



AUTONOMOUS NETWORKS: BUSINESS AND OPERATIONAL DRIVERS

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Autonomous networks: Business and operational drivers

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We hope you enjoy the report and, most importantly, will find ways to use the ideas, concepts and recommendations detailed within. You can send your feedback to the editorial team at TM Forum via editor@tmforum.org

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The big picture

Any project’s business case must either increase revenue or reduce costs, or both, to a degree worthy of the time, effort and investment involved. The longer a project takes, the harder it is to predict the total investment required and the point of payback. Nor is it always possible to tell in advance where all the benefits lie or how to quantify them. Building the autonomous network (AN) is this kind of project. The reach of ANs is far and wide, touching all aspects of telecom operators’ businesses, with an uncertain outcome.

ANs will provide fully automated network and ICT services for vertical industries, consumers and partners that support self-configuration, self-healing, self-optimization, and self-evolving infrastructure and operations. They comprise simplified network architectures, autonomous domains, and intelligent business and network operations, resulting in full automation of the operations lifecycle and maximum resource utilization.

The four primary domains of an AN are access, edge, transport and core. Communications service providers (CSPs) may subdivide these domains as they roll out specific autonomous capabilities. ANs have the following characteristics:



Self-governing – actions and behavior of managed entities are controlled within an autonomous domain.



Programmable – open APIs and standardized external reference points support interoperability.



Explainable – an autonomous domain can describe why a decision was made in terms understandable to humans.



Composable – a function or service can be built from smaller functions or services.



Business-driven – offered services are defined by business rules and goals.



Model-driven engineering – the systematic use of domain models occurs in all stages of the software engineering lifecycle.

Benefits of automation

ANs can deliver on cost reduction. For example, in a **recent TM Forum case study**, Windstream Communications, a US broadband and managed services provider that recently exited from bankruptcy, says it reduced the cost of network monitoring and troubleshooting by 82% by applying a “sliceable, autonomous, programmable and scalable network”. Similarly, a TM Forum report published in December on **AI in operations**, finds that a 20% increase in automation investment could reduce labor costs for operators by 90%.

There is little doubt that automation could increase revenue by delivering high-value, real-time services, and CSPs see this as a primary driver. But building autonomous networks needs to be done strategically and carefully, with as little impact on customers and the business as possible.

Good engineers have built networks this way for years, but handing responsibility over to machines and algorithms is what gives CSPs pause and is partly why automation has been incremental to date. Based on our research, we expect it to remain that way for some, although others are far more ambitious.

Research methodology

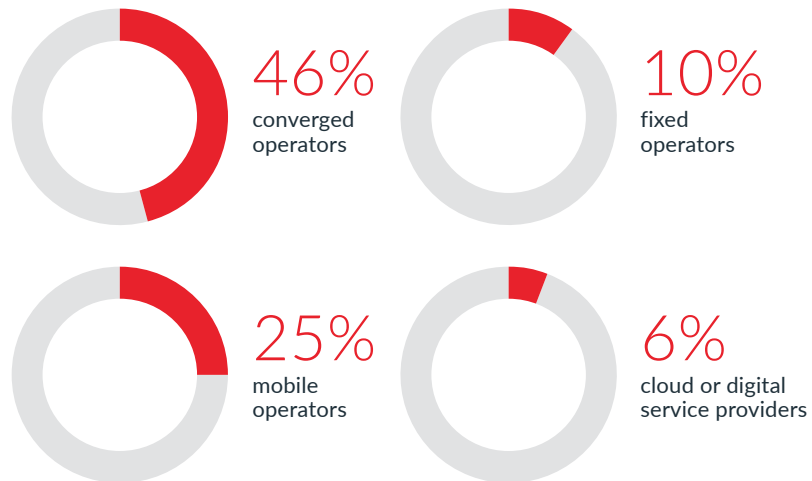
This report draws on a targeted survey of CSPs from around the world, conducted during the first quarter of 2021. All regions of the globe are represented, with about 20% of respondents indicating that they work for companies with global operations. Respondents' roles include enterprise architect; engineers working in network optimization and analytics; and director of product management, among others. We also carried out in-depth interviews with CSP and supplier executives to discuss automation strategies and the challenges to implementing them.

Read the report to understand:

- Where CSPs are in implementing automation
- Which issues are informing their AN strategy
- What the business drivers are for ANs
- What the operational drivers are for ANs
- The relationship between 5G and ANs
- The six-level journey to ANs

Who are the AN survey respondents?

60 CSP respondents from 42 unique companies or divisions



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Section 1

How CSPs are approaching autonomous networks

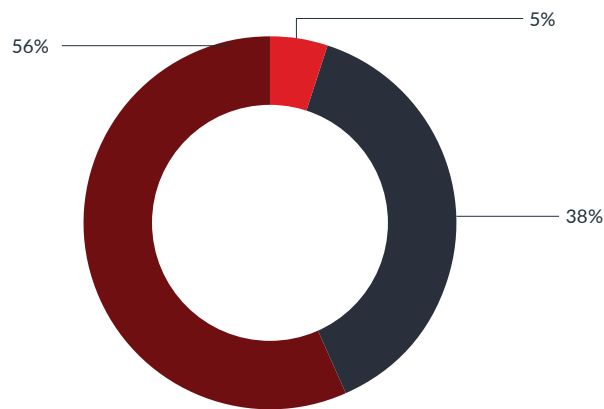
From the targeted survey of communications service providers (CSPs) conducted for this report, we wanted to understand how operators are implementing autonomous networks (ANs), how they perceive their progress, and which issues are driving their strategies. We also delved into how centralized and coordinated – or otherwise – those strategies and their execution are.

The graphic opposite shows that only a small percentage of CSPs have not formulated an AN plan. Of those that have, just over a third are taking a pragmatic approach of automating some domains, rather than implementing a coordinated, enterprise-wide plan.

However, more than half say they have a vision of integrating automation across their organizations. A TM Forum report on the use of AI for network automation published a year ago, **found** that 43% of CSPs were concentrating their automation efforts simultaneously on the four key areas listed below, although not necessarily integrating them. So, it appears that CSPs are moving in the direction of a centralized, enterprise-wide effort toward AN.

- Self-configuring, self-healing, self-optimizing and self-evolving network infrastructure
- Zero-wait, zero-touch, zero-trouble services
- The best possible user experience
- Service lifecycle automation and maximum utilization

CSPs' approaches to automation



- We are taking a pragmatic approach to automating as many of our existing domains as possible but with no overall plan
- We have an integrated vision for automation within our organization
- We have no plan

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Read the automation & AI report:



Driving the AN strategy

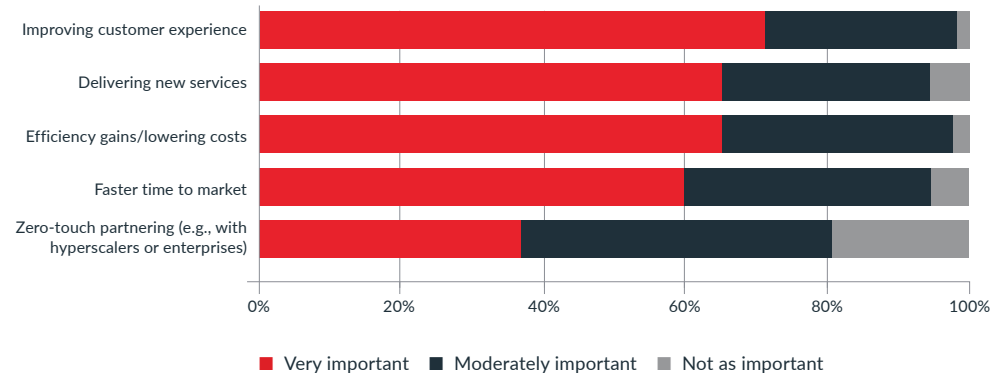
The top 3 drivers for autonomous networks are improving customer experience, delivering new services and lowering costs, with at least two-thirds of CSP respondents choosing each as very important. In the 2020 automation report CSPs were focused on faster time to revenue, proactive self-healing and supporting real-time services – we did not ask about partnering then. Several CSPs we spoke with for this report said proactive self-healing is still important, but now they are thinking about automation and other transformations less in terms of their technology improvements and more in terms of business results, which in this case is improving customer experience.

