RESEARCH

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White paper

Automated assurance is key to the automation of 5G and SD-WAN operations

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Anil Rao

Contents

List of figures

1. Executive summary

Communications service providers (CSPs) worldwide are undergoing multi-pronged digital transformations in order to increase service and business agility. The aim of these transformations is to enable CSPs to better compete in the digital economy with a flexible and programmable network powered by network function virtualization (NFV) and software defined networking (SDN). This network, in turn, will provide a foundation for the delivery of both on-demand services such as SD-WAN and a superior customer experience. NFV and SDN will also power the new 5G networks, which will lead to the introduction of 5G New Radio and 5G Core, new transport network architectures with disaggregated fronthaul, mid-haul and backhaul, and new technologies such as network slicing and mobile access edge computing. Together, these new technologies will significantly increase network complexity and will result in new requirements and pressure points for operations. The traditional operations model, which is primarily based on manual and reactive approaches, will become uneconomical and unsustainable.

CSPs must embrace extreme operations automation and look at every opportunity to reduce human intervention in order to deliver on the promise of digital transformation and 5G, and to support dynamic services such as SD-WAN. However, CSPs must not wait for the full implementation of cloud-native 5G networks to start their journeys towards extreme automation. Assurance processes such as active testing provide an early opportunity for automation in today's operational scenarios for existing services on physical networks. These processes also set the stage for extreme automation in cloud-native 5G networks.

Advanced active testing technologies using cloud-native test agents and open API-based test controllers enable the software-based programmatic control of testing processes. CSPs can take advantage of the inherent capabilities of the cloud computing features of active testing technology to dynamically implement test agents, physically place agents where required in the network and provision the test routines on-demand. This can deliver a significant reduction in provisioning times by cutting the time to validate and activate new services or service modifications. Similarly, on-demand tests can be launched as part of root-cause analysis and troubleshooting processes to isolate network and service faults. Periodic tests can be scheduled to assess the service quality and end-user experience, which may point to micro-trends in service quality degradation before it manifests into a poor customer experience.

Assurance automation is even more critical in NFV and cloud-native networks than in physical networks due to the inherently dynamic nature of virtual network functions (VNFs) and service chains. New VNFs and service chains will be implemented due to changing customer demands and network capacity requirements, and will need to be automatically tested before going live. Furthermore, combining active test data with other assurance data sources (such as passive telemetry data) creates a rich data set for training machine learning (ML) models and for generating accurate insights to drive closed-loop automation via network orchestration systems.

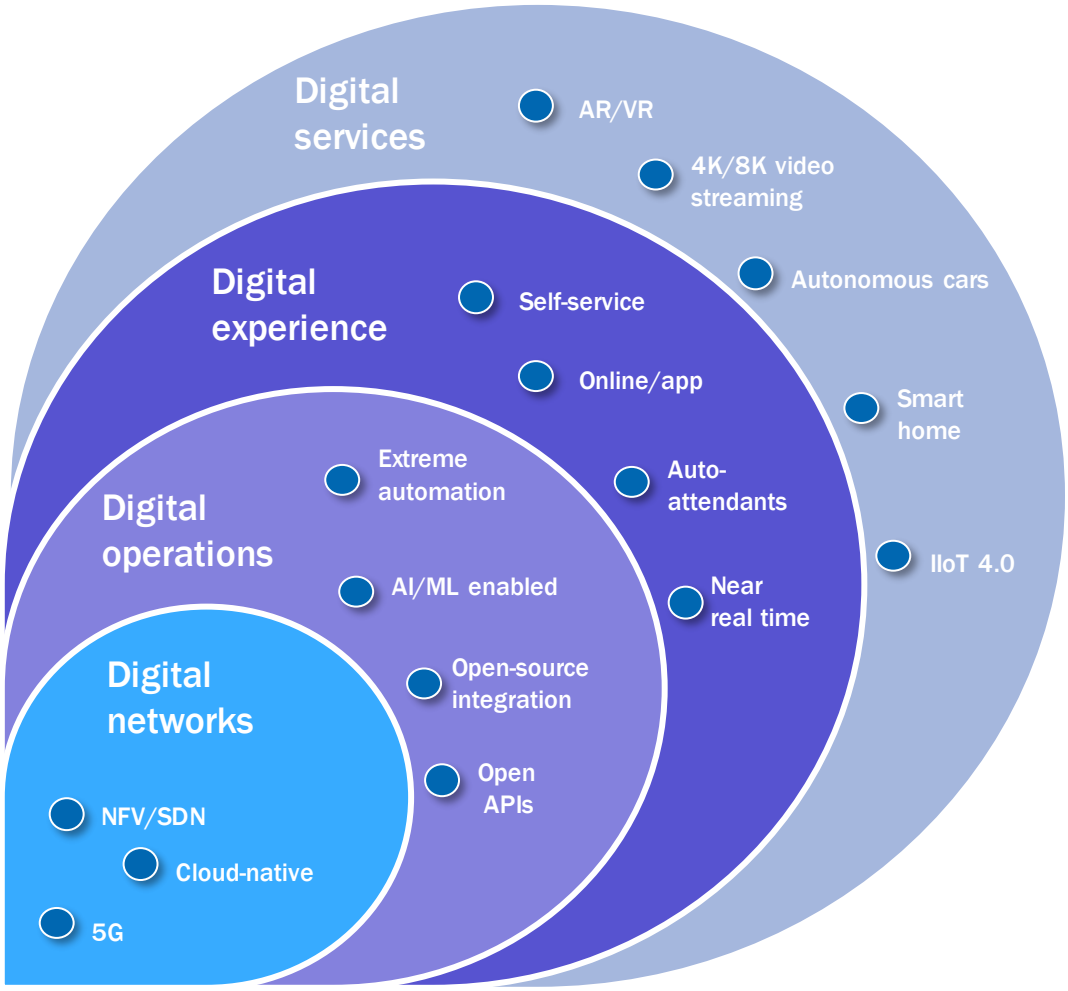
CSPs must continue to operate existing physical networks and services while rolling out NFV/SDN-based networks at scale, introducing SD-WAN and launching 5G services. After all, the existing networks and services still generate most of CSPs' revenue. Therefore, when choosing next-generation active testing solutions for hybrid networks, CSPs must consider a range of deployment options that will enable them to gradually migrate existing physical active test deployments to software-based, virtualized and cloud-native active test deployments in existing physical networks, hybrid networks, NFV/SDN and cloud-native networks as well as in the emerging edge clouds in 5G networks.

