processing capabilities, your operations control system can automatically read and classify tickets created by users across the organization. This means tickets no longer need to wait hours, or even days, just to be assigned to the right

expert or team. Auto-ticket handling means that as soon as a ticket is created, it can automatically be processed and sent for handling, thereby shortening time to a minimum for issue resolution.

Combine all three capabilities (see figure 1) and you get predictive and pre-emptive, zero-touch, self-healing operations. The system will detect issues before they impact customers, automatically classify the type of issue, and select the right action to take to avoid the issue – automatically.

Another use of AI is in auto-root cause detection, using deep learning analytics to group common issues and identify the root cause for a malfunction or a breakage in the service or process, whether it stems

from a defect in the code or from problematic infrastructure issues. It can then suggest a fix to the stem problem, thereby solving that specific cause for problem, helping to reduce the overall number of issues that occur, and improve the overall system stability.

One further AI-technology, machine learning, can be leveraged for continuous improvement. With machine learning, each interaction is a learning opportunity for the system, either to confirm its analysis, or to refine the models for more accurate analysis the next time. This allows for **automation of the automation**, with the AI system able to create its own automation routines, based on observation of the human behavior in each iteration.

Figure 1 – AI Use Cases in Operations



Getting started with automation

As we have seen, AI-driven automation can add tremendous value to your operations. But the value can only be achieved if performed correctly, using the right approach to implementing AI and automation. As we see from the TMForum study, 45% of service providers are currently focused only on implementing automation in a single process in one domain.

For the service provider who wants, or more accurately needs, to accelerate their automation, there are a few key points to consider to ensure a successful project.

Don't do it alone!

When implementing AI-driven operations, one of the biggest obstacles service providers face is a lack of expertise, whether in data analytics or software. Service providers have an abundance of data available to them but without the right expertise, it is difficult to know how to build the right data models to run the operations. And with a wealth of technology to choose from, service providers find it hard to decide which solutions are best for which applications.

To overcome this and accelerate your journey, you need to partner with an AI expert who can help you with:

1. Building the right data models – leveraging the data you have is critical to success. Knowing which data is important and which you can ignore, can be the difference between success and failure
2. Choosing the right technology – not all tools are created equal. Some may be better for some applications, while others may be better in other areas. Being aware of which technology to use can impact the success of your project
3. Knowing what to automate –

domain experts have the experience and knowledge to help drive a value-driven plan. You want to ensure that your automation drives the optimal value, and that you are not simply automating for automation's sake

4. Learning from others – in some cases, you may not have experience in a certain domain (e.g. IoT). Having a partner who works with other service providers involved in those domains can help fast track your deployment through the use of data from other sources to help build your initial data models.

Building confidence with a step-by-step approach

Another key challenge is the fear of "explainability" -- the inability to understand why the system made the decisions it did, which makes it harder for humans to hand over control to automation. This fear is understandable but can be overcome by a step-by-step approach designed to help the organization learn to trust the system. (see figure 2)

1. Use AI/analytics to help identify problems faster – the first step is to harness the analytics capability to find issues faster. This can be through constant monitoring and analytics of real-time data and spotting the anomalies which indicate issues. This can be taken one step further with predictive

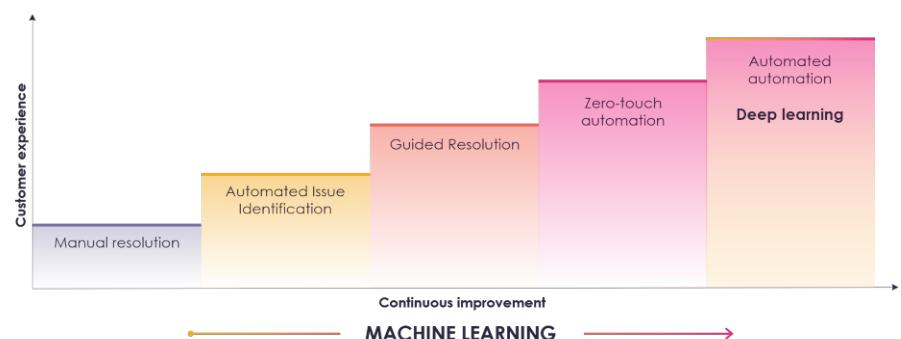
analytics that look for trends indicating a future issue. Further analytics can be applied to filter out noise and focus on the alerts that have real business value. Either way, the issue is identified quickly and can be resolved faster.

Additionally, the system learns from each incident to see how the operations team reacted, and refines its models through machine learning, leading to more accurate issue identification in the future.

2. Use AI to identify problems and recommend solutions – once a problem has been identified, the system can identify the right resolution path. The system can guide a human on the correct steps to take. Through machine learning, the system can learn which of its recommendations are implemented, and which are not. This helps the system become better at selecting the correct action.
3. Use AI-driven automation to implement the resolution – the final piece to the puzzle: automating the resolution of the issue. This creates a complete zero-touch environment. Operations can be fully automated, driven by intelligence.