Seeing results

As noted in the introduction to this report, Windstream Communications reduced the cost of network monitoring and troubleshooting by more than 80% using automation. The company also fully automated its order-to-activation lifecycle management process and reduced overhead expenses by two-thirds.

Windstream claims to have automated 100% of its processes from subscriber registration to service activation. The programmable, autonomous network domain lets consumer and enterprise customers define, manage and prioritize their own services, such as SD-WAN, business broadband, managed security and Wi-Fi.

Key drivers for autonomous networks



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In the Middle East, Etisalat is focusing on automating its transport network domain. The company's CTO, Haitham Abdulrazzak, **said in November** that the company's transport network is at the heart of all autonomous networks, and by reducing manual operations and automating order-to-service processes, Etisalat was able to reduce the time it takes to introduce new services by 70% to 90%.

In the next section, we'll look more closely at business drivers for ANs.

Read more about Windstream's transformation:



Zero-touch partnering enables new services, cuts time to market

While it ranks lower than the other drivers, partnering will be important to CSPs' go-to-market strategies. In fact, zero-touch partnering is becoming integral to many industry initiatives, including edge computing, network-as-a-service, connectivity-as-a-service and IoT. Partnering ties directly to delivery of new services and faster time to market. CSPs must be easy to do business with before they can excel at multi-party services.

An **MIT report on 5G**, which discusses the importance of partnering, notes that to take full advantage of capabilities like ultra-low latency, real-time and predictive analytics, and significantly faster transmission speed, CSPs will need to enable open and agile service creation environments with a growing ecosystem of partners and service providers.

In the report, BT's Michael Sherman, Chief Strategy and Transformation Officer, explains that partnerships will be foundational to taking up enterprise opportunities.

During the first phase of an **ongoing TM Forum Catalyst proof of concept** looking at zero-touch partnering, Steve Ranford-Bragg, Principal Architect at BT, called partner onboarding "a painful process that discourages companies from working with telcos." Even with partnerships in place, changes to products or services could take the CSP nine months plus another nine for partners to integrate those changes into their support systems.

Several TM Forum collaboration projects are working on how to automate partnering, and in all cases the answer lies in using an architecture such as the **TM Forum Open Digital Architecture** (ODA) and **Open APIs** to expose capabilities to partners.

"We believe Open APIs and this zero-touch partnering approach is critical in rapidly reducing our time to market," said Dr. Lester Thomas, Chief Systems Architect, Vodafone Group, speaking during a **Digital Transformation World Series** session that highlighted several partnering Catalysts.

Read this report for more on zero-touch partnering:



Section 2

Business drivers for autonomous networks

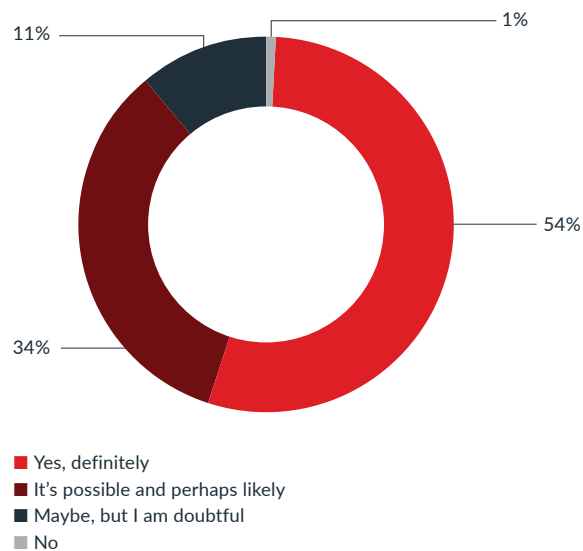
Communications service providers (CSPs) are beginning to think about autonomous networks (ANs) from a business perspective more than making the operation of their network more accurate and efficient. This section focuses on business drivers and concerns that CSPs are starting to address. They include expected AN timelines and tangible benefits, the barriers to realizing these benefits, and how organizational roles may change.

A big question for CSPs is how long it will take for networks to become fully autonomous. Over half of respondents to the survey conducted for this report are convinced their companies will deploy large-scale, fully autonomous networks run by AI within 10 years. Another third said it is at least possible the industry will get there in a decade, which overall is a big vote of confidence. (See **Section 5** for a discussion about the six levels of autonomous networks and what it means to be fully autonomous).

Not all CSPs expect to become fully autonomous, and each company with a strategic plan is plotting its own journey. Members of TM Forum's **Autonomous Networks & Operations Project** are working on architectures to facilitate AN and maturity models for measuring progress (we'll discuss this more in **Section 5** as well). There is no fixed path to a definitive end, however.

We also asked CSPs where they are today on their AN journeys, and where they expect to be in five years' time. We asked them to rate their progress on a scale of 0 to 100, and on average, CSPs that have embarked on their journeys feel that they are a little more than 40% toward their goals. This is due in part to the incremental automation CSPs have been building into operations over several years – before there was talk of autonomous networks.

Will CSPs deploy large-scale, fully autonomous networks run by AI within 10 years?



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The survey we conducted a year ago about automation and AI **found** that 63% of CSP respondents did not see a clear path to fully autonomous networks. Current survey respondents said they think they will be about two-thirds of the way to fully autonomous networks in five years.

This balances the optimism of some forward-thinking CTOs, especially those from greenfield operators such as Rakuten Group’s CTO, Tareq Amin. In February, **he said** Rakuten Mobile and perhaps the wider industry could achieve considerable advances towards AN within two years, adding that Rakuten was 55%-60% of the way into its journey.

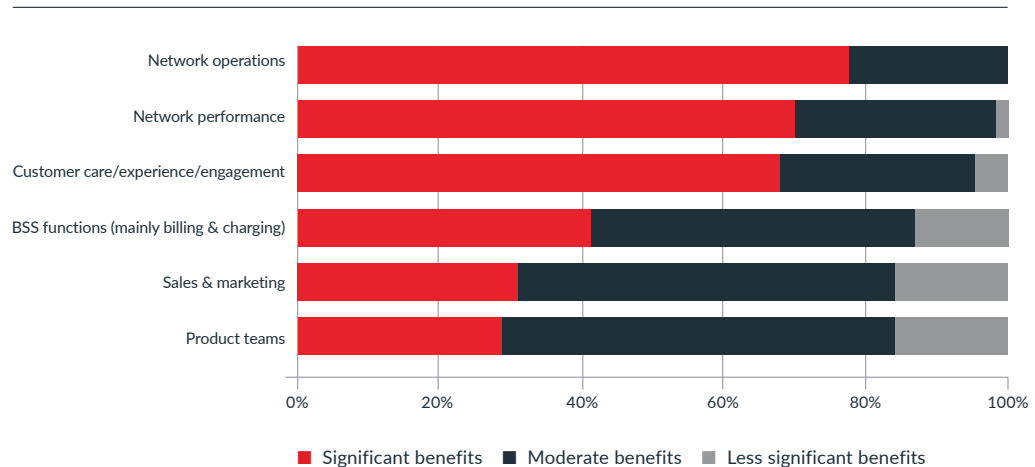
IT is important to the business

Improving network and IT capabilities may seem to be more about operations than business, but the CSPs we spoke with see clear business benefits to automating both the network and IT operations. They are keenly interested in the new services their product teams will be able to develop and bring to market with support functions that match the speed and latency of the emerging standalone 5G network.

After years of low expectations due to poor internet performance and spotty wireless service, network performance will again be a differentiator, especially for enterprise customers. The CSPs that can prevent outages and service degradation, guarantee performance, and provide visibility into performance will be winners.

BSS functionality is also expected to benefit from AN, allowing CSPs to monetize those capabilities. Charging and billing, as well as customer care systems, will be able to automatically apply relevant data about performance and customers from all areas of the business, meet service level agreements and assure customer experience.

