



Executive Briefing

END-TO-END NETWORK AUTOMATION: WHY AND HOW TO DO IT

True E2E automation has not yet been achieved, but network automation is a reality now, and one which telcos must master to survive. What steps are telcos taking to implement network automation, what challenges must be overcome and what benefits can be expected?



Executive Summary

End-to-end network automation

- In this report we'll explore the opportunities, ambitions and challenges for operators grappling with end-to-end network (E2E) automation. We define E2E as referring to the lifecycle of a network, encompassing automation across network planning, innovation, provisioning, optimisation, orchestration and security.
- The interview programme with operators on which this research is based was concluded before the full impact of COVID-19 was clear. However, it is more relevant than ever now to evaluate how automation can make networks more resilient, especially in times where human intervention may need to be limited.

A key opportunity: 6 reasons to focus on network automation now

- There are six key reasons why operators should see network automation as a key opportunity for them today:
 - **Only with automation can operators deliver the degree of agility that customers will demand.** Customers today expect the kind of speed, accuracy and flexibility of service that can only be achieved in a cost-effective manner with high degrees of network automation.
 - **Telcos must automate to prove their pedigree to potential customers, and inspire trust that they can provide more than just connectivity.** External partners have an expectation that telcos are highly skilled at handling data and are highly automated, particularly within the network domain, which is perceived to be their core capability. These partners will only view operators as able to support them with services above and beyond pure connectivity, if investment in these core internal processes have also been achieved.
 - **Automation can free up resource for service innovation.** If operators are going to do more, and play a role beyond connectivity, they need to invest in service innovation. In order to do this, operators need to reallocate resources from other areas of their business. Reducing operating costs is a key way that operators can enable increased investment in innovation – and automation is a key way to achieve this.
 - **5G won't fulfil its potential without automation.** 5G standards mean that automation is built into the design from the bottom up. Most operators believe that 5G will essentially not be possible without being highly automated, particularly when considering next generation network services such as dynamic network slicing.
 - **Intent-based network automation is a maturing domain.** Newer technologies, like artificial intelligence and machine learning, are increasing the capabilities of automation. With the increased use of AI and ML, operators can move from automation 'that augments what

humans do, allowing them to do it faster and more accurately', to automation to achieve outcomes which could not be achieved manually.

- **Network function virtualisation is increasing automation possibilities.** As networks are increasingly virtualised, and network functions become software, operators will be afforded a greater ability than ever before to automate management, maintenance and orchestration of network services.
- For some operators, it's their guiding star, for others, it's unclear whether E2E automation is an achievable goal. For all, there is agreement that the network must be increasingly automated.

Key recommendations for operators to drive their network automation journey

- In order to accelerate their automation journeys, operators should:
 - **Have a clear people, culture and change management vision.** For operators that have a network automation roadmap, the focus is invariably on technical implementation or requirements of specific use cases being pursued. When asked about how the role of network engineers and network ops teams will change with increasing automation or how many people will be required to support network operations in 5 years' time, answers were usually less clear. Considering the vital importance of the right people and culture to successful automation, operators must define clearly for their employees how their job roles will evolve as automation is implemented.
 - **Build automation into products and services from inception.** Previously, operators have often taken the viewpoint of getting a service up and running and then automating in order to scale it. To reap the full rewards of network automation in a 5G era, this approach will not be helpful. While most (mobile) operators agree that 5G will be a key opportunity to increase their network automation capabilities, there is less clarity around exactly how this will happen. Not in the least because 5G will be phased, and in most cases will require a 4G underlay for some time. For operators to use 5G as a springboard to E2E automation, investment and strategy must be formulated now, so that automation can be in-built from the beginning.
 - **Ensure cross-team collaboration so common goals and issues around standards, orchestration, and management are dealt with coherently and cohesively.** In particular, collaboration between those responsible for NFVI deployments and those responsible for 5G rollout need to collaborate on their automation efforts. Doing this will ensure that new technology is designed with automation in mind, as well as ensuring that automation use cases are "future-proofed" rather than driving efficiencies with soon to be retired legacy equipment.
 - **Embrace closed-loop automation.** By this, we really mean automating the decision-making and execution process. For most operators, live network automation is primarily rules-based,

determined and overseen by a human. In order to transform networks to the self-optimising, self-healing vision operators have, decision-making processes will need to be automated too. This means moving from automated recommendations that need to be actioned by a human, to closed-loop automation responses. In order to be comfortable with this, operators will likely need to establish clear governance (testing, peer review, etc.) to ensure that there is clear accountability even for decisions that have not been directly made by a human.

There are challenges operators need to overcome

- Despite the promise of network automation, and the fact that operators have been pursuing it for more than one hundred years, in many cases operators are still far from achieving “end-to-end network automation”.
- The challenges to achieving this can broadly be split into three groups:
 - **Strategic challenges around coordination and prioritisation of use cases.** Building a joined-up network automation strategy is challenging. A lot of the time, decisions about prioritisation are dealt with in a fragmented manner by different teams. Each have their own priorities. While this enables opportunistic decision-making that enables relatively quick decisions about investing in automation use cases, it also leads operators to have increasingly fragmented initiatives, preventing sharing of tools, resources, best practices and learnings. It also increases the likelihood of several overlapping solutions from vendors, with no one clear management and orchestration system. This presents real challenges to achieving E2E automation.
 - **Technical challenges to implementation.** Operators face challenges around creating the right, secure environment for automation, and settling on common toolsets and approaches. One example is how operators navigate their data lake strategy. Technical challenges can range from:
 - Being unable to extract the necessary data for automation in real-time, particularly from legacy systems.
 - Data being in a non-standardised format and sometimes even requiring manual clean-up before it can be used.
 - Ensuring security of data lakes, including creating clear permissioning around which individuals or applications can have access to which types of data and in what format.
 - Ascertaining when it is appropriate for data to be stored in one unified data lake versus where different types of information need to be stored separately.
 - **Cultural and organisational challenges to automation.** In terms of people and culture, we heard from operators that automation can help with employee retention and experience – by removing the tediousness of repetitive tasks and reassigning employees to focus on more complex issues (see Figure 6). This can enable employees to focus on long term progress

rather than one-off solutions to immediate, pressing problems. But, for this to be the case, the right culture and communication of efforts must be achieved. The perception of automation within the workforce is often still one of fear or distrust that the ultimate purpose is to cut jobs.