This whole process can be repeated for each operations domain, giving you complete control of what, and when, to automate your operations.

Figure 2 – Evolving towards pre-emptive operations



Taking it one more step – predicting the unknown

Deep learning is an area where we see limited investment [only 10-15% of service providers cited deep learning investments in a couple of use cases] but its potential is tremendous. With deep learning, AI systems can train themselves to spot trends, correlations and so on from amounts of data so vast that humans are unable to make sense of it. This can be a critical tool for service providers as they launch new services, such as IoT-based solutions, for which they have no historical data

to build data models. Deep learning-based systems would help identify potential issues and alert the operations team, along with providing analysis on which to base the conclusions. Humans would then be able to make educated decisions about how to proceed, and help the system become more accurate in its assessment.

Amdocs Global SmartOps – driving business value through Intelligent automation

Amdocs Global SmartOps harnesses operations to enable digital

transformation within a hybrid ecosystem, driving business growth and enabling service providers to deliver a superior, seamless customer experience. This is achieved through our unmatched domain expertise and an end-to-end operations approach, including AI-driven automation, self-healing and pre-emptive issue resolution. Amdocs Global SmartOps is powered by Amdocs' unique atomIQ platform, a standardized platform of tools, global best practices and capabilities, which infuses artificial intelligence, analytics and automation into all aspects of operations.

About Amdocs

Amdocs is a leading software and services provider to communications and media companies of all sizes, accelerating the industry's dynamic and continuous digital transformation. With a rich set of innovative solutions, long-term business relationships with 350 communications and media providers, and technology and distribution ties to 600 content creators, Amdocs delivers business improvements to drive growth.

Amdocs and its 25,000 employees serve customers in over 85 countries. Listed on the NASDAQ Global Select Market, Amdocs had revenue of \$4.0 billion in fiscal 2018.

For more information, visit Amdocs at www.amdocs.com

The reality of Artificial Intelligence and Intelligent Machines

“Wasn’t it your mother that said you should learn to walk before you run?”

Uncertainty in the markets always creates opportunity, but market uncertainty for Communication Service Providers over the last 10 years seems to have constrained innovation. Considering the heightened challenges faced from high value content providers; over the top services; and diversity in markets, now more than ever innovation and improved customer service must be of primary concern.

There will always be challenges in a market that is so capital intensive. Whether coming from vendors who incite CSP's to invest in the latest 5G technology, IoT offering, SDN/NFV solution, or the next “best” thing. This accentuates the temptation to confuse big capital projects, with innovation or market shifts. Supplier innovation rarely in itself creates sufficient value in new products, new markets, or new opportunities, etc. Some will window dress remanufactured services such as “quad play” as ground breaking, some will laud incremental, faster, better, cheaper, developments such as 5G as revolutions, whilst many acquiesce to the demand of investors with strategically significant acquisitions and divestments, none of these are competitive innovation. True innovation in complex and mature markets such as CSP's takes the full focus of clever and experienced people in those markets. Like most innovation most attempts will fail, but

without testing sufficient opportunities, success will never emerge. This determination comes from those with deep market experience and service knowledge that are buried deep inside the current operations.

So how are CSP's supposed to seek innovation and competitive edge in a world where the best placed members of their organisations are buried in network design, operations, and customer services? Consigned to daily firefighting just to maintain the legacy leviathan capitalised infrastructures to support ever more stressed services to increasingly demanding clients... more... faster... cheaper.

AI Fiction

From Artificial Intelligence gurus comes a new generation of promise which has been generated by vast arrays of cheap storage; the abundance of low quality, fragmented, datasets combined with the exponentially increasing compute power. The accuracy, reliability, durability, resilience of the results is usually high enough to be interesting but too low to be useful. Examples are abound of chatbots that are easily defeated, analytics that produce pretty patterns but misleading results, neural networks that can reliably demonstrate human weakness, and bias.

The problem with “shock and awe” is that it rarely delivers the claims and usually creates a baptism of fire for the uninitiated. The benefit of “shock and awe” is that it can often provide some political “air cover” diverting the prying eyes of judgement; giving time to the less fantastical and more practical revolution happening on the ground.

AI Fact

Whilst the AI press makes all the noise and many outlandish claims, the quiet revolution that is really transforming operations in some of the less conventional corners of CSP's has accelerated less noticed... Whilst the boardroom is having its head turned by main news streams carrying the “shock and awe” stories about the “Artificial Intelligence revolution”, or “Robots taking over the workplace”, some real operations have been making transformational strides using the less sensational, and more realistic, machine intelligence combined with dynamic process orchestration known as “Intelligent Automation”. Not bearing the sequined jazzy coats of the Artificial Intelligence movement, Intelligent Automation deftly implements reliable machine intelligence capabilities that are robust, accurate and scalable. These release skilled operations teams to do significantly higher value work; most importantly tackling the innovation challenge that is presented to all CSP's.