Network & IT functions that will benefit from autonomous networks



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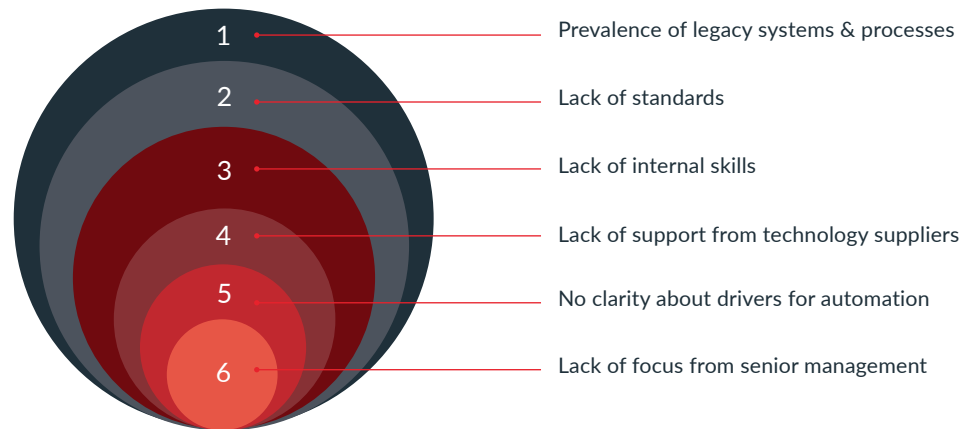
“ CSPs that can prevent outages and service degradation, guarantee performance, and provide visibility into performance will be winners.”

CSPs also say that automation will help sales and marketing teams position their companies as proactive and innovative, and sell services reflecting these capabilities. This corresponds with our survey from a year ago which showed that nearly 90% of CSPs felt the lack of automation was impacting their ability to deliver differentiated services – 43% said the impact was significant.

Standing in the way of progress

When it comes to the challenges to automation, the prevalence of legacy systems and processes tops the list, followed by a lack of standards. The graphic opposite shows how the issues rank. However, it's important to note that all six challenges were rated as very or moderately serious barriers by at least 70% of respondents. TM Forum members are developing the **Open Digital Architecture** and **Open APIs** specifically to address the legacy issue (see **page 14**).

Ranking the barriers to automation



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“ All six challenges to automation were rated as very or moderately serious barriers by at least 70% of respondents. ”

Addressing legacy systems with an open architecture

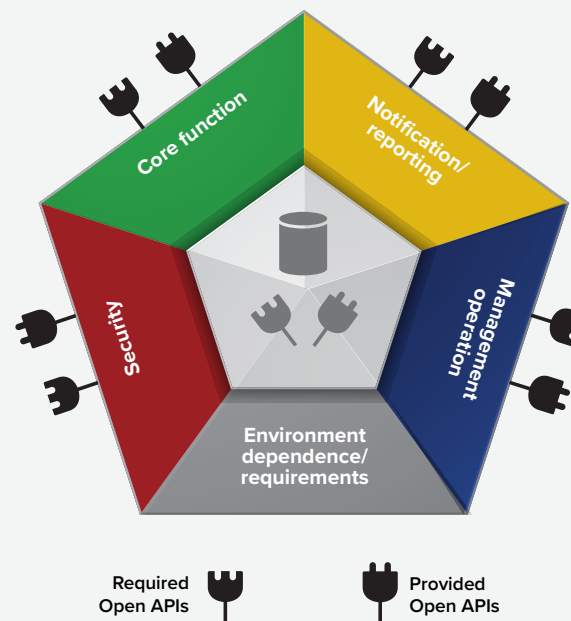
The **Open Digital Architecture**, part of the **Open Digital Framework** (see page 36), is a component-based approach, which enables CSPs to evolve to a fully automated, cloud native operations environment that relies on analytics and AI to deliver zero-touch services. The ODA defines standardized, interoperable software components organized into loosely coupled domains. These components expose business services through **Open APIs**, which are built on a common data model. Importantly, the ODA provides machine-readable assets and software code, including a reference implementation and test environment.

The ODA offers a blueprint for evolving from legacy support systems to applications that are cloud based and cloud native, but widespread agreement, collaboration and contribution among many CSPs and vendors is necessary to advance it.

A new ODA **Component Accelerator project** is developing a reference implementation that acts as the basis for testing commercial ODA components. It is a step toward the Forum's goal of developing a market for standardized and interoperable software components to run service provider businesses.

The graphic opposite illustrates an ODA component, which is an independently deployable piece of software, typically built out of one or more microservices. Components have an "envelope" that provides metadata to describe its core function and specify which Open APIs it exposes or depends upon.

The test platform's roots stem from one of TM Forum's award-winning **Catalyst** proofs of concept called **BOS – an implementation of ODA Core Commerce Management**, which implemented a business operating system that allows CSPs to focus on innovation instead of integration issues.



Read this report to learn more about ODA and Open APIs:



In addition to TM Forum members' collaborative efforts on AN, ODA and Open APIs, the organization is hoping to build a coalition of standards development organizations to work cohesively toward enabling ANs. In addition, the International Telecommunication Union (ITU) **has launched a new focus group** to support more efficient ICT networks through automation control. The ITU group says it will lead an exploratory 'pre-standardization' study to determine how ITU standards will support the realization of ANs and their evolution.

Focus on skills

CSPs believe lack of internal skills is a barrier to automation, signaling more organizational changes ahead as operators pivot to software-centric, data-oriented, AI-enabled network operations. Finding people with software skills in automation and AI is difficult because they are in demand everywhere, and CSPs are often perceived as culturally traditional and less desirable places to work than digital native companies.

Many jobs also will disappear as a result of widespread automation. The roles most likely to be affected are entry level such as data entry and customer service, with 54% of operators saying data entry jobs will be cut by more than 25%, and 36% saying customer service representatives will be reduced by the same amount.

But lower-skilled jobs are not the only ones that will be eliminated: Nearly 60% of CSPs said they believe network operations center (NOC) technicians will be reduced by up to 25%. Field technicians and sales engineers will suffer slightly fewer losses, but still feel the pain. Sales engineers are more likely to lose a greater number of jobs when intent-based networking is combined with automation to make it easier to

build and support solutions based on customers' expressed or implied needs. We will discuss skills and changing roles more in the next section.

Importance of leadership

Senior management's lack of focus is a slightly less significant barrier to advancing ANs. Only a quarter rated it as a very serious barrier, but nearly half said it is a moderately serious problem.

While it seems clear that automation across the business will yield positive results, ANs are part of wider digital transformation, which is fuzzier. In a recent survey about **connectivity-as-a-service (CaaS)**, we found that CSPs are close to exhaustion with transformation: More than a third of respondents said the biggest inhibitor to CaaS is that they are already pursuing too many complex projects. Respondents' concern about the lack of focus from the top in this survey makes sense.

Corporate leadership is not wholly to blame, however. Respondents also cite not getting the support they need from technology suppliers. This doesn't mean a lack of capabilities, but primarily being unable to extend those capabilities across all CSPs' domains and beyond – to customers and partners. Standards and open architectures should help with this.

In the next section we look at operational drivers for ANs.

Section 3

Operational drivers for autonomous networks

There are considerable operational challenges in the quest for autonomous networks (ANs). The necessary changes represent how leaders in operations plan to adapt to and meet the needs of increasingly automated and data-driven operations.