This paper explores a range of network automation use cases

- A (non-exhaustive) list of some of the use cases discussed with operators and explored in more detail in the report is below.

Operator type (Used throughout the report to anonymise interviewees)	Automation use case description	Maturity of use case
Wholesale arm of European operator	Automated inventory management system for fixed infrastructure assets	About to launch
Western European single country operator	Automated DDOS mitigation and response	Live in networks – automated actions newly implemented
North American single country operator	Automated provisioning of new virtualised EPC gateway	Live in networks – provisioning and testing automated, go-live decision still manual
Western European single country operator	Automated reconfiguration of RAN for optimisation (within set radio parameters)	Live
EMEA multi-national group	Planning of RAN including predicting cell loading and power requirements of new sites	Live (relies on both automation and machine learning technology)
European / APAC Group Operator	Automatic triggering of replacement of batteries at base stations based on indicators highlighting when battery is low	Live
APAC single country operator	Alarms trigger automated reset of device before sending instruction to nearest field technician	Live

North American single country operator	Forecasting usage of more than 180,000 product sets	Live (relies on both automation and machine learning technology)
APAC single country operator	Workforce management system for job orders (automatic allocation of trouble ticket with nearby field team member)	Live for 3-4 years, now have almost 100% adoption across field teams

STL Partners: Next steps

- This report focuses on the opportunities and challenges in network automation.
- In the future, we will also look to more deeply evaluate the implications of network automation for governments and regulators, a key stakeholder within this ecosystem.

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Automation, analytics and AI: A3 unlocks value for operators

STL Partners has been writing about automation, artificial intelligence (AI) and data analytics for several years.¹ While the three have overlapping capabilities and often a single use case will rely upon a combination, they are also distinct in their technical outcomes.

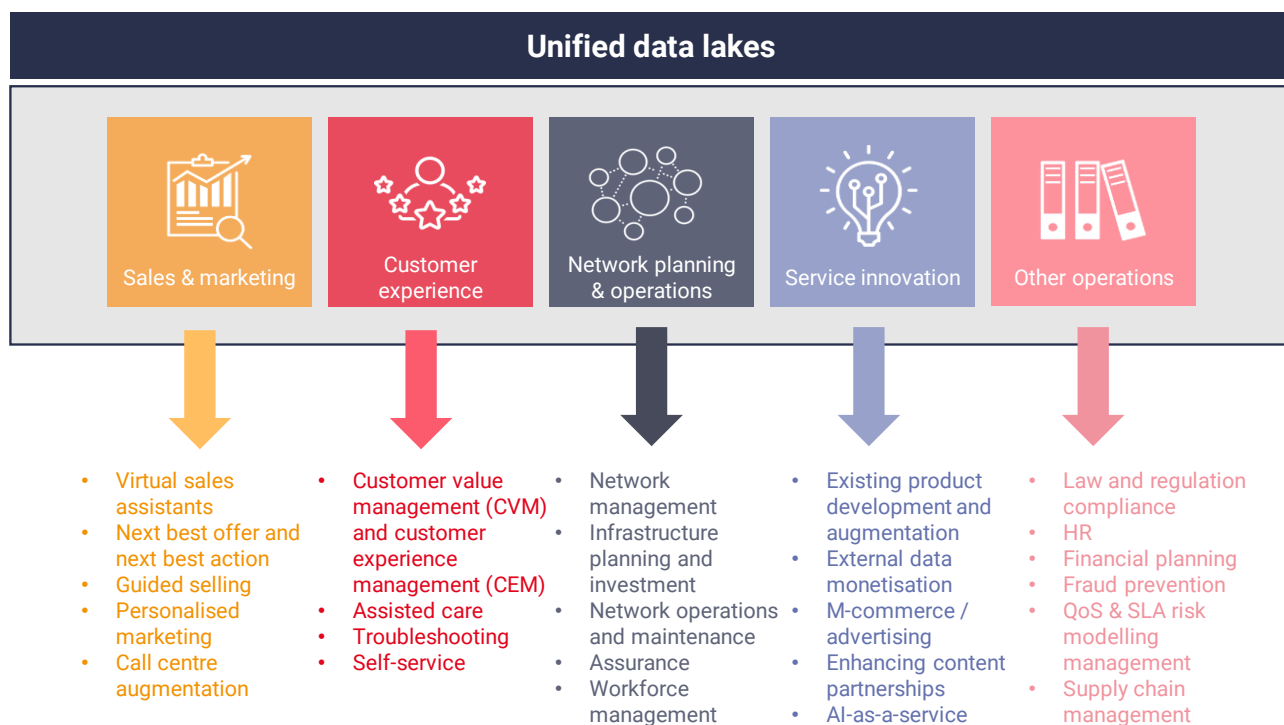
Figure 1: The three As, while interconnected, are defined differently

Automation	Doing with machines something that previously required human input or assistance.
Artificial intelligence	Using computing capabilities in order to perform activities traditionally associated with the human brain: thinking, planning, predicting, learning etc.
Data analytics	Collecting and analysing data to drive better decision-making.

Source: STL Partners

Operators have been heavily investing in A3 use cases for several years and are making significant progress. Efforts can be broadly broken down into five different domains (see Figure 2). Some of these domains, such as sales and marketing and customer experience, are more mature, with significant numbers of use cases moving beyond R&D and PoCs into live, scaled deployments. In comparison, other domains, like service innovation, are typically less mature, despite the potential new revenue opportunities attached to them.

¹ See, for example, [Telecoms data analytics: Where's the real value?](#) and [Telco AI: How to organise and partner for maximum success](#)