Man Machine Collaboration

As we are a long way from AI doing everything, if ever, the promise of AI will only be delivered in a collaborative environment by building a trust relationship between man and machine. In every case, this trust must be first built between man and machine, then extended by the participants in forming the confidence to allow the machines to operate unaided in the environment. The current rolling media squall of advanced and, the currently mythical, general AI promising to transform the world is failing to build the trust required to formulate a road to autonomous operations. At the other end of the scale, the basic action based "Robotic Process Automation" which seeks to integrate intelligent action to establish the trust to act autonomously, is so fragile that it undermines the very trust required to operate autonomously. The road to trust, let alone the road to confidence, does not support unpredictable or generalist techniques.

Based on well proven and reliable methods of operational analytics and deterministic decision models, Intelligent Automation implements techniques that provide more predictable outcomes rather than the

probabilistic approximations that more advanced AI methods propose. This produces a rapid route from the "Human in the Loop" type operation to the Supervisory mode where real transformation releases significant resources to innovation and customer service.

Sense, Analyse, Decide, Act

Intelligent Automation is "the application of analytical and decision systems to take actions to achieve predictable outcomes.". This is often confused with AI which the Forbes Insights survey defines as "the science of training systems to emulate human tasks through learning and automation.". We would argue this definition is riddled with issues: Not least because, AI is typically numerical analysis applied in discrete mathematics, it is more an engineering discipline than a science. Also, the word "emulation" and "learning" do not sit comfortably in the same sentence in the same sense as "learning" by rote is more emulating than learning.

However, even with this very loose definition, Forbes draw a similar conclusion for AI as Cortex make for Intelligent Automation that "Trust will play perhaps a larger role in the

evolution of AI than it has for any technology in recent memory."

Taking the Next Steps

Cortex Intelligent Automation is the first platform specifically built to solve the challenges that prevent organisations accelerate down the road to an autonomous future. Cortex technologies build the trust and confidence that create the ultimate collaboration between human and machine. Advanced AI will eventually provide predictable outcomes that can transform operations to release more resources to innovation and customer services, however, to take advantage of this organisations must start to build trust and confidence in today's predictable technologies. There is no shortcut to advanced AI, and leading innovation.

The road to autonomy is littered with painful lessons that has been well-trodden by the aircraft and robotics manufacturers alike who understand the necessity to build trust through deterministic human in the loop activities, and confidence through predictable automation with a human supervisor, ultimately gaining high levels of machine autonomy in a man-machine collaboration built on trust and confidence.

About Cortex

Cortex Intelligent Automation is the first unified platform specifically built to solve the challenges preventing organisations' acceleration to an autonomous future. Cortex rapidly creates value, using multi-purpose intelligent automation software to transform telecommunications operations.

A unified, no-code, automation and orchestration platform, Cortex delivers Workflow, Orchestration, Automation, Reasoning, Integration and Event processing. Unique, decision-driven, closed-loop, and self-adjusting automation technology seamlessly integrates into existing and legacy technologies, automating processes to increase accuracy, speed, agility, and to deliver tangible ROI.

With strategic partners including Capgemini, TCS, and Tech Mahindra, Cortex applies proven strategies and methodologies for Intelligent Automation deployment, together ensuring that the most successful outcomes and ongoing autonomous operations are achieved.

For more information, visit Cortex at www.cortex-ia.com

Succeeding with big data, AI and analytics – Real-world examples

Communications service providers (CSPs) that have succeeded at monetizing data have improved their operations and customer care in ways that have substantially benefited their bottom lines. Let's look at a few examples of CSPs that have used AI-driven analytics to realize sizeable cost savings, measurably improve customer satisfaction and Net Promoter Scores, accelerate new service rollouts, and drive digital transformation in their organizations.

Accelerated troubleshooting, millions saved

A top North American cable operator using customer care analytics has **reduced costs by more than \$102 million** while improving customer satisfaction levels.

Here's how:

Slashed problem resolution times. The MSO was receiving large volumes of customer service calls, and the operations team was struggling to identify the root of the problem. Technicians were dispatched to customer locations, only to frequently find that the glitch wasn't in the customer's set-top box, but in a headend device instead. The situation frustrated both the customers and cable operator, wasting time and money.

The MSO used the Guavus Reflex® solution with Guavus Live Ops to

adaptively correlate data from multiple sources – technical support calls, subscriber trouble tickets, and truck rolls – allowing their Care Ops team to quickly discover issues common across micro-populations of subscribers. Using machine intelligence, Guavus helped the team immediately triage and pinpoint the problem and resolve it.

Results: Not only were customers happier but by slashing truck rolls and customer service calls, **the operator saved approximately \$70 million in the first year alone.**

- **Proactive maintenance** – Guavus Live Ops has now been integrated into the same operator's step-by-step methods of procedure (MOP) that its technicians follow when implementing a network change or upgrade. Guavus Live Ops allows the MSO to proactively monitor any potential negative impacts of an upgrade across the operator's infrastructure and if any are found,

to take measures to correct them before they become a widespread problem.