2. Automated assurance is pivotal to the success of digital transformations

2.1 CSPs are embarking on a path towards digital transformation

Many CSPs are undergoing digital transformations to become digital service providers (DSPs) in order to better compete against traditional service providers and web-scale companies such as Amazon, Facebook, Google and Netflix, to defend their existing revenue streams and to generate new revenue by offering innovative digital services. Increasing business and service agility by using dynamic networks, dramatically reducing operational costs while continuing to support the traffic growth from new services, and delivering superior customer experience are also key drivers of the digital transformations.

Figure 2.1: Digital transformation



Source: Analysys Mason, 2019

Figure 2.1 illustrates the main components of the DSP vision; this vision consists of the following four key pillars.

- **Digital networks:** DSPs deploy software-driven, virtualized and cloud-native networks using NFV/SDN and container technologies.
- **Digital operations:** DSPs implement insight-driven automated operations approaches using machine learning and AI techniques to achieve higher efficiency and employee productivity.
- **Digital experience:** DSPs deliver a superior, real-time experience to consumers and enterprises across all channels.
- **Digital services:** DSPs offer new innovative and differentiated services that can be implemented on-demand

CSPs should be able to use the elastic cloud-based digital network to rapidly create and decommission services to reflect the fast-changing demands of consumers and enterprises. CSPs must also digitalise their operations (that is, move towards highly automated and data-driven operations that are delivered at a fraction of the cost of their current operations) in order to operate and support digital networks and dynamic services. Finally, CSPs must transform the nature of customer interactions by delivering instantaneous and personalised digital experiences across all channels.

2.2 Operations automation is essential in order to improve service agility and achieve digital transformation success

The introduction of software- and cloud-based networking technologies such as NFV and SDN promises to increase service agility and allows CSPs to quickly react to changing service and customer demands. VNFs (the software equivalent of appliance-based networking components) are expected to behave like cloud applications, that is, software instances that can be dynamically created and modified. CSPs can use VNFs as building blocks to compose, implement and switch on new services effectively on-demand. The telecoms industry is taking the leap towards deploying NFV/SDN-based networks based on the promise of improved service agility, among other factors.

NFV/SDN is behind some of the most important digital networking initiatives. For example, initial 5G launches and some IoT services are based on a virtualized mobile core. Advanced 5G use cases based on ultra-low latency will require network slicing and edge clouds which rely on NFV. The transport networks consisting of Ethernet fronthaul, mid-haul and backhaul architectural segregation will enable network slicing which, in turn, will mean that network slice requirements will have to be mapped to a transport-level quality of service (QoS). Next-generation enterprise services are being offered using universal CPE platforms, and innovation is accelerating in virtual RAN and cloud RAN technologies.

CSPs envision a future in which customers use a self-service digital interface to request new services, and expect these services to be supplied and working in a matter of minutes. In this future operational model, the digital network, the digital channels and the operational systems must work in perfect harmony to deliver and assure services with minimal manual intervention. However, this cannot be achieved using traditional operational approaches, manual processes and tools that were designed for physical networks. CSPs need a new operational model that is based on the principles of automation.

2.3 Automated assurance is key to enabling operations automation

Assurance solutions must undergo some critical changes to become fit for purpose for the new automated operations models. Primarily, the assurance solutions themselves must become automated and provide the supplementary capabilities required to drive overall operations automation. Assurance solutions must become 'cloud-ready', that is they must be able to rapidly adapt to the dynamically changing cloud-based virtual network and service configurations in order to provide accurate monitoring and root-cause analysis of issues and to enable feedback loops for orchestration and automation. Assurance systems must become virtualized and cloud-native to support virtual and cloud-native network infrastructure. Assurance solutions must also make use of advanced analytics capabilities (such as machine learning and artificial intelligence) to enable operators to deliver proactive and predictive service assurance across a range of use cases (for example, predicting and preventing network performance and service quality issues before they occur). Lastly, assurance must become an integral part of the network and service lifecycle from early-stage validation testing in the lab, to service activation testing to ensure accurate service provisioning and finally, to the ongoing operational assurance of the network and services.