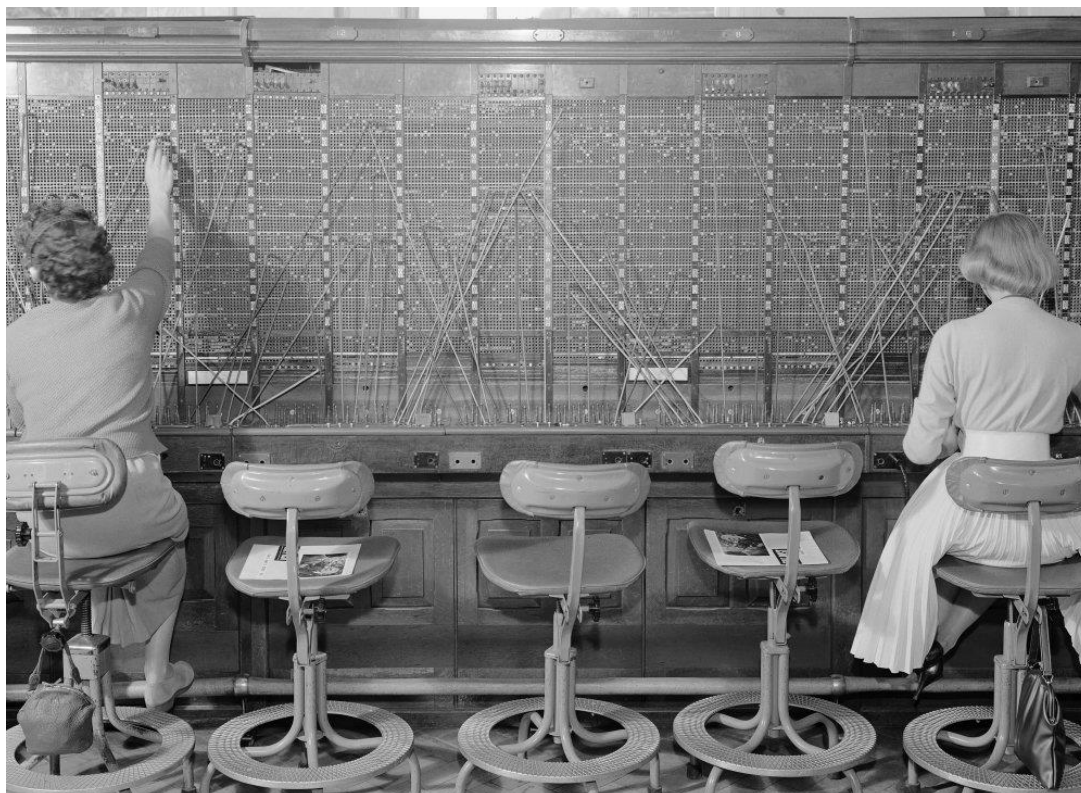
Figure 2: There are A3 use cases across every key telco domain

Source: STL Partners

Use cases often overlap across domains. For example, a Western European operator has implemented an advanced analytics platform that monitors network performance, and outputs a unique KPI that, at a per subscriber level, indicates the customer experience of the network. This can be used to trigger an automated email or SMS to customers who are experiencing issues with their network performance (which might include an offer for free mobile hotspot until issues are sorted). In this way, it spans both customer experience and network operations. For the purpose of this paper, however, we will primarily focus on **automation use cases in the network domain**.

The time is ripe for network automation now

Network automation is not new. In fact, it's been a core part of operator's network capabilities since Almon Strowger invented the Strowger switch (in 1889), automating the process of the telephone exchange. Anecdotally, Strowger (an undertaker by profession) came up with this invention because the wife of a rival funeral parlour owner, working at the local community switchboard, was redirecting customers calling for Strowger to her own husband's business.

Figure 3: Manual switchboard operators at Enfield telephone exchange, 1960Source: [Science Museum](#)

Early advertising called the Strowger switch the "girl-less, cuss-less, out-of-order-less, wait-less telephone" or, in other words, free from human error and faster than the manual switchboard system. While this example is more than 100 years old, many of the benefits of automation that it achieved are still true today; **automation can provide operators with the ability to deliver services on-demand, without the wait, and free from human error.**

Despite automation not being a new phenomenon, STL Partners has identified six key reasons why network automation is something operators should prioritise now:

1. **Only with automation can operators deliver the degree of agility that customers will demand.** Customers today expect the kind of speed, accuracy and flexibility of service that can only be achieved in a cost-effective manner with high degrees of network automation. This can be both consumer customers (e.g. for next generation network services like VR/AR applications, gaming, high-definition video streaming etc.) or enterprise customers (e.g. for creating a network slice that is spun up for a weekend for a specific big event). With networks becoming increasingly customised, operators must automate their systems (across both OSS and BSS) to ensure that they can deliver these services without a drastic increase in their operating costs.

One wholesale operator exemplified this shift in expectations when describing their customers, which included several of the big technology companies including Amazon and

Google: “They have a pace in their business that is really high and for us to keep up with their requirements and at the same time beat all our competitors we just need to be more automated”. They stated that while other customers may be more flexible and understand that initiating a new service takes time, the “Big 5” expect services in hours rather than days and weeks.

2. **Automation can enable operators to do more, such as play higher up the value chain.**

External partners have an expectation that telcos are highly skilled at handling data and are highly automated, particularly within the network domain. It is only through investing in internal automation efforts that operators will be able to position themselves as respected partners for services above and beyond pure connectivity. An example of success here would be the Finnish operator Elisa. They invested in automation capabilities for their own network – but subsequently have been able to monetise this externally in the form of Elisa Automate, a Network Operations Centre (NOC) solution that it sells directly to other telcos, in competition with traditional vendors.

A further example would be STL Partners’ vision of the Coordination Age.² There is a role for telcos to play further up the value chain in coordinating across ecosystems – which will ultimately enable them to unlock new verticals and new revenue growth. The telecoms industry already connects some organisations and ecosystems together, so it’s in a strong position to play this coordinating role.³ But, if they wish to be trusted as ecosystem coordinators, they must first prove their pedigree in these core skills. Or, in other words, if you can’t automate your own systems, customers won’t trust you to be key partners in trying to automate theirs.

3. **Automation can free up resource for service innovation.** If operators are going to do more, and play a role beyond connectivity, they need to invest more in service innovation.⁴ Equally, they must also learn to innovate at a much lower cost, embracing automation alongside principles like agile development and fast fail mentalities. To invest more in service innovation, operators need to reallocate resources from other areas of their business – as most telcos are no longer rapidly growing, resource must be freed up from elsewhere.