- **Prioritization of capital expenses** – When the cable operator rolled out a new video service, analytics enabled it to prioritize which pieces of equipment to upgrade first. The Guavus solution correlated subscribers to each type of equipment, examined failure rates over time, and identified the impact of these failures on customers. Using this information, the team was able to prioritize equipment changes, minimize capital expenses, and roll out enhanced video-on-demand services faster.

Results: The operator realized a **capital expense savings of \$32 million** while maintaining high customer satisfaction levels throughout the deployment of the new services.

Detecting irregular behaviors, improved QoE, stronger security

A large North American mobile network operator is using AI and analytics to detect traffic-pattern irregularities to improve overall user quality of experience (QoE), shorten the time needed to troubleshoot problems, and reduce security breaches.

Using the Guavus Reflex solution, this MNO is able to detect unauthorized tethering use, a situation in which a user with an unlimited data plan allows multiple users to piggyback on that connection with high-usage activities such as movie downloads. Such use can result in radio-access network (RAN) clogs, which impacts the experiences of other subscribers served by that user's cell site.

Knowing which subscribers are using unauthorized tethering, the operator can suggest a different data plan that better meets that customer's needs or throttle usage from that user, if necessary, to improve performance and overall QoE for all subscribers in that area.

The operator's security team also uses Guavus analytics to track malware, through the detection of erratic traffic patterns and behaviors indicative of malware or access breach. The security team is able to view a comprehensive dashboard allowing them to query, analyze and generate reports on subscriber activity and then take the appropriate action. The operator may elect to shut down a certain Internet port or send a message to the subscribers' phone recommending that he update his phone with the latest security software version.

Results: The MNO has **reduced the time needed to discover malware infection from days to hours.**

Additionally, common problems across mobile devices are rapidly identified by correlating device and dropped call statistics. Feedback is provided to the appropriate team or device manufacturer to correct the problems before they become widespread.

Pinpointing root causes fast

Like the North American MSO discussed, a European cable operator has turned to Guavus AI and analytics to identify and resolve network problems faster, particularly those that could impact customer service levels. With the cost of a truck roll in the MSO's country running about €60 to €70 and the handling of incoming customer service calls running about €5 to €10 each, the provider implemented Guavus Live Ops as a way to ID root issues quickly – and, at the same time, to reduce customer service costs and improve customer satisfaction.

As the barriers between data silos were removed, the European MSO discovered hidden insights and root issues. By correlating massive amounts of disparate data and running advanced analytics on it in real-time, the MSO's Net Ops and Care Ops teams learned that they could identify and troubleshoot issues faster – sometimes even before they occurred.

Results: By reducing customer calls, trouble tickets, and truck rolls, the company says **it is saving "seven digits" annually** and has **improved its Net Promoter Score (NPS) by a full point.**

Which network alarms indicate real issues?

Most CSP network operations centers (NOCs) receive a minimum of one alarm per second (or about 86,400 each day). However, only 2% to 3% of the alarms actually lead to true incidents or problems; the rest are simply noise that can and should be ignored. The problem, of course, is distinguishing which is which – or, if that's not possible, how to arbitrarily decide which alarms to ignore.

A large North American cable operator has used the Guavus Alarm IQ analytics to eliminate this conundrum. Using machine learning and AI, Guavus Alarm IQ takes in alarm streams and classifies which alarms will lead to customer problems, which ones are already associated with open tickets and which ones are merely noise – with a 99.2% accuracy level! Now the cable operator can focus on resolving a much smaller subset of alarms and confidently ignore the rest.

Results: The operator **has reduced alarm volume by more than 90%,** while providing **increased visibility into customer-impacting issues** developing in their network.

Turning big data into gold

Hear how Unitymedia is [“Driving Value from Big Data in Practice”](#) in this videotaped presentation by Philipp Gröne, Senior Delivery Expert at Unitymedia.

And read more about how [Comcast](#) as well as [other CSPs](#) are achieving strong results using [Guavus’ big data analytics solutions](#).

Breaking down big data silos, succeeding with AI and analytics across your business

Most telecom analytics and AI use cases to date have been focused on streamlining operations and improving customer care. Early adopters have learned that getting analytics to work meaningfully across the various formats in their vast data lakes was more difficult than they anticipated, particularly when using off-the-shelf software. It's essential to have analytics products that cross organizational boundaries to link operations with marketing insights and customer QoE levels for a holistic – and often real-time – approach to automation and decision-making.

One of the only vendors to have AI-based solutions that span customer care, marketing, networking, and security operations, Guavus is a supplier to six of the seven top telecommunications providers and three of the four top MSOs globally. The company has a long track record of working with service providers to apply AI and advanced analytics to key areas across their businesses.

They know that just having big data doesn't take you where you need to

go. You need an analytics and AI platform that brings the important data to life – and filters out the data that's insignificant. Their team has the long-standing CSP and real-time analytics domain expertise that addresses CSP challenges at the scale, speeds, and resiliency levels that carriers require.

These are the reasons that the CSPs

discussed here have turned to Guavus. As a result, they are improving customer experiences while dramatically reducing costs and attaining the scale and security they require to support the blossoming internet of things (IoT).