The following sections will explore the pivotal role of active testing in enabling automated assurance as part of the new operational model for digital transformation.

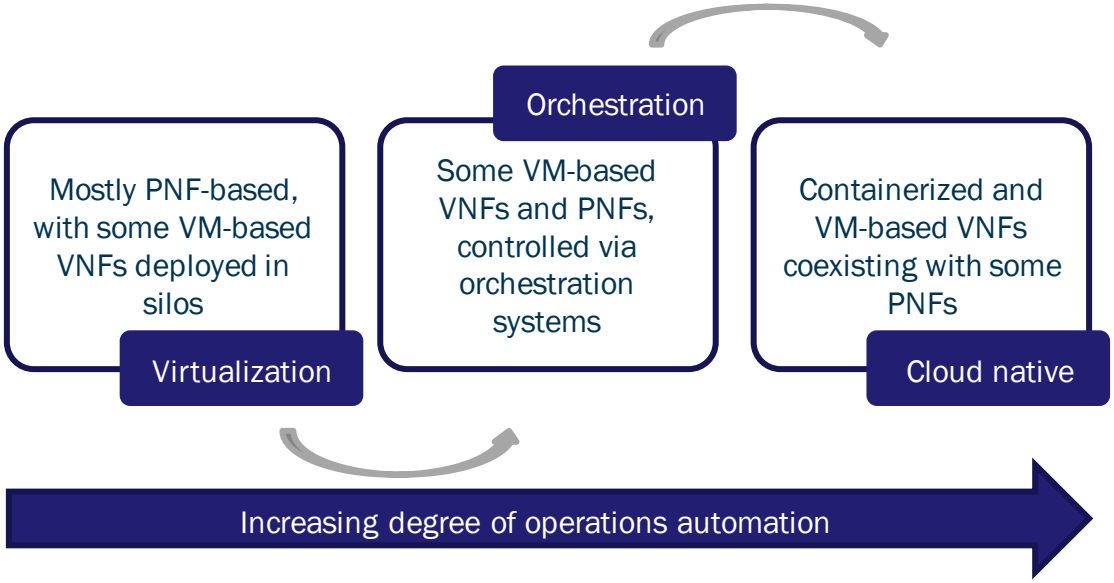
3. Active testing automation can bolster CSPs' operations automation strategies

Achieving the vision set by each component of digital transformations (that is, digital networks, digital operations, digital experience and digital services) will put new demands on service assurance. Active testing, in particular, is expected to become a crucial part of CSPs' overall service assurance strategies for NFV/SDN-enabled networks. Each of the following sub-sections discusses the new operational challenges and requirements created by each component of the DSP vision and how these affect the role of active testing.

3.1 CSPs should not wait for the realisation of cloud-native networks to implement automation initiatives

The evolution of networks towards being cloud-native, flexible and programmable will only be possible if CSPs' operational processes become highly automated. Figure 3.1 below gives an overview of the different phases of network virtualization.

Figure 3.1: Phases of network virtualization



Source: Analysys Mason, 2019

Today, most CSPs are either in phase 1 (virtualization) or phase 2 (orchestration) of this network virtualization, and only a few advanced CSPs are deploying cloud-native VNFs (and even then, only a limited number are being deployed). Network and service dynamicity is a key feature of virtualized and cloud-native networks. 5G networks will support the dynamic implementation of network functions and network slicing to support differentiated and ultra-low-latency services. Similarly, uCPE platforms will support the on-demand provisioning of VNFs that are associated with enterprise services such as SD-WAN. Furthermore, the dynamic digital networks that are enabled by NFV and SDN will transform network infrastructure assets into powerful platforms for service innovation for CSPs, for their ecosystems of partners and for enterprises alike.

Achieving a fully dynamic and automated cloud-based digital network is the end goal, but CSPs are pressing ahead with launching 5G/IoT and enterprise services based on partially virtualized and hybrid networks. Therefore, CSPs cannot wait to implement automation until they migrate to a fully cloud-native network; they must start now and make incremental progress on the journey towards full automation.

3.2 Active testing automation can be easily implemented

Active testing automation can bolster CSPs' overall automation initiatives, as discussed in Figure 3.2 below.

Figure 3.2: Active testing for digital networks

Use case	Role of active testing
Need to validate new VNFs	Inherently, cloud-based digital networks will be highly dynamic. New VNFs will be implemented due to the changing demands of the customer and network capacity requirements. Active testing enables the validation and certification of VNFs as they are implemented.
Need for continuous, proactive monitoring of services	Certain services such as connected home or smart metering IoT services require extremely reliable connectivity and high performance, but may only be used sporadically. In these cases, active testing capabilities enable the continuous monitoring of the network, service availability and performance, even when