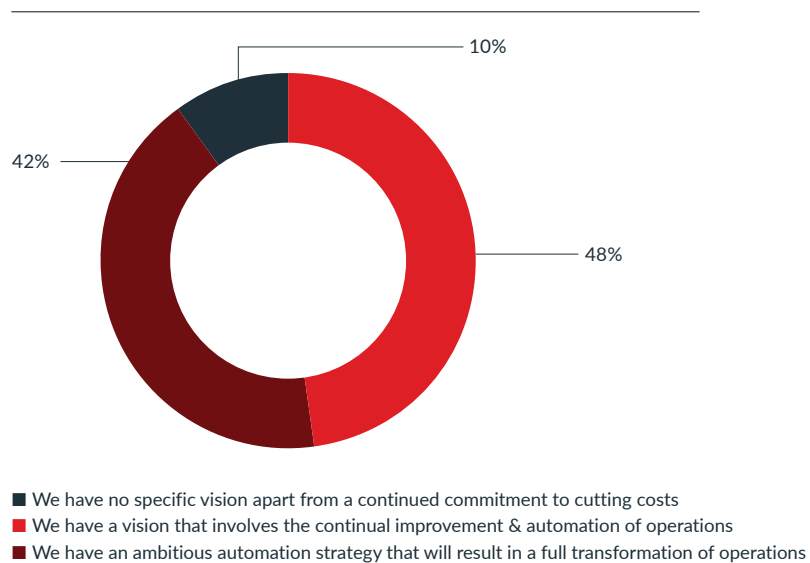
Four of the five main drivers of AN (delivering new services, getting to market faster, improving customer experience and zero-touch partnering) all have a business component in that they are about growing revenue. The fifth driver is about reducing costs through the operational drivers.

How to respond to the drivers has split communications service providers (CSPs). Nearly half of respondents to the survey conducted for this report chose continual improvement and automation of operations when asked about their visions for the future, while 43% said they have an ambitious automation strategy that they expect to result in a full transformation of operations. Another 10% are focusing on cutting costs.

In an interview ahead of the **FutureNet World event**, Ibrahim Gedeon, CTO of Canadian CSP TELUS, said about digitally transforming to become a digital service provider that if CSPs don't have the right network automation, they will be adding more teams because operating the network is becoming more complex. He added that with network automation, CSPs have more flexibility regarding the kinds of teams they put in place.

"Network automation should enable people to 'fake' multiple skill sets," Gedeon said. "So, instead of getting this expert and data experts and optical experts, I would like to have a general engineering person with the right tools so that they can become [expert]."

CSPs' visions for operations



TM Forum, 2021

He added that before cloud and network functions virtualization (NFV), network faults generally involved dealing with a single vendor. But now, he said, “I’m averaging three to eight vendors per issue.” Solving those issues needs automation.

Changing roles

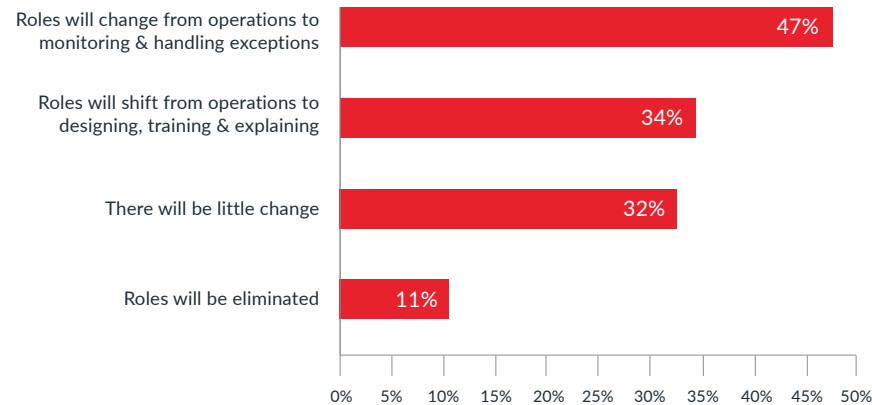
The biggest change for network operations personnel is that those who remain will shift from primary troubleshooters to monitoring and handling exceptions. In our survey, 47% of respondents said they consider this scenario highly likely in the era of ANs. If the promises of AI and machine learning come true, exceptions should steadily decrease over time.

About a third of CSPs think it highly likely that there will be little change in operations roles, which says more about CSPs’ perceived ability to adapt than about the change required: They don’t think CSPs can adapt.

Nearly 90% of respondents think it is reasonably or highly likely that many roles will change from hands-on operations to designing systems or training and explaining automated, AI-driven operations tools to humans. This is essential to maintain oversight, understanding and institutional knowledge of the processes at work so humans can step in as necessary.

The systems-design part of this equation poses a real challenge for CSPs. In our [2020 TM Forum survey about automation and AI](#), 82% of operator respondents said they did not have enough internal expertise to develop the insights necessary for automated decision-making and closed loop operations. Being able to explain decisions by AI algorithms and a loss of control over tracking changes in the network were among the top concerns about introducing AI into the process.

Changing roles in operations



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Operational change becomes increasingly hard when practices and processes appear to be working well enough. It is the old, “If it ain’t broke don’t fix it” mentality. But in the face of new competition, working well is not always well enough.

In a recent interview published on [TM Forum Inform](#), PCCW Global CTO Paul Gampe said that the most significant improvements his company has made through its ongoing transformation were in automation and the adoption of **Agile** practices. However, he added that, “the biggest challenge in this transformation was recreating the willingness and the desire to adopt new ways of working within a very successful company with a well-established operating model. When something works well there’s often no urgency for change, so part of the challenge was to create that desire to want to embrace new ways of working.”

Read the full interview with PCCW’s Gampe:



AIOps in autonomous networks

PCCW was part of a multi-operator group of champions for a TM Forum Catalyst proof of concept looking at how to introduce AI Ops into the AN plan. It sets the groundwork for getting to the point where the technologies begin to merge into hands-free operations.

China Telecom, China Mobile, China Unicom, KDDI Research, PCCW/Hong Kong Telecommunications (HKT), Smart Communications and Telefonica Deutschland collaborated on the **AI for IT & Network Operations project**. They created multiple AI-based use cases within IT and network operations around improving customer experience, service quality and efficiency by automating and optimizing CSPs' processes and services.

The AIOps Catalyst project implemented solid use cases based on AI algorithms covering vital operational needs, like predicting a decline in customer experience, correlating alarms and events, identifying potential faults, preventing customer complaints, planning infrastructure capacity, performing preventive maintenance and continuous service improvement.

Watch the video to learn more:



Time-consuming tasks

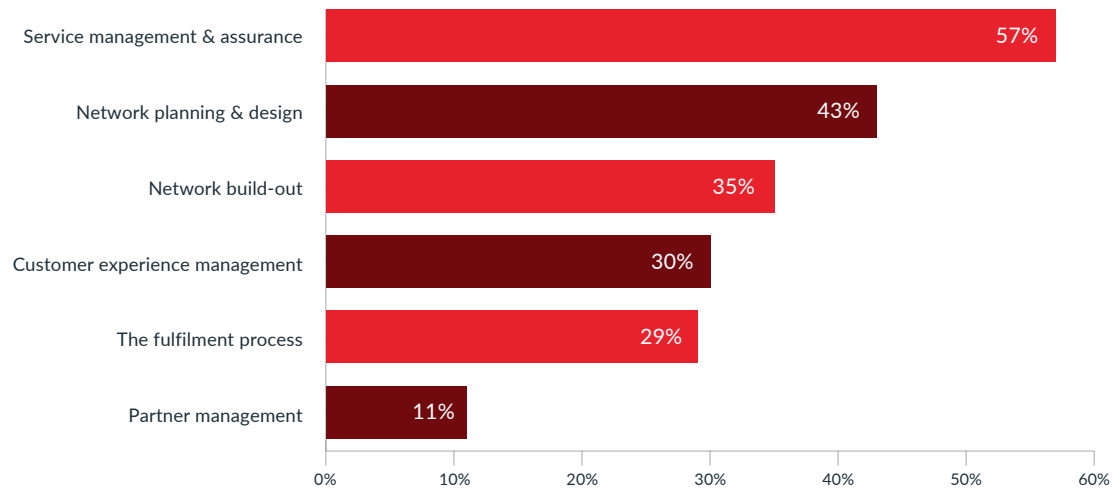
Such change begins with a hard look at where effort is being applied. More than half of respondents to our survey said they are spending the most time on automating repetitive tasks, such as re-keying common data into multiple forms and initiating system backups, to more complex but still repetitive standard device configuration, incident report distribution, testing, inventory updates and low-level parameter changes. About 25% said lifecycle related tasks are most time consuming, and 20% said closed loop tasks are.

Getting rid of repetitive tasks does not need a centralized or coordinated effort but is part of the overall AN strategy. However, this consumes human resources that could be better applied to an enterprise-wide drive toward AN.