To learn more about how Guavus can help you get results like these, go to www.guavus.com

Guavus AI/ML-powered Analytics Solutions Lineup

Live Ops: adaptive analytics that correlates separate data sources to identify and understand customer-impacting events in real time and then recommends steps to repair.

Proactive Ops: proactively anticipates events that may cause network problems, identifies which ones will have the biggest customer impact, and takes automated actions as needed.

Security Intelligence: automatically detects anomalous behavior to show security analysts where threats may be imminent without overwhelming them with false positives.

Smart Care: integrates with existing customer care systems and

recommends resolutions through advanced predictive algorithms and AI.

Marketing Insight: creates customer segments for custom campaigns in real time to increase acceptance rates.

Smart Industry & IoT: out-of-the-box solution that automatically pinpoints customer behaviors and preferences, classifies asset usage, identifies performance issues and root causes, and takes closed-loop actions.

Alarm IQ: harnesses the power of AI to eliminate alarm “noise” without changing NOC operator workflows.

About Guavus

Guavus is at the forefront of AI-based big data analytics and machine learning innovation, driving digital transformation at 6 of the 7 world's largest telecommunications providers. Using the Guavus Reflex® solution, customers are able to analyze big data in real-time and take decisive actions to lower costs, increase efficiencies and dramatically improve the end-to-end customer experience – all with the scale and security required by next-gen 5G and IoT networks.

Guavus enables service providers to leverage both customizable 'self-service analytics' and out-of-the-box analytics applications for advanced systems planning and operations, mobile traffic analytics, marketing, customer care, security and IoT. Discover more at www.guavus.com

The promise of AI is holistic transformation

The era of artificial intelligence is upon us and has the potential to transform our lives, industries and society in ways that may be difficult to imagine today. AI offers us new ways to boost employee productivity and creativity, increase business agility, improve customer engagement and jumpstart new product innovation – and that's just the beginning of what is possible.

Throughout Microsoft's 43-year history, we have focused on democratizing the benefits of computing to overcome barriers to human progress, enabling every person and organization on the planet to achieve more.

Microsoft AI is not a product that comes in a box. It is our vision to empower every developer, organization and individual to innovate and transform the world with AI.

Empowering developers to innovate

Microsoft has been creating the building blocks for AI for 25 years and our relentless focus on innovation has culminated in an explosion of breakthroughs. More than ever before, we are investing heavily in putting this innovation into the hands of developers around the world. Since the announcement of Project Oxford more than three years ago, which was the beginning of what ultimately became Azure Cognitive Services, we pioneered the creation of AI as a service.

With Azure Cognitive Services, we offer pre-built AI Services for any developer to use, surfacing innovation and breakthroughs in speech, text,

vision and translation – and these innovations are now included in the Azure AI Platform, which bundles the largest set of pre-built and customizable AI services.

It has been thrilling to see the growth in the ecosystem of Microsoft AI developers — more than 1 million developers are now using Azure Cognitive Services. The usage of AI services and the pace of innovation is rapidly increasing. We are committed to helping every developer become an AI developer with our investments in AI School and AI Lab, which are targeted at making it easy for developers to experiment, learn and create.

Empowering organizations to transform

Gartner reports that while 85 percent of enterprises will be using AI by 2020, only 25 percent have started or are planning to start their AI initiatives in the near term. The foundation for AI is data. The volume of data is doubling every year, so it's no surprise that the task of turning chaotic data estates into knowledge is daunting. We consistently hear from customers that their data is siloed, and much of it is unstructured, making it hard to

move and even harder to get insights from. In a world where time to market is key, productivity is king and organizations are struggling to grow and nurture the development skills needed in their organization to embrace AI. There are also concerns regarding just how ready AI is for prime-time in an organization where reliability, security, trust and scale are table stakes.

Every company is unique and there is no single path to driving AI transformation. Our approach with Microsoft AI is to meet you wherever you are on your path to transforming. A major differentiator in our approach is that Microsoft's data platform enables you to reason over data no matter where it resides. Whether data is on premise, in the cloud or on the IoT Edge, you don't need to move your data to reason over it. We empower developers to use the tools and frameworks they know and love with Azure AI, meaning developers can use skills they already have and can deploy AI models anywhere, in the cloud or their own datacenter. The Azure platform is engineered for the future with the enterprise-grade service-level agreements, scale, built-in privacy, compliance and security that your organization needs to make AI real for every application, every business process and every employee.

Redefining the intelligent software-defined telco through AI

At Microsoft, we believe that the enterprise can achieve far more with a comprehensive AI strategy rather than incremental changes through isolated use cases. Our vision for the enterprise is to enable every company to transform by bringing **AI to every application, every business process, and every employee**—and as a result, achieves more than they ever thought possible.

Every application

Quickly and easily develop intelligent applications to create engaging user experiences and surface unprecedented insights.