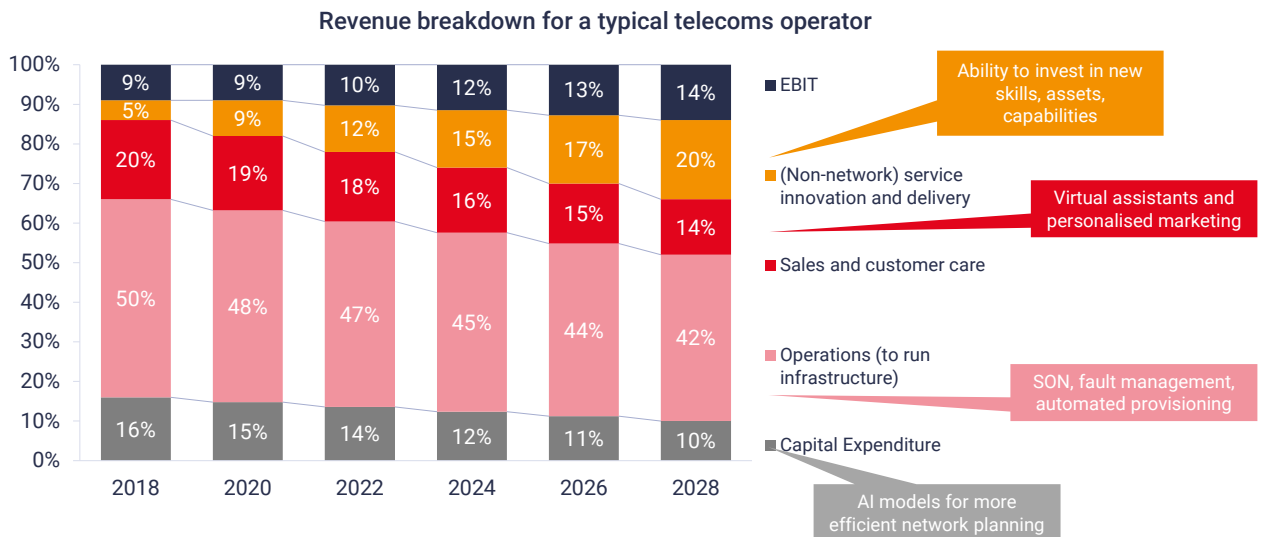
² See [The Coordination Age](#)

³ We feel there is a particular opportunity for telcos in verticals where there is a strong national focus, such as smart cities or healthcare. Here, operators, often with government ties and used to being heavily regulated, have a potential advantage over the hyperscale technology companies.

⁴ [Why CFOs must start to drive telecoms business model change](#)

Reducing operating costs is key way that operators can enable increased investment in innovation – and automation is a key way to achieve this.

Figure 4: Data analytics and automation can drive fundamental change in telcos' financial and commercial models



Source: Telecoms operator accounts, STL Partners estimates and analysis

4. **5G won't fulfil its potential without automation.** 5G standards mean that automation is built into the design from the bottom up. Most operators believe that 5G will essentially not be possible without being highly automated, particularly when considering next generation network services such as dynamic network slicing. On top of this, there will be a ranging need for automation outside of the standards – like for efficient cell-site deployment, or more sophisticated optimisation efforts for energy efficiency. Therefore, the capex investment in 5G is a major trigger to invest in automation solutions.
5. **Intent-based network automation is a maturing domain.** Newer technologies, like artificial intelligence and machine learning, are increasing the capabilities of automation. Traditional automation (such as robotic process automation or RPA) can be used to perform the same tasks as previously were done manually (such as inputting information for VPN provisioning) but in an automated fashion. To achieve this, rules-based scripts are used – where a human inputs exactly what it is they want the machine to do. In comparison, intent-based automation enables engineers to define a particular task (e.g. connectivity between two end-points with particular latency, bandwidth and security requirements) and software converts this request into lower level instructions for the service bearing infrastructure. You can then monitor the success of achieving the original intent.

Use of AI and ML in conjunction with intent-based automation, can enable operators to move from automation 'to do what humans can do but faster and more accurately', to automation to achieve outcomes that could not be achieved in a manual way. ML and AI has a particular

role to play in anomaly detection, event clustering and predictive analytics for network operations teams.

While you can automate without AI and ML, and in fact for many telcos this is still the focus, this new technology is increasing the possibilities of what automation can achieve.⁵ 40% of our interviewees had network automation use cases that made some use of AI or ML.

6. **Network virtualisation is increasing automation possibilities.** As networks are increasingly virtualised, and network functions become software, operators will be afforded a greater ability than ever before to automate management, maintenance and orchestration of network services. Once networks are running on common computing hardware, making changes to the network is, in theory, purely a software change. It is easy to see how, for example, SDN will allow automation of previously human-intensive maintenance tasks. A number of operators have shared that their teams and/or organisations as a whole are thinking of virtualisation, orchestration and automation as coming hand-in-hand.

⁵ It should be noted that the use of AI and ML in network operations presently tends to be limited to areas such as root cause analysis and network planning. This is partly because data collected from the networks tends to be highly structured and so lends itself to rules-based automation, as well as a reticence among operators to allow any uncertainty of outcomes into such a critical part of their business.

Looking to the future: Operators' strategy and ambitions

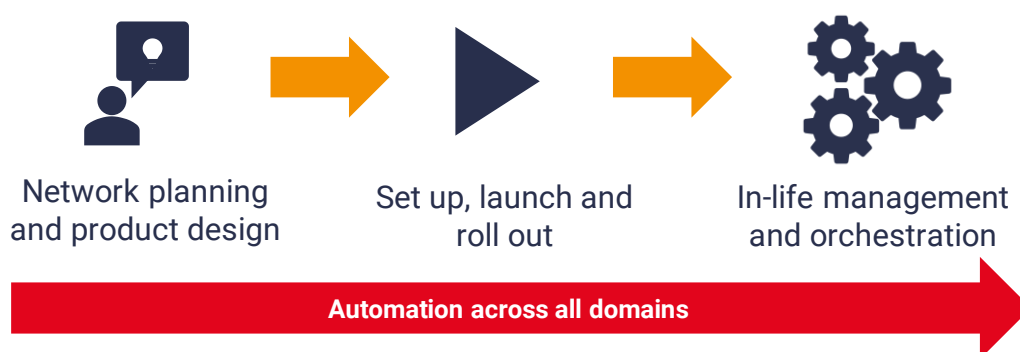
Defining end-to-end automation

End-to-end (E2E) network automation has become a key goal for operators, particularly since the release of ETSI's architectural framework for E2E automation in October 2019⁶. However, operators are defining this ambition of E2E automation in different ways.

Some think of "E2E" as referring to automation *across the entire lifecycle* of the network, from planning through to in-life management. For one EMEA multinational operator, their focus since the 1990s has been on automation for RAN planning and optimisation. They now use machine learning to forecast requirements for new network infrastructure. For them, the majority of their efforts have been focused on the far left-hand side of Figure 5.