Eliminating repetitive tasks is necessary and desirable, but does not automatically address the most urgent automation priorities for operations. There are bigger payoffs, for example, in automating service management and assurance than managing partners, at least for now, because their own house must be in order regarding automation before they can implement any type of zero-touch partnering arrangement.

Hence CSPs see service management and assurance as among the most urgent automation needs. The graphic on **page 20** shows the percentage of respondents who rated each option in their top two priorities.

Systems & processes most in need of automation



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Network planning and design also sits high on the list. As the result of a 2019 **Catalyst project**, BT was able to reduce the time it took to perform planning tasks by 70% through automation of its network planning and fulfillment processes, plus having a centralized plan that could leverage automation from adjacent functions. Note that these benefits and possible advantages were before 5G, cloud adoption, a virtualized core and broad AI adoption.

The third most urgent system in need of automation is the fulfillment process: Fulfillment and assurance are increasingly intertwined and will likely be automated as part of a unified effort. We'll discuss some of these issues more in the next section where we look at the intersection of 5G and AN.

“ BT was able to reduce the time it took to perform planning tasks by 70% through automation of its network planning and fulfillment processes. ”

Section 4

Looking ahead – Where 5G & autonomous networks meet

It was obvious from the start of 5G that the speed and scale of traffic and devices would require a new method of management and orchestration. However, network functions virtualization (NFV) had already started the push for autonomy. In their book, *Cognitive Autonomous Networks: Network Management Automation for 5G and Beyond*, Nokia Bell Labs engineers Stephen Mwanje and Christian Mannweiler, explain that the virtualization of network functions renders autonomy an absolute necessity. 5G reinforces this.

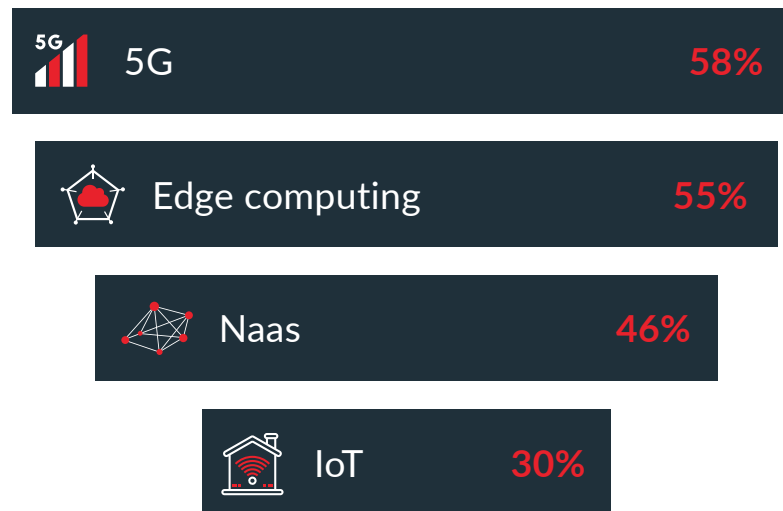
Mwanje and Mannweiler contend that achieving autonomy requires:

- Collection and aggregation of insight about network states and the proliferation of cognitive decision making for peripheral network operations functions
- Unified control and coordination of the automation system
- Abstraction of the network operations interface

We will look at each in more detail in this section and at the six levels of autonomous networks (ANs). They are applicable regardless of the technology supporting the network – whether it is any generation of wireless, wireline, cable or satellite.

In the survey conducted for this report, we asked communications service providers (CSPs) which network capabilities, or domains, will benefit the most from autonomous networks. The graphic opposite shows the percentage of respondents who chose the capability as No. 1 or 2. It is no surprise that 5G came out on top.

Network capabilities that benefit most from automation



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5G is the enabler of other domains, including IoT, edge computing and network-as-a-service (NaaS), although more accurately, 5G and AN are the joint enablers. In fact, 5G's extremely low latency through edge computing relies on autonomous service assurance and analytics being part of the package. **IDC projects** that by 2022 about 75% of all data will need analysis and action at the edge.

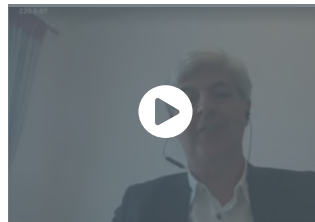
Automation is also an inherent characteristic of NaaS, with its primary role being to automatically configure network assets into a service. Operators such as Telstra, Vodafone, AT&T and Orange tested how to automate NaaS as part of a multi-phased Catalyst proof of concept called **Automating network as a service** which began in 2018. The team leveraged **the TM Forum Open Digital Architecture (ODA)** and **Open APIs** to expose network capabilities.

Since then, operators have made little progress with NaaS, even Telstra which has been a market leader and has invested substantially, says Johanne Mayer, Founder and Director at NaaS Compass. Mark Sanders, Group Owner of Shared Tech and Orchestration, Networks and IT at Telstra, confirmed that the company needed to take a more customer-centric approach by focusing on the entire service management layer, which it has done. AN architecture will be able to help NaaS complete the automation process.

More than 90% of survey respondents said they see a relationship between 5G and automation, with half characterizing automation as essential to 5G. Of those who see 5G and automation as separate initiatives, about 40% still say automation will contribute to 5G's success.

Autonomous networking and 5G were demonstrated in an award-winning 2020 Catalyst project called **5G Ride On!** It harnessed their joint capabilities to provide business continuity services for electric vehicle charging providers, through business and operational orchestration, in a severe weather scenario.

Watch a video about the
5G Ride On! Catalyst:



“ More than 90% of survey respondents said they see a relationship between 5G and automation, with half characterizing automation as essential to 5G. ”

Section 5

The six-level journey to autonomous networks

In a **2019 white paper**, members of TM Forum’s **Autonomous Networks Project** laid out six levels of automation that range from manual operations and maintenance to fully autonomous networks (ANs). This is to help communications service providers (CSPs) assess their level of maturity and show how they can progress step by step, with each level building on the capabilities outlined in the previous one. Defining what happens at each level makes the concept more concrete so that operators understand when to take the next step. It is unclear whether the highest level of autonomy will be possible or necessary for all companies.

The graphic opposite describes the six levels. While no CSP still operates at Level 1, the climb gets increasingly steep, especially as AI is introduced.

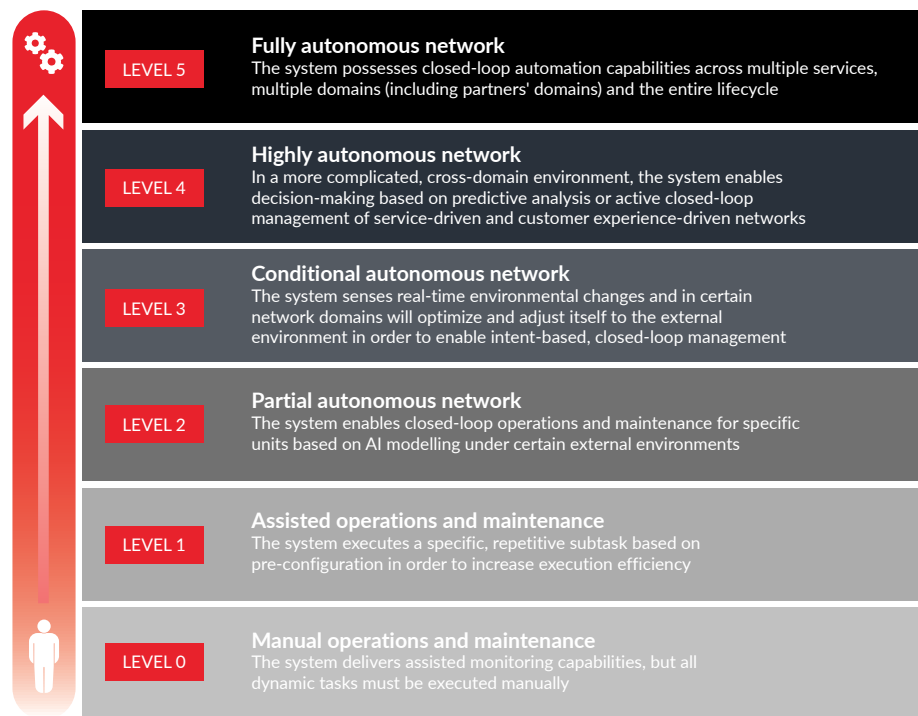
In our **2020 survey about automation**, most CSP respondents said their companies had achieved Level 1 automation or had a clear path to getting to Level 2 within two years. A year later and despite a pandemic that has threatened productivity for all companies, many of the CSPs we interviewed said they have made progress and are contemplating Level 3.