Just like the internet explosion catalyzed organizations to create corporate websites, companies will start to infuse AI into existing applications and create completely new applications with cognitive services. Through this infusion, we foresee companies revolutionizing how they engage externally with customers and internally with employees. For example, breakthrough innovations are enabling organizations to push the boundaries of what's possible with conversational AI. Customers such as Vodafone, Telefónica and TIM are using Microsoft AI to customize and personalize their customer and employee engagements, thus transforming the telecommunications industry.

Every business process

Enhance every business process with intelligence to expand customer engagement, optimize operations, and improve products and services.

At the other end of the spectrum, organizations are looking to AI to help re-invent and re-define complex business scenarios. Microsoft's approach is to empower complex business process transformation with

enterprise-ready, out-of-the-box, AI-infused solutions, like the new Dynamics 365 AI for Customer Service Insights. With a robust ecosystem of 300,000 partners around the world, Microsoft has partnered with organizations across a wide range of industries to meet vertical-specific needs. Leading telecom suppliers like Amdocs, Ericsson, and Blue Prism are embracing Microsoft AI and Cloud services to improve customer experiences and optimize operations across the datacenter, network, contact center, and more.

Telecom customers are transforming their business processes with AI:

Next Best Action (NBA) – AI-powered NBA solutions use sophisticated rules, analytics, and algorithms to better predict customer needs and in turn offer more relevant actions and promotions, leading to improved wallet share and loyalty.

Revenue assurance and fraud prevention – Real-time data streaming and machine learning make more accurate fraud, and customer models possible, enabling faster discovery of revenue leaks and potential fraud, recovering millions in lost revenue.

Efficient network capacity planning – Anticipate capacity needs and maximize CAPEX spend across the network, creating just-in-time capacity that results in cost savings and improved customer experiences.

Predictive maintenance – Estimate the remaining useful life for customer premises equipment, machines, switches, radio-equipment and their components, enabling maintenance technicians to be proactive about repairs and reduce costly downtime.

Robotic Process Automation – Streamline and improve manual tasks like order entry with intelligent, configurable automated workflows that increase productivity, enable employees to focus on more important tasks, and reduce OPEX.



Every employee

Foster innovation and collaboration across the enterprise by placing AI in the hands of every employee.

Imagine the possibilities available to your business when the huge amounts of siloed data across your organization become connected and enriched with world data, becoming the center of gravity for knowledge. Now expand upon this and imagine the possibilities if you were able to expose that knowledge to every employee in your organization with a conversational AI interface that makes it intuitive and simple to access and query. It's about empowering employees to participate with a self-service AI approach, helping them to become citizen data scientists and enabling them to get information faster and in ways that previously would have been highly difficult, if not impossible. We believe the full potential of AI is realized when it's truly democratized and for us that means putting it into the hands of every employee. This is the next frontier of fully democratizing AI.

Transform your organization by bringing AI to...

Every application

Quickly and easily develop intelligent applications to create engaging user experiences and surface unprecedented insights.

Every business process

Enhance every business process with intelligence to expand customer engagement, optimize operations, and improve offerings.

Every employee

Foster innovation and collaboration across the enterprise by placing AI in the hands of every employee.

Empowering people to transform society

Microsoft's vision of empowerment goes far beyond business. In fact, the impact of AI will be the greatest when used to empower all of us to positively transform society. Societal change requires a deep commitment to ensuring the benefits of AI are spread throughout society. While AI provides us with massive opportunities, it also creates new societal challenges and concerns that we must address head on. At Microsoft, we've identified six principles – fairness, reliability and safety, privacy and security, inclusivity, transparency, and accountability – to guide the development and use of AI in ways that would increase its trustworthiness. We established an internal committee, AETHER, to proactively establish internal policies and ensure our AI platform and experience is grounded in these six principles. However, the task of building responsible and trusted AI is not the responsibility of any one company. We're actively engaging and participating with governments, institutions and associations including the Partnership on AI, the Organisation for Economic Co-operation and Development, and the International Standards Organization.

to help shape policies and standards to guide trusted and ethical AI development.

Through our AI for Good initiative, Microsoft has committed over \$115 million to AI for Earth, AI for Accessibility and, most recently, AI for Humanitarian Action. Our goal with all of the AI for Good programs is to empower and accelerate the impact that people around the world can have in solving some of society's biggest challenges.

Get started today

We recognize, however, that every enterprise is unique and you will have your own path to transforming your organization. To help you take the first step towards your own AI transformation, we have created the AI Ready assessment tool. This tool evaluates your own organizational readiness for adopting AI-based systems and provides customized recommendations around appropriate AI implementations for your business.

The future we create is a choice we make. Learn more about how Microsoft is empowering developers, organizations and society to harness and reap the benefits of AI at our recently published Microsoft AI White Paper.

Top considerations to ensure an AI-ready culture:

Adopt a data-driven culture

Ensure your AI solutions are founded on high-quality data.

Share knowledge

Commit to breaking down data siloes across the enterprise and making data accessible to all.

Choose the right AI solution

Align the AI solution to your unique enterprise and ideal business outcomes.