This chronological mapping of automation across domains from planning through to in-life management is being blurred, however, as operators embrace new working practices, like network devops and CI/CD (continuous integration/continuous delivery) practices. In this case, the network is not designed once and then deployed, but is instead continuously reconfigured and optimised while in-life.

Figure 5: E2E automation can mean automation across all parts of a network lifecycle



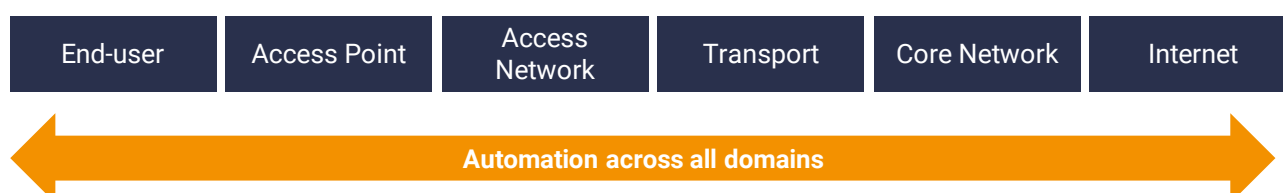
Source: STL Partners

However, others think of "E2E" as referring to automation *across all the different network domains*. E2E automation is only achieved when there is automation across all parts of the network, from access to core. What this definition fails to capture is the amount of effort going into automating processes that are technically "off-network" (i.e. not part of the network infrastructure) but still within the domain of

⁶ ETSI [Zero-touch network and service management architecture](#)

network operations. This includes, for example, automation of workflow management for field engineers or inventory management of network kit such as routers, switches etc. It may also fail to capture inter-operator automation efforts, such as MEF's LSO Sonata APIs which aim to create standardised APIs for dynamic service assurance across multiple operators.⁷

Figure 6: E2E automation can alternatively be defined as automation across different physical infrastructure layers



Source: STL Partners

Belief in E2E automation as an achievable goal is also divided. One Western European operator stated that they believed that true E2E automation was not achievable in the next 10 years. They suggested that no domains would be untouched by automation but that not every journey will be automated end-to-end. For example, they highlighted that some configuration changes are too complex and some faults that have never been seen before will not be solved with automation (even with maturing ML solutions). Another European operator sees E2E automation as more of a continuous journey for their organisation as opposed to an end goal, given that there will always be certain elements that will be too complex to automate, new incidents that they may not have come across before and advancements in technology.

What operators did agree on was that for E2E automation to happen, interoperability between network automation solutions is key. As E2E automation will only increase the sophistication and number of automation solutions in place, operators are looking to vendors to provide orchestration E2E as well.

A Western European operator described the importance of a standardised delivery pipeline for CI-CD and the need for more vendor support in things like industry standards, data models and APIs (e.g. for streaming telemetry, network configurations). A North American operator described the burden of the number of network management systems they have – because for each one they have to retrain staff in the way that it works. They felt that someone within the industry needed to create a common orchestration and management system that could interoperate with the several different solutions from different vendors they have already implemented.

Defining ambitions

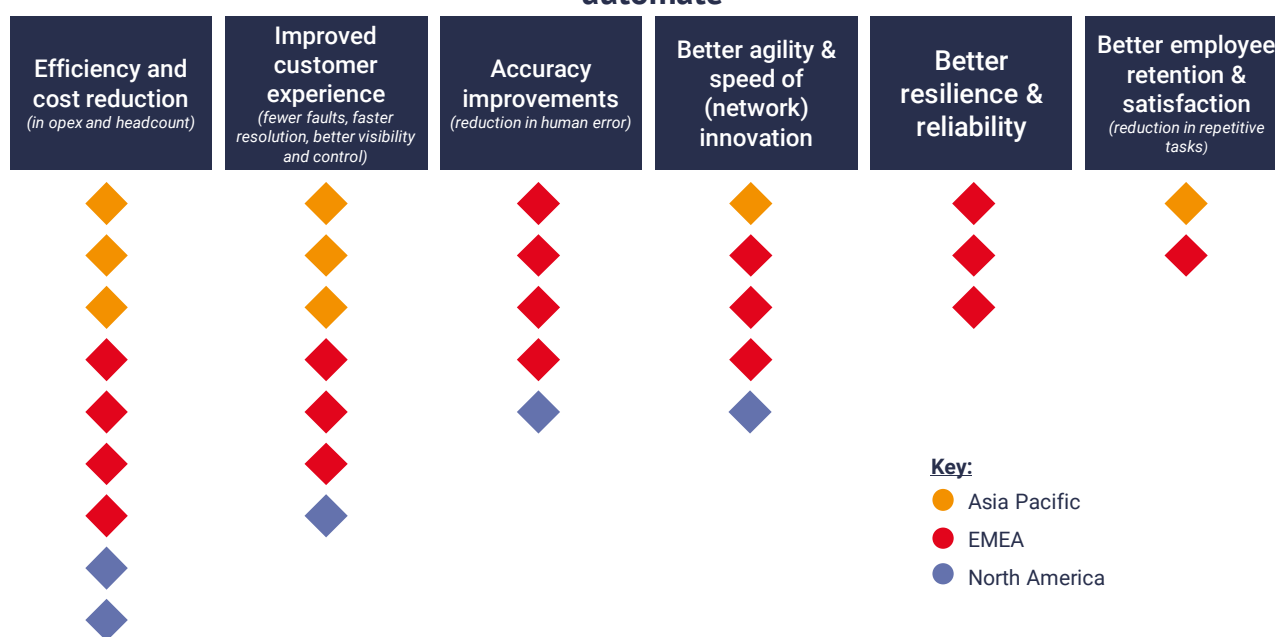
Just as definitions of E2E automation are not always consistent, different operators have different outcomes in mind. For some, the aim is to achieve a 'dark NOC', where they require very few or even

⁷ <https://www.capacitymedia.com/articles/3824514/automating-inter-provider-service-delivery-with-mef-lso>

no employees in their network operations centre. For others, the ambition is to use automation to “do more with less”, or to increase the pace of innovation and grow new revenue without increasing their operating costs. One Western European operator highlighted that achieving energy efficiency as well as cost efficiency in their networks was a core driver for automation.