The quest for Level 3

Roadblocks remain, however, in the push for autonomy in network and operations. When asked in the 2020 survey what barriers were in the way of advancing to Level 3, CSPs stressed the same obstacles to automation discussed throughout this report. They also cited the lack of good enough quality data as another significant challenge.

CSPs say they cannot leverage data in a timely fashion through analytics and data sharing, in part because of their suppliers. Nearly 70% of CSP respondents to the survey conducted for this report said that lack of solutions is either a moderate or major barrier, with the inability to manage data across domains as the most glaring issue.

The path to fully autonomous networks



TM Forum, 2021

During interviews, some CSPs said that too few suppliers use **TM Forum Open APIs**, which results in poor integration and data sharing.

Suppliers counter that CSPs are not demanding Open APIs in their requests for proposal (RFPs) and would support them if they did. In fact, 68% of suppliers that have adopted Open APIs did so because their CSP customers demanded it, according to a survey conducted late last year for our January 2021 report *How to lead in the Open API economy*. Only 24% of requests for information and RFPs explicitly require Open API support, while 59% require them some of the time.

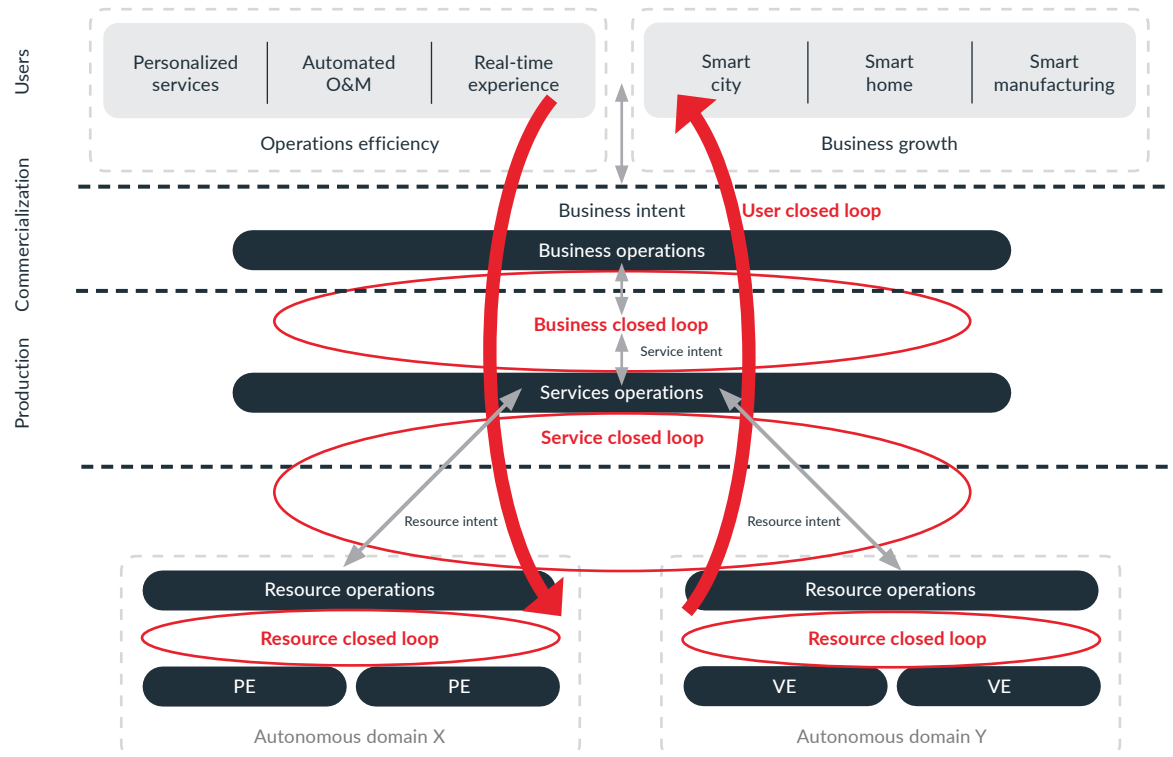
Whereas Level 2 enables closed loop operations for specific units, or domains, Level 3 begins to self-optimize and self-adjust not only to the external environment but also based on the intended performance of the network. This requires more data from more sources, some external to the operator's domain.

What's next?

As operators look ahead, it is clear that they need to prioritize autonomous domains and bring as many to Level 3 as soon as possible. In a second **AN white paper** published in October 2020, TM Forum members provided a roadmap for adopting ANs. They are creating an industry-standard framework which is driven by use cases that are based on autonomous domains and intent-driven interactions.

Autonomous domains serve as the basic unit for fulfilling closed loop automation of the lifecycles of specific network operations. Examples of AN domain instances include closed loops for access, metro backbone, core, edge, customer network, SD-WAN, VoLTE and content delivery networks.

Layers and closed loops of autonomous networks



TM Forum, 2021

The AN framework identifies three layers and four closed loops to deliver ANs. The three layers are common capabilities of operations that can be used to support all scenarios and business needs.



Business operations layer – supports customer, ecosystem, and partner business enablement and operations



Service operations layer – supports network planning, design, rollout, provisioning, assurance and optimization operations across multiple autonomous domains



Resource operations layer – supports automation of network resources and capabilities in each autonomous domain level



Business closed loop – enables the interaction between business and service operations layers for the business-service lifecycle



Service closed loop – enables interaction between service and network resource operations layers for the service-resource lifecycle

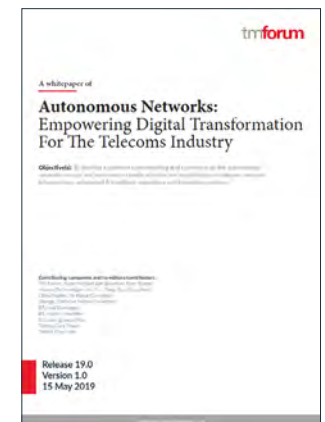


Resource closed loop – enables the interaction of network resource operations at a granular level of autonomous domains



User closed loop – enables the interaction across three layers and three closed loops for the end-to-end lifecycle of user services

Read the AN team's white papers:



“ One of the main challenges CSPs are facing is how to govern multiple instances of AI that will be deployed in their networks and operations environments. ”

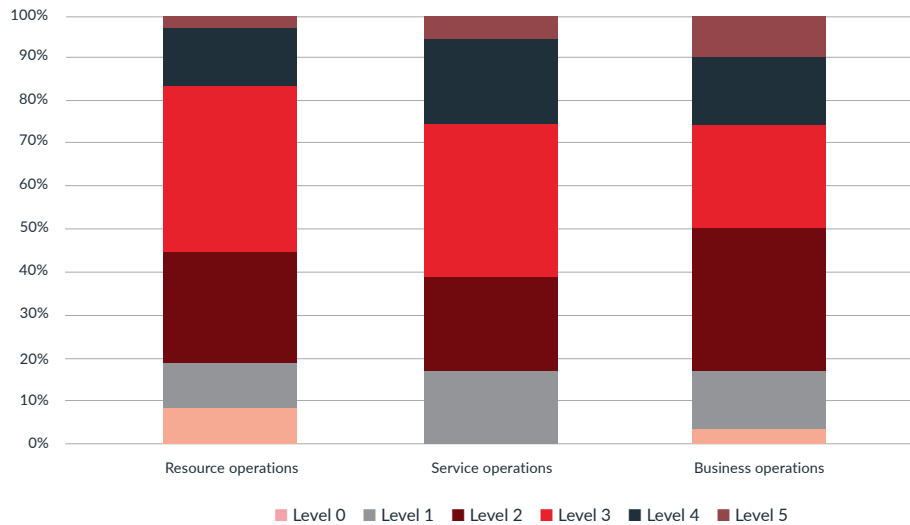
In our survey, we asked CSPs which levels of autonomous networking capability they hope to introduce into the business, service and resource operations layers during the next three years. The highest percentage believe they can introduce Level 3 automation in the resource and service operations layers, but a significant percentage also believe they can achieve Level 4 in all three layers.