Adapt AI to your enterprise

Test AI with minimally viable products and improve applications and processes that already exist—while always putting the customer experience first.

Plan ahead

Communicate the AI strategy throughout your business, be proactive about AI training, and be cognizant of ethical concerns.

About Microsoft

Microsoft enables digital transformation for the era of the intelligent cloud and intelligent edge. The telecommunications industry is striving to innovate with new services and improve their customer experience, business insights, and operational efficiency. Microsoft empowers the industry to achieve more with enterprise-class platforms and solutions that together with a rich partner ecosystem, help support the mission-critical operations of today's communications service providers (CSPs). Please visit www.microsoft.com/telco for more information and customer stories.

Company website:

https://www.microsoft.com/telco

Privacy policy:

[https://privacy.microsoft.com/en-us/privacystatement](http://privacy.microsoft.com/en-us/privacystatement)

TM Forum toolkit for digital transformation

Agile & Virtualized

TM Forum Digital Maturity Model

The DMM is a ‘living’ maturity model and set of metrics to help companies measure their true digital maturity. Members can access a guidebook as well as an Excel spreadsheet containing the actual model. It is also available as iOS app.

Agile OSS/BSS Toolkit

This toolkit includes a complete blueprint for a platform for managing a multi-vendor hybrid/NFV infrastructure, which includes open APIs, information models, best practices and deployment guides.

Open Digital Architecture

Developed collaboratively by the world’s largest telecom operators and their partners, the ODA provides a common operations and IT management ‘blueprint’. It combines proven cloud-computing best practices with TM Forum’s work on zero-touch orchestration operations and management; digital ecosystem management; data analytics; AI and Open APIs.

Open & Partner Effectively

Open APIs

TM Forum offers more than 50 APIs to manage services end to end and throughout their lifecycle in a multi-partner environment.

Digital Trust Challenges and Opportunities Standard

This technical report outlines the key concepts of digital trust and identifies the top seven digital trust challenges.

Monetizing the Internet of Everything Guide

This information guide describes a standardized approach and a monetization template for new, innovative services.

Customer Centricity

Customer Experience Implementation Suite

This set of tools consists of a guidebook, hundreds of metrics, a maturity model, lifecycle model, ROI model and more than 54 implementation use cases.

Big Data Analytics Solution Suite

This set of tools includes a big data reference model, a guidebook containing more than 65 use cases and 1700+ pre-defined metrics.

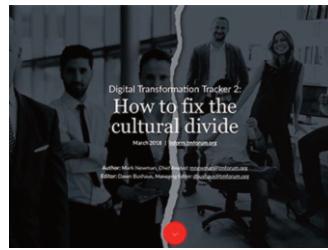
360 Degree View of a Customer

This guidebook offers a 360-degree view of a customer and explains how to put customers at the center of considerations and actions.

Research & Media



Digital Transformation Tracker 3
Why is network transformation so difficult?



Digital Transformation Tracker 2
How to fix the cultural divide



Trend Analysis Report
AI: The time is now



Digital Transformation Tracker 1
The race is on



Trend Analysis Report
Vision 2020:
Future CSP
Business models



White Paper
AI & customer experience:
Emerging best practices



Trend Analysis Report
5G monetization:
Operational imperatives



Quick Insights
Smart analytics pay dividends across the customer lifecycle



Quick Insights
Want to drive business benefits?
Improve customer experience



Quick Insights
Microservices:
Piecing together a strategy



Quick Insights
Building a data lake to drive digital transformation



ebook
Platforms: How to join the revolution



ebook
TM Forum Open APIs:
Enabling a zero-integration API economy

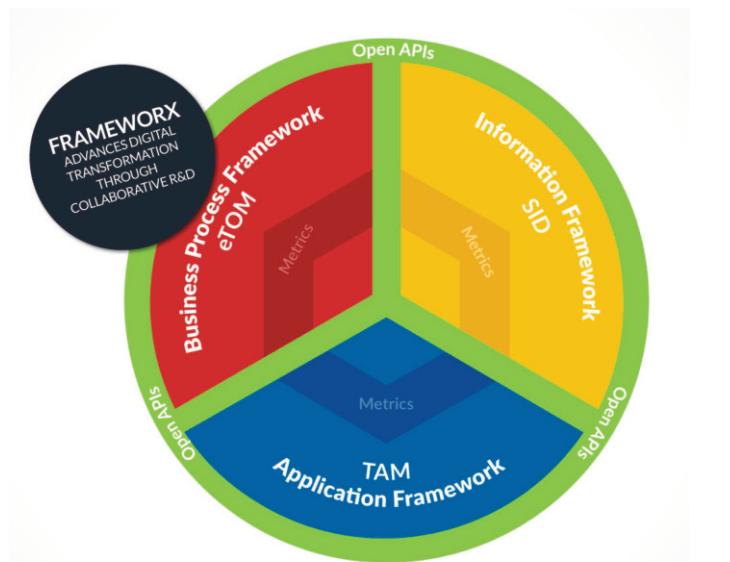
TM Forum Framework

TM Forum Framework is a suite of best practices and standards that, when adopted, enable a service-oriented, highly automated and efficient approach to business operations. Framework provides hundreds of standardized Business Metrics that allow for benchmarking, as well as a suite of interfaces and APIs that enable integration across systems and platforms. Framework also includes adoption of best practices to help companies implement and use the standards and management best practices to ensure ongoing conformance.