Use case	Role of active testing
	services are not being used (for example, IoT sensors that issue alarms and emergency services).
Validating services across multi-operator networks	Complex multi-cloud services that run across multiple provider network clouds need to be proactively monitored across the end-to-end service. Active testing delivers unique value when the service provider does not necessarily own all parts of the end-to-end network
Need for advanced fault isolation	Hybrid networks consisting of legacy and NFV/SDN components will be highly complex. The ability to test individual segments in a controlled, coherent manner will be required for the rapid, automated isolation of performance degradations across the end-to-end digital network.
Need to automate change management	Failure to thoroughly test and validate changes before switching on services can cause outages, resulting in significant monetory loss and brand value erosion. Making automated active tesitng an integral part of change management processes can alleviate some of the associated risks. It is even more essential in digital networks as the changes can occur on short notice.
Test and turn up automation for service upgrades	Active testing must support new services that are being introduced in today's physical networks even as digital networks are being rolled out. For example, 100GbE networks are supported by virtual active testing technology.
Validate services over hybrid networks	Validating hybrid servicesthat span the legacy physical and virtual network domains will probably require a combination of physical and virtual active test agents (refer to section 6.1).
Monitor QoS of transport networks	It is crucial for the performance of 5G services that the transport networks consisting of backhaul, mid-haul and fronthaul perform well. These networks need to be ready before the new 5G cell sites and the core are commissioned.

Source: Analysys Mason, 2019

4. Active testing must become an integral component of the automated assurance process

CSPs must develop a futureproof digital operations model based on the principles of extreme automation in order to achieve the goals of automated operations. The new operations model must be relevant to today's physical networks, and must evolve and adapt as CSPs execute their digital transformation strategy. An automated assurance platform is pivotal to this new operations model; it should provide data and intelligence-driven actionable insights to drive closed-loop and extreme automation.

4.1 Automated assurance platforms are the basis for operations automation

A unified data collection layer for acquiring data from all network data sources is the foundation of an automated assurance platform. For example, primary data (such as passive wire data) will be enriched by secondary data sources (such as active testing data); a unified mediation and visibility function will aggregate, curate and normalise the data inputs, thereby creating high-quality metadata in standard formats for consumption via KAFKA/REST APIs for analytics use cases and applications.

Once the data has been aggregated and curated, ML/AI-enabled targeted applications can be used to detect anomalies and predict the most-likely future outcomes (such as service quality and network performance degradation) based on historical and real-time data. Additional applications can be developed to deliver a higher level of functionality such as service management and root-cause analysis. The horizontal platform architecture enables the extensive use of metadata for the rapid creation of applications and automations.

Another key function of automated assurance platforms is the generation of actionable insights to drive closed-loop automation. Analytics models, when applied to the metadata, can create contextual insights to make decisions during the process runtime. Using machine learning, the analytics models can be trained to continuously improve the accuracy of the decisions and consequently reduce the degree of human intervention.

4.2 Active testing data can increase the accuracy of insights and automations

The accuracy of automations is dependent on the quality of insights and therefore on the quality of the data that is used to generate those insights. Higher quality insights can be generated by training the ML and AI models, but this requires large amounts, as well as a broad variety, of sample input data. Another area of concern for CSPs is the lack of operational trust. Network engineers and operations personnel are used to having a high level of control over day-to-day operational tasks such as troubleshooting, root-cause analysis and network configuration changes. CSPs cannot expect that these personnel will relinquish control and embrace automations overnight; they need to develop trust and confidence in automations, and this will take time to happen.

It is in this context that the role of active testing becomes significant. Active test data provides another view of network performance and service quality. Periodic active tests or on-demand tests could potentially expose micro-trends in performance degradation that may not be discovered through other assurance approaches. Additionally, active testing reinforces proactive assurance processes in which network and service issues can be identified before they affect the customer experience. Combining active test data with other assurance data sources creates a rich data set for generating accurate insights, and additionally, provides the all-important input data for training for ML/AI models.

5. Active testing can bolster digital experience initiatives

Digital service providers such as Amazon, Google and Netflix have reshaped customer expectations by delivering excellent customer experiences and personalised services. DSPs are more responsive to customer demands; they are constantly launching new services and features. DSPs also provide a more modern ‘digitalized’ experience overall. Customers are now demanding similar experiences from their CSPs.

Customers tend to gravitate towards CSPs that offer the best-in-class customer experience. As such, CSPs agree that it is in their commercial interest to transform these experiences. They can be influenced by a range of factors such as the quality of service (if there are dropped calls, network delays or congestion, for example) or the quality of customer interactions (if they are in real-time or if they are contextual, for example). It is therefore vital that CSPs use the most-suitable operational tools to measure the quality of service and experiences that the customer is receiving across touchpoints. Active testing can play a significant role in achieving some of these objectives.

5.1 On-demand services

Section 3.1 highlights how NFV/SDN powered digital networks will enable network and service dynamicity. Based on this dynamicity, CSPs can offer on-demand network services such as 5G network slicing and uCPE-based services, much in the same way as cloud service providers offer compute, storage and IT applications as-a-service. On-demand network services will have a profound effect on customer experience, especially in the enterprise services sector. CSPs can generate further benefits by offering a self-service experience using digital channels for on-demand services, thereby allowing customers to feel in control of the entire process.

Customers can request new services, make changes to existing services or even perform initial self-diagnostics using a self-service online platform. Whatever the delivery approach for on-demand services, enterprises will expect significantly shorter service times compared to the current norm which can be weeks or months. Enterprises may even perform basic troubleshooting themselves when they discover service issues, rather than contacting the CSP straight away.