However, ultimately, when asked, “why automate?”, across our ten interviewees⁸, several key drivers were highlighted:

Figure 7: Driving efficiencies are at the core of why operators are choosing to automate



Source: STL Partners interview programme, February 2020

For some, automation is strongly linked with their virtualisation and 5G efforts, seeing it as a key enabler and opportunity to introduce automated processes and workflows. Here drivers around **efficiency, accuracy and speed of network innovation** are crucial. In other cases, automation is being deployed more with legacy equipment which are often a resource-draining component of their networks – this can be, for example, workflow management systems to drive efficiencies among field teams doing manual upkeep and upgrades. One APAC operator explained their workflow automation system as such: once a ticket is issued it is automatically allocated to an available field team member with information as to what they need to do to fix the problem. They have achieved almost 100% adoption after a 3-4 year implementation journey. This sort of “off-network” automation is often driven by a need **to improve accuracy and improve customer experience**.

⁸ STL Partners interview programme with global operators ran from January to March 2020. 5 had headquarters in Europe, 2 in North America and 3 in APAC region. Had this interview programme concluded a month later the impact of COVID-19 may have seen increased numbers focusing on automation to ensure network reliability and resilience when handling heightened traffic. It will be interesting to see how this watershed global event will impact operators’ automation efforts going forward.

State of the industry: Network automation today

Which networks and what use cases: the breadth of network automation today

Automation use cases will differ across operator types. For mobile operators, the pressing roll out of 5G technologies will be a central focus. Equally, 5G will provide new opportunities and challenges for converged operators looking to bring their networks together. Automation efforts will need to span these networks, enabling, for example, end-to-end service assurance and a meeting of SLAs across mobile and fixed connectivity solutions. In comparison, fixed operators have their own set of challenges. While inventory management is largely well mature within mobile operators, fixed players, particularly in wholesale, have previously been much more manual. For one operator interviewed, this was deemed as the primary network automation use case that they had to develop before any others could be implemented.⁹

It is also true that operators are implementing automation use cases in different areas along our **end-to-end network automation framework**. Network planning provides opportunities for automation, data analytics and artificial intelligence. Companies like Mobile Systems International (MSI) have been offering powerful planning tools for decades and operators like Telefónica are using machine learning algorithms to analyse satellite images to understand where unconnected populations are and how best to serve them.¹⁰ However, in most cases, network planning teams are relatively small in size and have been using data analytics techniques to support their decision-making for some time. In a lot of cases, it is also considered a routine enough activity for operators to outsource these efforts.

In comparison, the bigger automation opportunity lies with roll out¹¹ and in-life network operations, orchestration and management. Here, much larger teams perform repetitive tasks on a scale far larger than in network planning. Therefore, while challenges around people management, coordination and change are more difficult, it's also where the bigger financial opportunities lie.

Within these broad categories or distinctions, the number of use cases being pursued is wide. The below table is a non-exhaustive representation of some of the use cases discussed by operators interviewed as part of this research.

⁹ Outside of mobile and fixed, Wi-Fi solutions are also becoming increasingly automated. While not the focus of this report, we have discussed this further in a recent report [Consumer Wi-Fi: Faster, smarter and near-impossible to replace](#).

¹⁰ <https://www.telefonica.com/en/web/public-policy/blog/article/-/blogs/how-telefonica-uses-artificial-intelligence-and-machine-learning-to-connect-the-unconnected>

¹¹ Reducing the time to switch on new cell towers, or new antennas on an existing tower is one powerful use case for automation. The administrative paperwork around compliance with planning rules etc. is mostly done manually today, and can take weeks to months to complete.

Figure 8: There is a wide span of network automation use cases already live within operators' networks

Operator type (Used throughout the report to anonymise interviewees)	Automation use case description	Maturity of use case
Wholesale arm of European operator	Automated inventory management system for fixed infrastructure assets	About to launch
Western European single country operator	Automated DDOS mitigation and response	Live in networks – automated action newly implemented
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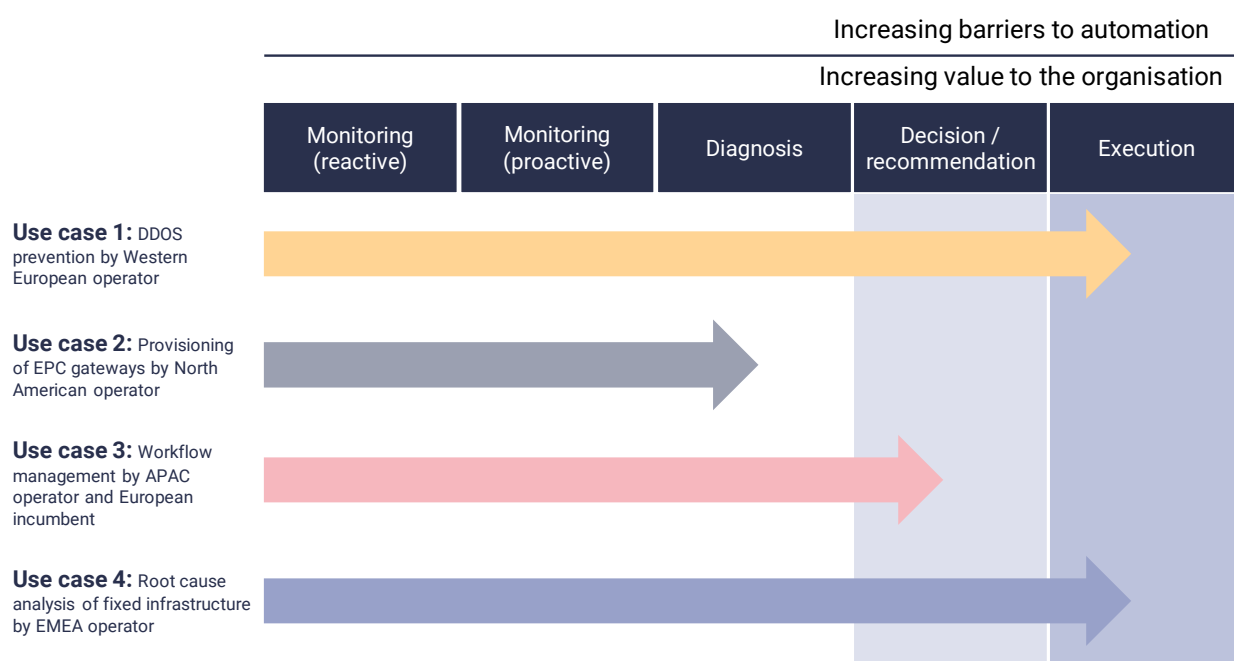
	allocation of trouble ticket with nearby field team member)	
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Removing the human? There is a continuum within automation use cases

Human input can be removed from the following stages of a single use case:

- To monitor network conditions and flag alerts (which we call **Monitoring (reactive)**)
- To monitor network conditions and flag unusual activity which may cause an alert in the future (which we call **Monitoring (proactive)**)
- To diagnose root causes of network issues (which we call **Diagnosis**)
- To suggest a decision on what needs to be done to try and fix the issue (which we call **Decision / recommendation**)
- To actually go out and make the changes (e.g. to network configurations) in order to fix the issue (which we call **Execution**)

In many use cases live in operators' current networks, humans still have input, particularly in the latter few stages through to execution (see Figure 9). For example, where a North American operator had automated provisioning of new EPC gateways, the provisioning and testing requires no human input, but the decision to "go-live" still rests with a human.