Framework has been widely adopted and proven to significantly improve agility in IT and operations, resulting in increased margins, lower costs and optimal customer experience. Framework is created and evolved by TM Forum members who participate in the Forum's Collaboration Community.

8 things Framework can do for you:

- 1.** Reduce transformation risk by delivering a proven blueprint for agile, efficient business operations
- 2.** Innovate and reduce time-to-market with streamlined end-to-end service management
- 3.** Create, deliver and manage enterprise-grade services across a multi-partner ecosystem
- 4.** Improve customer experience and retention using proven processes, metrics and maturity models
- 5.** Optimize business processes to deliver highly efficient, automated operations
- 6.** Reduce integration costs and risk through standardized interfaces and a common information model
- 7.** Gain independence and confidence in your procurement choices through conformance certification and procurement guides
- 8.** Gain clarity by providing a common, industry-standard language

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Business Process Framework (eTOM)

The Business Process Framework (eTOM) is a comprehensive, industry-agreed, multi-layered view of the key business processes required to run an efficient, effective and agile digital enterprise.

6 things you can do with the Business Process Framework:

1. Create a common language for use across departments, systems, external partners and suppliers, reducing cost and risk of system implementation, integration and procurement
2. Adopt a standard structure, terminology and classification scheme for business processes to simplify internal operations and maximize opportunities to partner within and across industries

3. Apply disciplined and consistent business process development enterprise-wide, allowing for cross-organizational re-use
4. Understand, design, develop and manage IT applications in terms of business process requirements so applications will better meet business needs
5. Create consistent and high-quality end-to-end process flows, eliminating gaps and duplications
6. Identify opportunities for cost and performance improvement through re-use of existing processes and systems

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Information Framework (SID)

The Information Framework (SID) provides standard definitions for all the information that flows through the enterprise and between service providers and their business partners.

5 things you can do with Information Framework:

1. Reduce integration costs by adopting standards-based information models and using them in applications and interfaces
2. Save hundreds of design hours by starting with a mature framework and 1500 entities developed and vetted by subject matter experts

3. Speed time to market by using well-understood integration interfaces based on the Information Framework, eliminating the need for data translation between systems
4. Avoid wasting precious development time on debates with your team, partners, or vendors by adopting a widely proven, industry accepted, rich and extensible information model
5. Mandate conformance to the Information Framework and save time and money during vendor evaluation and procurement

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Application Framework (TAM)

The Application Framework (TAM) provides a common language and means of identification for buyers and suppliers across all software application areas.

5 things you can do with the Application Framework:

- 1.** Streamline procurement by using common definitions and language to specify and evaluate solutions
- 2.** Document and then rationalize your application inventory during transformation projects or mergers and acquisitions

- 3.** Integrate faster and with lower costs by defining and clearly communicating the functions provided within each application
- 4.** Reduce custom development costs with modular, standard application requirements
- 5.** Increase automation and efficiency with standard, deployable components

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Open APIs

TM Forum's 50+ REST-based Open APIs have been developed collaboratively by communications service providers (CSPs), government organizations and their partners. When used internally, the Open APIs help companies transform their IT, increase operational agility and improve customer centricity. Externally they enable end-to-end seamless connectivity, interoperability and portability across complex digital ecosystems.

To date, 42 of the world's leading CSPs and technology suppliers have signed the Open API Manifesto publicly demonstrating their endorsement of TM Forum's Open APIs. CSPs that adopt the Open APIs can position them as a preferred requirement in their IT requests for proposal, and technology partners can commit to using the Open APIs in relevant product applications. Together they can unlock many growth opportunities, including dramatically improving business and IT agility, reducing the cost and complexity of operations, and reducing integration cost, risk and time for the entire supply chain.

The Open APIs are often tested, improved and extended through TM Forum's Catalyst Program. Catalysts are proof-of-concept projects that bring together companies large and small to create innovative solutions to common challenges, demonstrating how solutions can be achieved by leveraging key TM Forum best practices and standards. Catalyst teams work on the projects for four to six months before demonstrating them at TM Forum's flagship events.

[Access the Open APIs](#)[Learn more](#)

Best Practices

TM Forum members have collaborated to produce an extensive library of standards, best practices, guidebooks, technical reports and much more covering the most important topics for companies operating in the digital economy.

We have arranged these resources into toolkits by topic. Click on the link below to access the full toolkits and download* all the available resources.

*Downloads are available to employees of TM Forum member companies only. Interested in joining as a member? [Click here.](#)

[Access the Toolkits](#)

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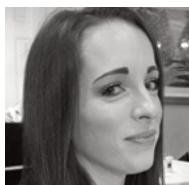
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