To meet the requirements of on-demand network services, all the internal process steps associated with service provisioning, service validation and service troubleshooting must be seamlessly integrated. Embedding active testing into these processes will provide a frictionless customer experience for on-demand services. Active test agents can be dynamically implemented as part of the provisioning process and can be triggered to execute test and turn up routines before services go live. Similarly, suitable active test capabilities can be presented to the customer via the digital channel to enable them to perform basic troubleshooting.

5.2 Empowered customer care

The experience that the customer receives when interacting with the customer care department is one of the prime determinants of overall customer satisfaction. A customer care department that lacks insights on why the customer is receiving a poor quality of service can leave a bad impression, and can drag down the customer's opinion of the CSP as a whole. In today's digital landscape, customers expect CSPs to provide a personalised and contextual customer experience.

By supplying the customer care department with active testing and diagnostics capabilities, customer care agents can diagnose issues and provide real-time feedback while interacting with customers. Furthermore, the overall resolution times are reduced if the customer care department can troubleshoot and resolve issues because fewer issues are escalated to the network operations department.

5.3 Ongoing service quality testing

Many CSPs are making the transition from network-centric operations to service- and customer-centric operations as part of their customer experience transformation initiatives. The idea that services must be monitored in an end-to-end context is at the heart of these new operations approaches, as this would allow CSPs to take actions based primarily on service impact and not on the siloed view of domain-specific network (for example, RAN, core, backhaul) performance. Such an approach enables CSPs to allocate important resources, care processes and troubleshooting initiatives by performing targeted analysis to accurately pinpoint the network resources that are causing the degradation in service quality.

CSPs are also attempting to become proactive in the way in which they identify degradations in service quality and network performance before they affect the service received by the customer. CSPs want to be in a position to take pre-emptive action on potential degradations so that customers can consistently receive the same high quality of service.

Employing active testing to perform periodic end-to-end service quality tests can support both of the above strategic initiatives. Active tests, albeit using synthetically generated data, provide an early indication of service quality and network performance degradations, thereby giving CSPs an early opportunity to take proactive measures.

6. Virtualized and cloud-native active testing solutions

Active testing has an important role in allowing CSPs to achieve some of their automated operations goals in the broader context of digital transformation; sections 3, 4 and 5 discussed some specific use cases around automation and digital experience. However, active testing solutions must overcome some key limitations to support these use cases. Traditional active testing solutions are built on proprietary appliances that offer limited operational flexibility (much like physical network functions) and are therefore not fit for purpose to achieve the goals of extreme automation in NFV/SDN-enabled digital networks.

6.1 Deployment options for active testing

Modern active testing solutions must become hardware-independent software modules. The following range of deployment options must be offered in order to support CSPs' journeys towards implementing cloud-native digital networks.

- **Software.** Active testing solutions that are software-based provide a basic level of operational flexibility with the ability to patch/upgrade the modules without swapping out hardware.
- **Virtualized.** Apart from being NFV compliant, virtualized active testing solutions provide dynamic run-time control and automation through the orchestration process for on-demand testing.
- **Cloud-native.** Cloud-native active testing solutions are based on containers, the most-advanced software development paradigm for cloud platforms. They enable the highest level of operational flexibility and automation through DevOps, and support highly granular microservices architecture for independent upgrading/scaling.

CSPs can choose the most suitable deployment option for their needs, depending on their preferences and NFV readiness. However, advanced active testing solutions such as those that are cloud-native are futureproof, as they can be used for rapid, cost-effective automation in today's networks and can lay the foundation for the move to future cloud-native networks. For example, CSPs deploying white boxes in preparation for future SD-WAN services should consider one of the advanced active testing options to achieve operational agility and automation for the physical network.

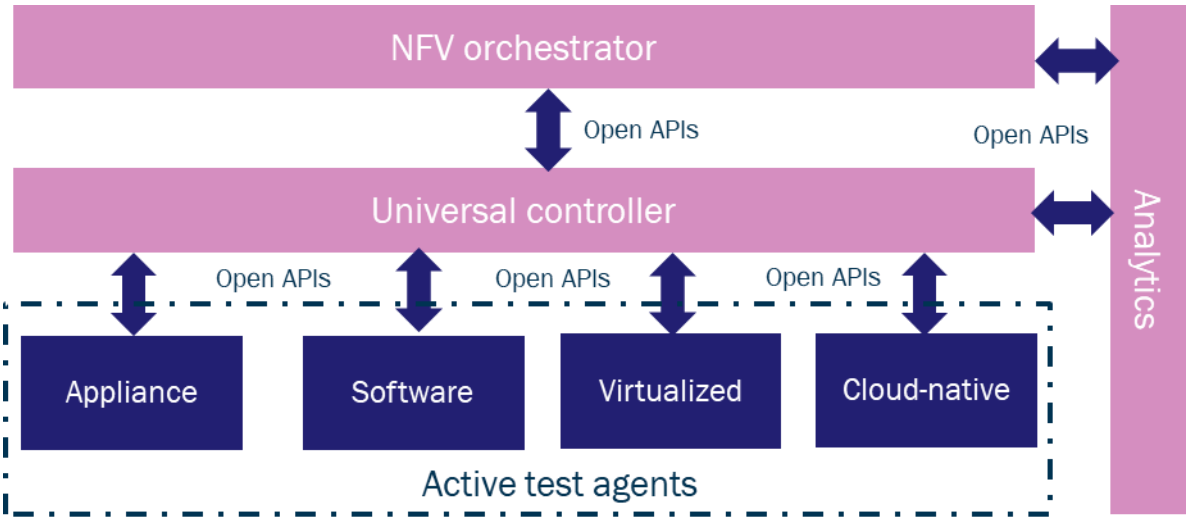
Another emerging area of interest for CSPs is edge clouds. In addition to supporting the ultra-low-latency 5G use cases, edge cloud architecture will be necessary for CSPs to realise 5G at scale, especially in the context of cell site densification, cost optimisation of backhaul transport and RAN. The magnitude and distribution of these cell sites coupled with the varying capabilities/services hosted on them means that monitoring and assurance will be paramount. However, the assurance solution must be lightweight, flexible and cost-effective as site optimization and footprint will be critical. Cloud-native active test agents that are embedded into the distributed edge clouds could be used to guarantee the performance requirements and orchestration of these cell sites.