Figure 9: Many automation use cases still require human intervention

Source: STL Partners interview programme, February 2020

It is not necessarily the case that it is technically more challenging to automate the final few stages of **decision / recommendation** and **execution**. Instead, it is more of a cultural challenge among operators that holds them back. This was the case with the first use case depicted in Figure 9, an automated DDOS prevention and mitigation use case by a Western European operator. While they had implemented the use case up to the point of automated recommendations of actions to mitigate DDOS attacks, they have only recently begun using the pre-existing capability to also automate execution of these recommendations without human input. Technically this has been a feature provided by their partner Arbor for some time, but only recently have they felt enough confidence in the recommendations to remove the need for a human overseer. With automated execution, operators fear that there will no longer be a clear chain of command, and that ultimate accountability for decisions will not be obvious.¹² We'll return to this in the later section **Challenges to network automation— people and culture are key**.

Despite these difficulties, if operators want to achieve true E2E automation, they will need to embrace closed-loop automation on a use case basis. In doing this, they will unlock more value, since an automated system can instigate optimisation, mitigation, orchestration etc. more frequently than human can.

¹² This is, of course, also a central concern for governments, regulators and national cybersecurity organisations.

Strategic challenges: How to effectively prioritise (network) automation efforts

Step one: prioritising between telco domains

At an overall business level, automation is being pursued across all business units and areas (see Figure 2). This spans from the network, to customer care, to sales and marketing, to other internal areas like finance, legal and HR functions. **As a core part of their business, the network is almost always a priority.** However, there is some debate about whether it is the domain that will bring the quickest wins when it comes to automation. This is partly because of the critical nature of the infrastructure and the complexity of most operators' heterogeneous network systems. One North American operator stated "if you had to put \$1 into automation, there may be areas outside of the network that could use it better". This attitude is often taken by operators concerned about the critical importance of network infrastructure, who feel that experimentation with technology like automation introduces risk. Therefore, they feel that automation should be tested and validated in domains where "best-efforts" are better tolerated.

Step two: prioritising between network automation use cases

Even within the network, prioritisation has to happen. On the one hand, automation is certainly an area that intuitively makes sense to CFOs. Some operators describe the ease of making the business case for automation when presenting the ability to do more, with less resources. On the other hand, A3 use cases usually require significant up-front investment.

While point solutions may have a clear ROI, the more ambitious transformation programmes are harder to evidence and tie back conclusively to cost savings. Equally, there may be no clear financial impact from other benefits delivered by an automation programme. An example of this could include a network team previously working on human resource intensive tasks now being freed up to work on more innovative roles.

Step three: ensuring that selected use cases complement each other

On top of this, building a joined-up network automation strategy is challenging. A lot of the time, decisions about prioritisation are dealt with in a fragmented manner by different teams within network planning, innovation and operations. Each have their own priorities and areas they wish to automate. While this enables opportunistic and tactical decision-making that ensures relatively quick decisions about investing in automation use cases, it also leads operators to have increasingly fragmented initiatives, preventing sharing of tools, resources, best practices and learnings. It also increases the likelihood of several overlapping solutions from vendors, with no one clear management and orchestration system. This presents real challenges to achieving true E2E automation. Vendors should consider how they can support operators in preventing this. The starting point may be partnerships

for specific unified solutions, such as Infovista and iBwave collaborating to enable indoor and outdoor network planning and design for wireless connectivity.¹³

One European operator highlighted the challenges of coordinating efforts across its own organisation, stating that it is developing an automation maturity framework partly in an effort to understand what progress has been made where. Often this is a priority for operators who wish to limit the number of bespoke automation projects in favour of re-useable skills and capabilities.

As an example, in one APAC operator, the responsibility for network automation was split across CNO and CIO teams. With two different organisations responsible for automation, coordination across the departments became difficult, which slowed down decision making. Another operator in North America is looking to combat these challenges through investing in a team of around 70 software developers that develop automation capabilities and platforms for various parts of the network. The individual business domains (e.g. network planning) will become their internal customers. The team is trying to develop a common automation platform and framework.

Challenges to network automation – people and culture are key to success

Decisions pertaining to the prioritisation of automation efforts and the degree to which things are automated are often closely tied to the way people within an organisation approach their network automation journey. This is something we have discussed already. While there are technical challenges that operators are facing when it comes to becoming more highly automated, it is cultural and people challenges that are pervasively holding operators back. This is shown in Figure 10 below.

On the technology side, operators discussed challenges around creating the right environment for automation, including their network infrastructure design.¹⁴ An operator in Asia Pacific highlighted the technical challenge of trying to automate legacy systems not designed to support automation. Part of the challenge comes from being unable to extract the necessary data in real-time from legacy systems. When data can be collected, it is often in a non-standardised format and sometimes even requires manual clean-up before it can be used. Then, a decision must be made on how it should be stored – in common or separate data lakes, with appropriate access permissions, and storage and collection governance, and so on. These challenges were echoed by an EMEA operator who specified that issues with legacy systems had led them to focus their automation efforts on new 5G network infrastructure. In comparison to previous generations, 5G infrastructure has been designed with automation in mind, and in combination with more virtualised infrastructure, innovative automation opportunities exist.¹⁵

¹³ <https://www.infovista.com/press-release/infovista-and-ibwave-collaborate-to-deliver-unified-solution-for-indoor-and-outdoor-wireless-design>

¹⁴ While not mentioned explicitly by interviewees, the technical challenge of the impact of automation use cases on network security is also a key concern for many.

¹⁵ For example, automated provisioning of a network slice providing temporary connectivity with a particular QoS for an event, such as a gaming expo. This would enable audiences to experience next generation applications like AR/VR, all play sessions, multi-view points etc.