Given the advances made in predictive analytics, the breaking down of silos that comes with open architectures, and increases in software-defined networking, there is reason for optimism that CSPs can reach Level 3 automation in multiple domains within three years. However, it may be a struggle to reach Level 4.

Some internal domains will still be driven in part by legacy systems that may be difficult to automate. In addition, extending automation into partners' domains will pose both technical and business challenges and may take longer than three years.

Finally, as CSPs move up the levels of autonomous networks, AI is required. One of the main challenges they are facing is how to govern multiple instances of AI that will be deployed in their networks and operations environments. As noted, TM Forum members are working on the [AIOps Service Management Framework](#) to help with this.

Levels of automation CSPs expect to introduce in the next 3 years



To move to Level 4, CSPs need to be able to govern AI

Introducing AI models into operations makes the production environment dynamic. Unlike traditional software, AI can reason, learn and evolve autonomously when exposed to new input data. AI models tend to be “black-boxes”, and they can be fragile, exposed to bias and are nondeterministic by nature.

Typical governance includes management of strategy, quality, risk, security, compliance and other processes, but AIOps adds new ones, such as bias management, which may be necessary to govern sensitive AI models and address “black box” concerns among CSPs. The TM Forum AIOps Service Management Framework aims to re-engineer the processes in the software lifecycle and service operations management to govern AI software at scale. This will enable operations teams, process owners and business users to exploit AI safely. The idea is to mitigate risks and ensure the appropriate level of network and service quality.

Because of the way it has been designed, the AIOps Service Management Framework is applicable to any type of architecture, and it can operate as an independent process framework to help CSPs manage the deployment of AI into their current and target architectures. Using the framework, CSPs can:

- Redesign software deployment processes to release and commit AI software and components to production
- Redesign production processes to operate and maintain AI-based systems
- Redesign operations governance processes to govern AI-based systems
- Deal with fast changes coming from Development (Dev) to Operations (Ops) and from Ops to Dev for both offline and online models
- Integrate effective AI data operations and training practices for machine learning

To find out how you can get involved in TM Forum’s work on autonomous networks and AI governance, please contact **Aaron Boasman-Patel**.

To learn more, read this research report and white paper:



Section 6

Make it happen – Strategies for implementing autonomous networks

Meaningful automation across a communications service provider's (CSP's) business requires commitment at all levels including from executive leadership. Directors of each domain (business, network and operations) must formulate and communicate a clear strategy for moving forward – and communicate with directors of other domains to ensure compatibility. Managers of groups within domains must provide the people, tools, training, practices and processes to make it happen. As Donald P. Coduto, Professor of Geotechnical Engineering at California State Polytechnic University, said of complex engineering challenges: “The most important thing is to keep the most important thing the most important thing.” Autonomous networks (ANs) are the most important thing. They will improve every other function and process across the business. Following are strategies for keeping automation on track:



Move beyond pragmatism

Many of the capabilities CSPs need to lead in the digital economy involve seamless automation. Many operators are taking a pragmatic approach to automating individual domains but lack an integrated plan for building ANs. Given the extended timelines identified in this report, pragmatism needs to be replaced by greater ambition.



Deal with legacy systems

The drag of legacy systems is still the biggest challenge for CSPs that want to automate their networks and operations. The **TM Forum Open Digital Architecture** and **Open APIs** offer a component-based approach that can help operators evolve incrementally to a fully automated, cloud native operations environment that relies on analytics and AI to deliver zero-touch services. To learn more, please contact **Ian Turkington**.



Accelerate merger of fulfillment & assurance

Data is a barrier to Level 3 automation. Accessing it is difficult and it typically has limited efficacy because it is not derived from end-to-end systems or easily shared. CSPs could reduce the burden by leveraging AN to merge fulfillment and assurance systems which is already underway. This would make automated service lifecycle management easier and more accurate.



Drive business-oriented data output

As TELUS CTO Ibrahim Gedeon noted in **Section 3**, CSPs must create a situation through AI and automation that allows them to rely on more well-rounded engineers to tackle a wide range of functions rather than needing specialists for each. Part of enabling this is to focus on the output of intelligent systems. Creating business-oriented outputs that are comprehensible to people in any domain is important for maximizing AI as well as automation for the good of the business.



Move on from repetitive tasks

It is important to eliminate the redundancy of manually performing data input, device configuration, inventory updates, testing and other repetitive tasks, but CSPs are still spending more than half of their time on this activity. They need to quickly apply whatever resources are necessary to get this done faster and move on to intelligent automation.



Emphasize zero-touch partnering

Zero-touch partnering is becoming integral to many initiatives such as edge computing, network-as-a-service, connectivity-as-a-service and IoT. Automation of partnering ties directly to delivery of new services and faster time to market, and is necessary for end-to-end management. Several TM Forum projects are working on how to automate partnering, and in all cases the answer lies in using Open APIs to expose capabilities to partners.



Join a collaboration group

Consider contributing to the direction and advancement of autonomous networking by joining a standards organization or collaboration community. **TM Forum's Autonomous Networks & Operations Project**, the **ITU's Focus Group on Autonomous Networks** and **ETSI's Zero Touch Network** are all developing standards and best practices to help CSPs evolve to ANs. To learn more about how you can get involved in TM Forum's work on automation, please contact **Aaron Boasman-Patel**.

“ Automation of partnering ties directly to delivery of new services and faster time to market, and is necessary for end-to-end management. ”

Collaboration on Autonomous Networks enabling the digital transformation of Telecom and vertical industries



Digital transformation is becoming the main trend of every industry, from the launch of 5G in the telecommunications industry to the development of autonomous vehicles, the creation of smart services within cities, the trialing of smart health services, the drive for industrial automation to support smart manufacturing, to the exploitation of low latency and high bandwidth for cloud-based gaming services.

With every industry striving to transform their business process and management operations into a more agile, flexible, and collaborative mode through automation and intelligence across all domains, the foundation of enabling automation and intelligence is how to

provide easy-to-use, automated, and quick responsive information processing capabilities AKA fully automated intelligent ICT/Network services that include connectivity service but also beyond-connectivity services from e2e perspectives, i.e., end-to-end closed loop of information/data collection, distribution, analysis, decision and operations in the context of the production and services of SPs, which is named as Autonomous Networks.

Autonomous Networks aims to simplify and automate the use and management of ICT services and infrastructure through cutting edge technologies – 5G, AI & Big Data, Edge & Cloud Computing, Virtualization, etc., which provide Self-X (self-serving, self-fulfilling, self-assuring)

operations that are based on automated, intelligent, agile operations and simplified infrastructure for improving operational efficiency and increasing revenue growth. The ultimate goal of the Autonomous Networks is to “leave the simplicity (of usage of network/ICT services) to the users and keep the complexity (of the implementation of underlying infrastructure) to the providers” while helping the CSPs to improve the operational efficiency and support business innovation through a more agile approach.

The telecommunications industry and many vertical industries view Autonomous Networks as a key capability to deliver innovative solutions and easy-to-use dynamic, customized network/ICT services that enable digital transformation. CSPs did strategic planning and published white papers[13] and campaign PoC projects[12], focusing on how Autonomous Networks can help in various aspect of their business and starting from the key areas: alarm aggregation, 5G network optimization, energy efficiency, optical network troubleshooting, throughput optimization, VoLTE packet loss, 5G RAN self-configuration, and anomaly detection, as well as enabling disruptive digital services for verticals, e.g., smart cities. Vendors are developing strategies and solutions to evolve product offering toward Autonomous Networks [7][11][15]. The industry analyst firms also spot the trend and publish research reports to highlight the need for Autonomous Networks [8] [9] and state the timing is now to build Autonomous Networks [10].