Cloud-native active testing allows CSPs to standardise the active testing solution across the network and provides a high level of confidence that the active testing platform will only need minimal changes as they migrate parts of the network to NFV/SDN and to a cloud-native configuration. Therefore, the operationalisation of virtual/cloud-native active testing solutions can progress faster than the pace of deployment of NFV/SDN and cloud-native digital networks.

6.2 Control and orchestration

The active test endpoints deployed in the operational network will require dynamic run time lifecycle management for functions such as implementation, configuration and test script provisioning. Universal controller software that is typically offered by vendors and is bundled with active test agents provides this capability. The controller also interfaces with the NFV orchestrator to enable the sort of automation that is discussed in sections 3 and 4. It is possible for the NFV orchestrator to directly interface with the active test agents, but this depends on the CSPs' operational architecture and automation strategy.

Figure 6.1: Illustration of the integration of active test agents with a universal controller and an NFV orchestrator



Source: Analysys Mason, 2019

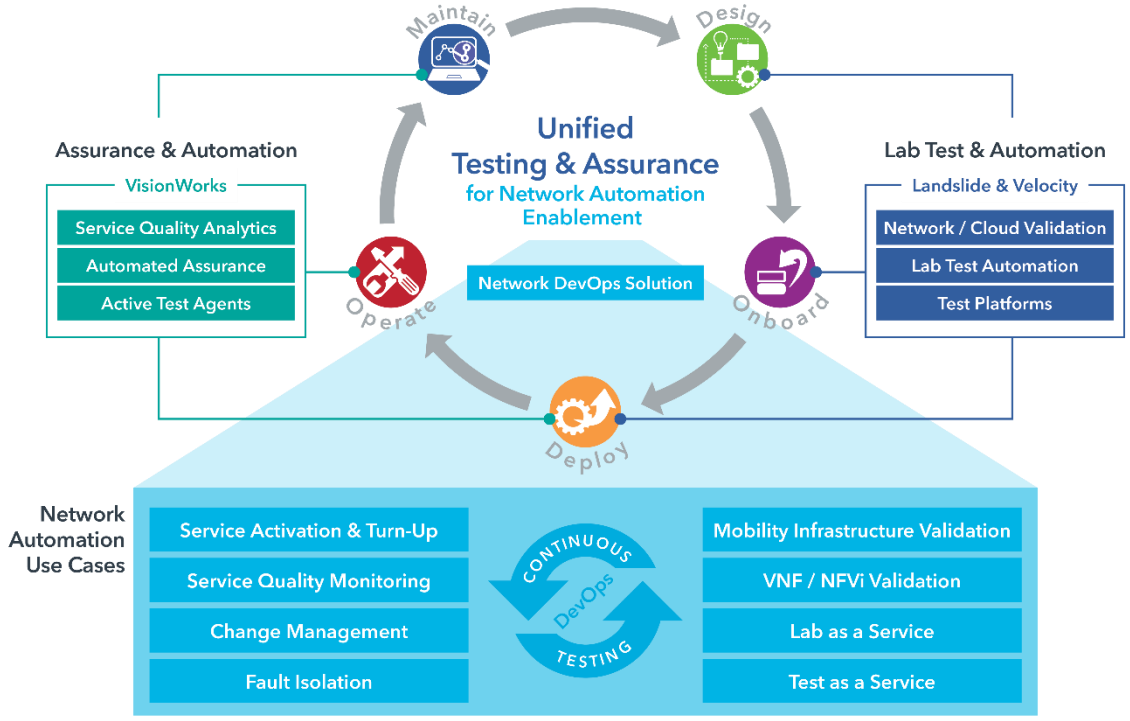
When choosing an active test solution, CSPs must insist on an open solution that supports open APIs for easy integration with adjunct and third-party applications. The maturity of standards for open API-based active testing means that it should be possible to deploy a multi-vendor testing solution with a universal controller and test agents that are sourced from different vendors. Open APIs would also enable a frictionless integration with the NFV orchestrator.