Figure 10: Technological challenges hold operators back from automation less than organisational and cultural ones

Technology-related challenges	Organisational and cultural challenges
Building the right network infrastructure	Establishing ownership and accountability
Effective collection and storage of network data	Communicating plan and changing employee habits
Interoperability across different systems	Building the right skills and knowledge
	Coordinating initiatives across domains and/or BUs
	Building the business case for automation
	Managing external pressures

Source: STL Partners interview programme, February 2020

Automation can help with employee retention and experience – by removing the tediousness of repetitive tasks and reassigning employees to focus on more complex problem-solving issues (see Figure 7). Without being prompted, operators often focused on the end-customers benefits of such automation (i.e. fewer faults thanks to reduction of manual error). However, when pushed, several acknowledged the benefits to their own employees. Of course, for operators to benefit from automation in this way, the right culture and communication of efforts must be achieved. The perception of automation within the workforce is often still one of fear or distrust that the ultimate purpose is to cut jobs.

One way that operators look to allay these fears is through commitment to re-skilling programmes. Most agree that they will also need to acquire new skills such as software, scripting and data science expertise, through hiring. These efforts to invest in in-house expertise chimes with belief from operators that automation is an area in which they must “get their hands dirty”. This attitude can take different forms: an EMEA operator highlighted their proud DIY spirit, with over 1,500 people working on network automation strategies across the group. In comparison, an APAC operator described their strongly employee driven RPA efforts. Their belief in the importance of bottom up initiatives led to 600 ideas from across the business being prioritised into 50 that were picked for internal development by the teams who had suggested the idea. As a consequence, they now have 40-50 RPA bots live in their network operations using UiPath. While they have reaped the benefit of real employee commitment to automation, their challenge now is in coordinating and maintaining these bots, looking to streamline efforts into a more coordinated strategy.

Efforts to reskill or hire to build areas of expertise around network automation goes hand-in-hand with strategic decisions about how aggressively operators are looking to develop the necessary skills in-house, rather than outsourcing to vendors or partners. For one North American operator, their strategy on this has shifted. Six to seven years ago they largely purchased traditional telco solutions from

vendors. More recently, they started developing many more network automation use cases in-house, investing in a 70 strong team of software developers. As of today, they are now looking again to widen their partnership options. This is primarily because they have identified that they do not have the resource to scale these initiatives and manage them in-life.

Operators also highlighted that through increasingly working with partners they'll be able to increase the speed at which they can implement new use cases.

Where options to reskill are limited, operators may instead be viewing automation as a way to replace the older generation of workers they have, as they retire. A North American operator highlighted this specifically within their wireline business – stating “when departures occur, there is no need to back fill”. This is particularly the case for historic incumbent operators. An APAC operator described having a database of employees that are retiring each year, and making decisions whether they need to hire to replace them, or whether they should look to automate instead. The sensitivities come from pressure from the government (to whom they still have ties), who see them as a key employer of the country’s population. This more opportunistic replacement strategy may be easier to manage from a people viewpoint, but limits the type of automation use cases pursued and the speed at which automation can occur.

Conclusions

As operators solidify their 5G rollout strategy and look to “do more with less” there are several key messages that those with a hand to play in network automation should consider:

Recommendations for vendors (and others in the ecosystem)

- **Seek out a route to providing common management and orchestration capabilities.** A North American operator exemplifies the need operators have for this when they stated “every time a vendor tries to sell us a function, they’re going to try and sell their management system on top of it, and every time we introduce a new system, we need to train people – then you end up with a massive fragmentation of systems and people skills”.
- **Traditional NEPs need to prove their value through highlighting their understanding of the complex, heterogenous network environment most operators have.** Traditional network equipment providers will come under pressure from software only players. Several operators highlighted that they were considering a wider range of partners than they have previously, particularly as their virtualisation efforts enable them to increasingly decouple software and hardware. Traditional NEPs will be better placed to support operators in automating both new, virtualised infrastructure, but also resource-intensive legacy areas of the network.
- **Vendors must be flexible and support operators looking for speed and scale.** Operators are often looking for partnerships which enable them to develop use cases and keep intellectual expertise and experience in-house, but give them support with long term management of use cases once they’ve been scaled across their networks.
- **Vendors should take a central role in spearheading efforts around industry standards, data models and open APIs.** Several telcos expressed desire to see vendors become proactive rather than reaction in these domains and, despite interest in industry bodies such as ONAP (Open Network Automation Platform), there was acknowledgement that global uptake and reach of the platform has so far been limited.

Recommendations for operators

- **Have a clear people, culture and change management vision.** While most operators could describe their network automation roadmap, the focus is invariably on technical implementation or requirements of specific use cases being pursued. When asked about how the role of network engineers will change with increasing automation or how many people will be required to support network operations in five years’ time, answers were usually less clear. Considering the vital importance of the right people and culture to successful automation, operators must define clearly for their employees how their job roles will evolve as automation is implemented.
- **Think and behave like technology companies and build automation into products and services from inception.** While most operators agree that 5G will be a key opportunity to increase their network automation capabilities, there is less clarity around exactly how this will happen. Not in

the least because 5G will be phased, and in most cases will require a 4G underlay for some time. For operators to use 5G as a springboard to E2E automation, investment and strategy must be formulated now, so that automation can be in-built from the beginning. Previously, operators have often taken the viewpoint of getting a service up and running and then automating in order to scale it. To reap the full rewards of network automation in a 5G era, this approach will not be helpful.

- **Ensure their cross team collaboration so common goals and issues around standards, orchestration, and management are dealt with coherently and cohesively.** In particular, collaboration between those responsible for NFVI deployments and those responsible for 5G rollout need to collaborate on their automation efforts. Doing this will ensure that new technology is designed with automation in mind, as well as ensuring that automation use cases are “future-proofed” rather than driving efficiencies with soon to be retired legacy equipment.
- **Embrace closed-loop automation.** By this, we really mean automating the decision-making and execution process. For most operators, live network automation is primarily rules-based, determined and overseen by a human. In order to transform networks to the self-optimising, self-healing vision operators have, decision-making processes will need to be automated too. This means moving from automated recommendations that need to be actioned by a human, to closed-loop automation responses. In order to be comfortable with this, operators will likely need to instigate clear lines of hierarchy, so there is comfort that there is clear accountability even for decisions that have not been directly made by a human.

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