Collaboration on Autonomous Networks enabling the digital transformation of Telecom and vertical industries



The survey conducted by TMF Research in this report indicates that lack of standards and lack of industry collaboration are among the significant barriers to realizing AN (see Page 13). Several Standards Defining Organizations (SDO) already started to conduct studies towards the standardizations on Autonomous Networks for their domains of interest. For instance, TM Forum has established an official Autonomous Network Project (ANP) and published several whitepapers and documents addressing the vision, business requirements and overarching framework, and basic concepts and capabilities related to Autonomous Networks Levels, etc. [1][2][3][4] and make the Autonomous Networks as one of the main strategies highlighted in the annual conference – DTWS 2020[16]. GSMA published a whitepaper to explore the use cases of network automation [5]. ETSI also published a whitepaper [6].

Multiple groups working on the relevant topics, e.g., ZSM is focusing on closed-loop automation [17], 3GPP is focusing on Rel-17 normative work of autonomous network levels and related standard interfaces to support network automation capabilities [19], ENI focusing on applying the AI capabilities to network automation [18].

Meanwhile, the industry-standard bodies fully realize that AN is too big an undertaking for any single standard organization to tackle; collaboration is a must. The industry has recognized that the challenge of E2E issues across Autonomous Network domains needs collective and urgent attention. Moreover, the range of skills and domain knowledge required is beyond the capability of any single organization.

Recently a cross SDO collaborative Autonomous Networks industry workshop was convened by TM Forum with representatives from 3GPP, ETSI, GSMA, NGMN, ITU, CCSA, IEEE, TM Forum and Linux Foundation Networking, which shared their related activities and results and their thoughts on common areas where joint industry action would be beneficial, and agreed to continue this collaboration to formulate the industry consensus and commonality on key concepts, framework, use cases, capabilities, and interfaces of Autonomous Networks.

In a nutshell, Autonomous Networks are looming as the evolution of the Telecom/ICT industry towards more automated and intelligent operations, which will enable the digital transformation of other sectors with simplified and easy-to-use network/ICT infrastructure, capabilities, and services. Industry-level collaboration is essential to the success of Autonomous Networks for digital transformation. In this survey, CSPs show certain degrees of confidence that they can reach Level 3 in the next three years, starting from resource and service operations then business operations (see Page 27). There is no surprise here because higher layer closed-loops depend on the realization of lower layer's closed-loops.

Thus, a pragmatic approach to realize AN is to start with simplifying business and network relationship with autonomous domains, then up to service and to business layers, i.e., a bottom-up approach to realize AN, scenarios by scenarios, layers by layers. Meanwhile a top-down approach to formulate the holistic AN vision and plan based on the business strategies and operations demands.

In the past two years, Futurewei has been working extensively with the SDOs, CSPs, vendors, industry analysts and academia to define the AN vision, business/operation drivers, overall framework, use cases and technology capabilities. Futurewei commits to continue the collaboration with industry partners to evangelize and realize the AN vision and ecosystem.

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“ The industry is actively collaborating on Autonomous Networks ecosystem and standardization. ”

TM Forum Open Digital Framework

A blueprint for intelligent operations fit for the 5G era

The TM Forum **Open Digital Framework** provides a migration path from legacy IT systems and processes to modular, cloud native software orchestrated using AI. The framework comprises tools, code, knowledge and standards (machine-readable assets, not just documents). It is delivering business value for TM Forum members today, accelerating concept-to-cash, eliminating IT and network costs, and enhancing digital customer experience. Developed by TM Forum members through our **Collaboration Community** and **Catalyst proofs of concept** and building on TM Forum's established standards, the Open Digital Framework is being used by leading service providers and software companies worldwide.

Core elements of the Open Digital Framework

The framework comprises TM Forum's **Open Digital Architecture** (ODA), together with tools, models and data that guide the transformation to ODA from legacy IT systems and operations.

Open Digital Architecture

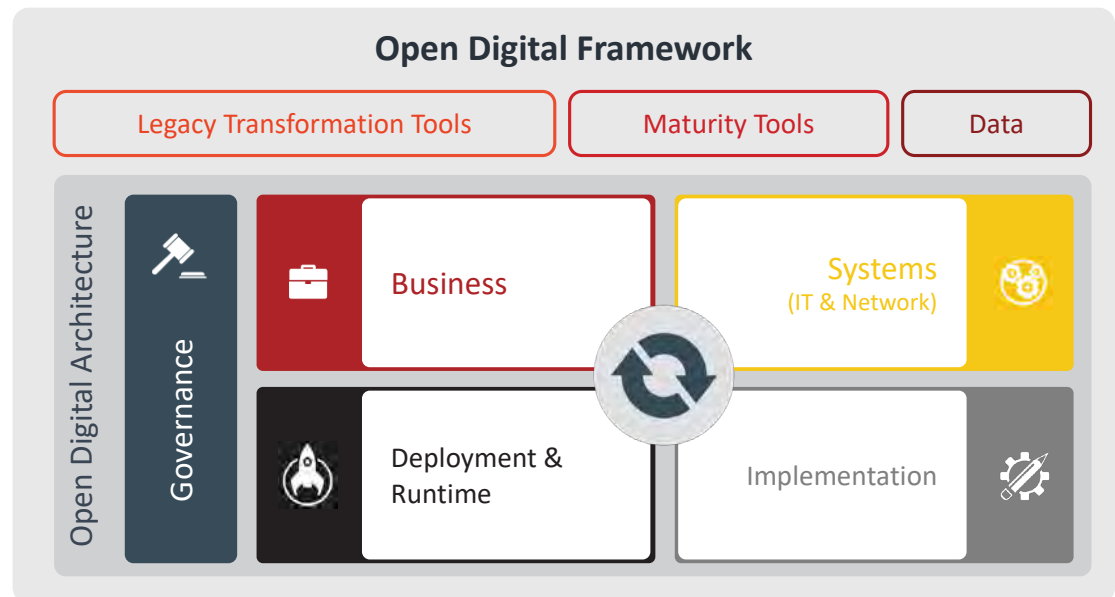
- Architecture framework, common language and design principles
- **Open APIs** exposing business services
- Standardized software components
- Reference implementation and test environment

Transformation tools

- Guides to navigate digital transformation
- Tools to support the migration from legacy architecture to ODA

Maturity tools & data

- Maturity models and readiness checks to baseline digital capabilities
- Data for benchmarking progress and training AI



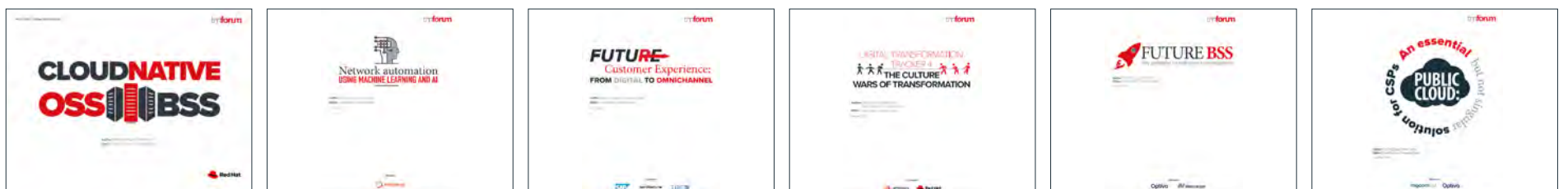
Goals of the Open Digital Framework

The Open Digital Framework aims to transform business agility (accelerating concept-to-cash from **18 months to 18 days**), enable simpler IT solutions that are easier and cheaper to deploy, integrate and upgrade, and to establish a standardized software model and market which benefits all parties (service providers, vendors and systems integrators).

Learn more about collaboration

If you would like to learn more about the project or how to get involved in the TM Forum Collaboration Community, please contact **George Glass**.

TM Forum Research Reports



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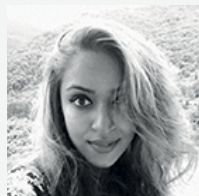
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