CSPs must demand native support for machine learning and artificial intelligence in active testing solutions. This will help CSPs to spot trends and anomalies, and to predict the most-likely network and service issues, based on the test data generated. In cases where the solution is integrated into an automated assurance platform, the test data becomes a key input for insight generation (as discussed in section 4).

7. Spirent Lifecycle Service Assurance

Service providers are embracing automation to accelerate the roll-out of new services, reduce operational costs and differentiate service quality in the face of unprecedented network complexity and competition. To enable providers to rapidly and cost-effectively deploy automation, Spirent has pioneered a new approach to testing and assurance called Lifecycle Service Assurance (LSA). Spirent LSA solutions deliver the critical testing and assurance building blocks that are required to quickly and easily automate key use cases across the service lifecycle. The main innovation that makes this possible is a cloud-native architecture that radically reduces the cost and complexity of integrating virtualized testing and assurance components with operational systems.

Figure 7.1: Spirent Lifecycle Service Assurance



Source: Spirent, 2019

Another unique attribute of the Spirent LSA solution is a unified approach to testing and assurance that spans development and operations teams. With LSA solutions, test cases developed in the lab can be rapidly ported to production environments, so providers can adopt DevOps continuous testing practices and streamline their entire service lifecycle. In addition, cutting edge knowledge gained in the lab can be directly applied to accelerate the successful deployment of new technologies in production networks. To learn more about Spirent's LSA suite, and the DevOps continuous testing and network automation use cases enabled by LSA, please visit www.spirent.com/solutions/lifecycle-service-assurance.

8. Conclusion and recommendations

CSPs should embrace automated operations powered by automated assurance to succeed in their digital transformation initiatives, and to operationalise 5G and SD-WAN at scale. Active testing automation provides an opportunity to automate testing for NFV/SDN and cloud-native digital networks as well as existing physical networks. Active testing data enriches the assurance platform and increases the quality of network insights that are key to automating assurance processes and closed-loop automation via network orchestration systems. Active testing automation helps CSPs to offer on-demand services and deliver a superior customer experience by proactively identifying network and service issues before they affect the customer.

Analysys Mason recommends that CSPs should:

- consider active testing technology as part of their automated assurance and operations automation strategy to operationalise 5G and SD-WAN services
- use active testing to provide a superior customer experience through the delivery of on-demand services, empowered customer care and ongoing service quality testing
- choose an active testing solution that supports a range of deployment options (software, virtual and cloud-native) to enable them to automate assurance in physical, virtual and cloud-native networks.
- demand a test controller that uses open APIs for easy integration with the active test agents, network orchestration systems and analytics platforms to drive closed-loop automation.

About the author

Anil Rao (Principal Analyst) is the lead analyst for Analysys Mason's Automated Assurance and Service Design and Orchestration research programs, covering a broad range of topics on the existing and new-age operational systems that will power operators' digital transformations. His main areas of focus include service creation, provisioning and service operations in NFV/SDN-based networks, 5G, IoT and edge clouds; the use of analytics, ML and AI to increase operations efficiency and agility; and the broader imperatives around operations automation and zero touch networks. In addition to producing both quantitative and qualitative research for both programs, Anil also works with clients on a range of consulting engagements such as strategy assessment and advisory, market sizing, competitive analysis and market positioning, and marketing support through thought leadership collateral. Anil is also a frequent speaker and chair at industry events, and holds a BEng in Computer Science from the University of Mysore and an MBA from Lancaster University Management School, UK.

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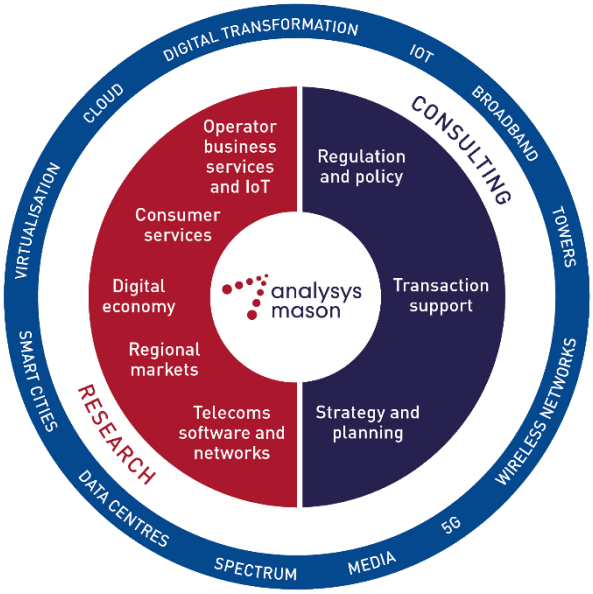

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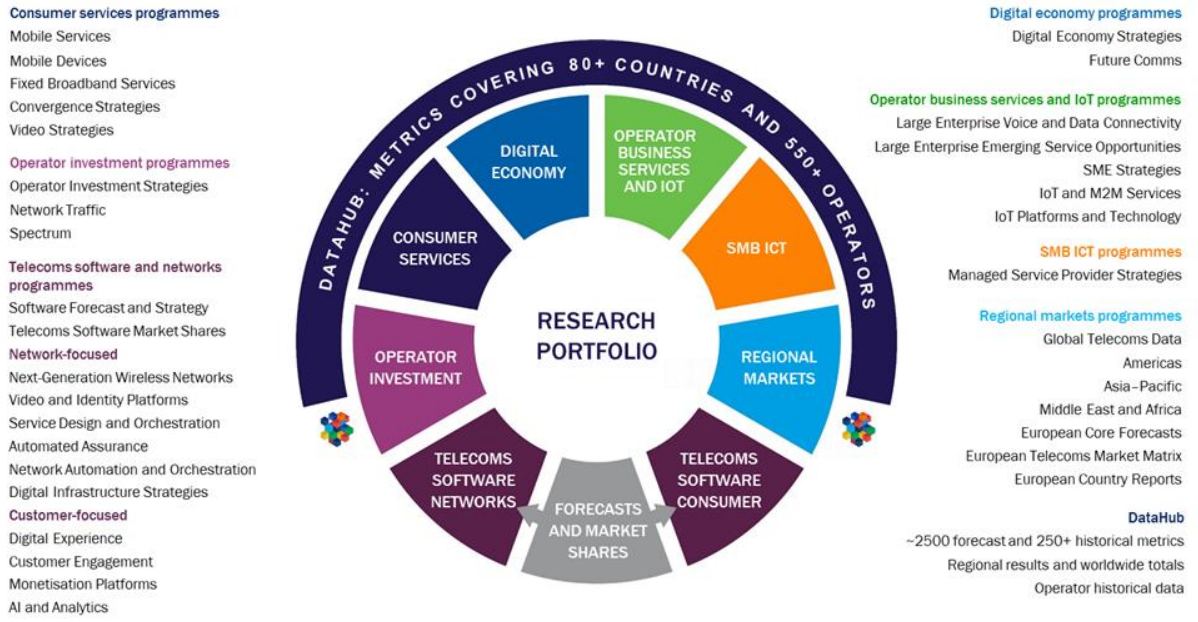

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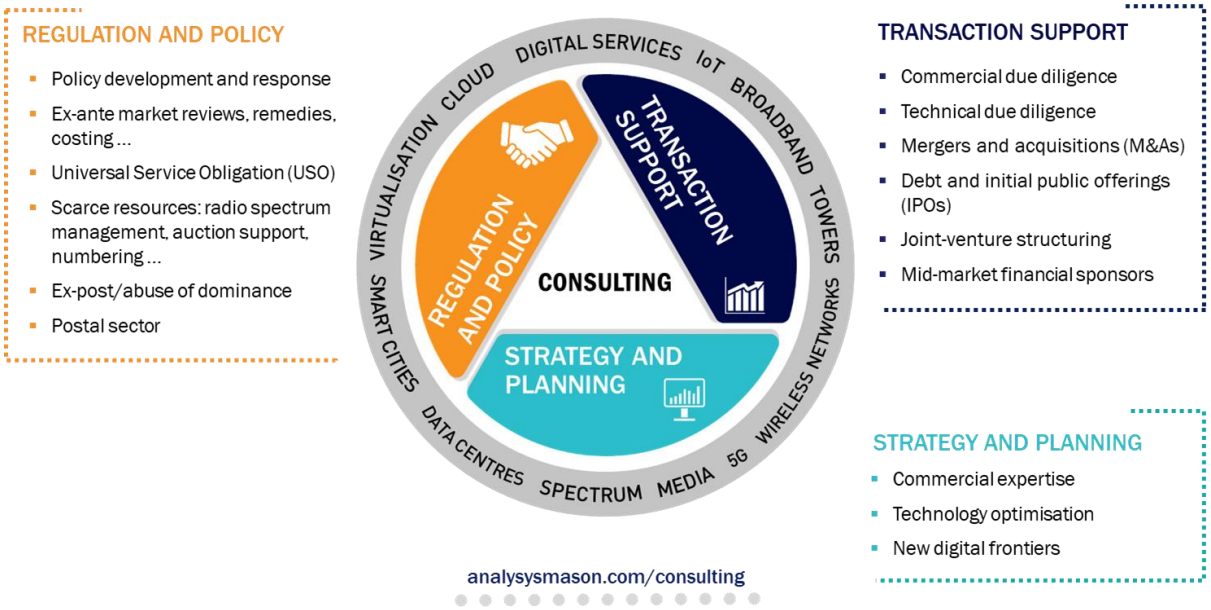
Our clients in the telecoms, media and technology (TMT) sectors operate in dynamic markets where change is constant. We help shape their understanding of the future so they can thrive in these demanding conditions. To do that, we have developed rigorous methodologies that deliver real results for clients around the world.

Our focus is exclusively on TMT. We advise clients on regulatory matters, help shape spectrum policy and develop spectrum strategy, support multi-billion dollar investments, advise on operational performance and develop new business strategies. Such projects result in a depth of knowledge and a range of expertise that sets us apart.



We look beyond the obvious to understand a situation from a client's perspective. Most importantly, we never forget that the point of consultancy is to provide appropriate and practical solutions. We help clients solve their most pressing problems, enabling them to go farther, faster and achieve their commercial objectives.

For more information about our consulting services, please visit www.analysysmason.com/consulting.