5G Service Assurance: The Case for AIOps

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EXECUTIVE SUMMARY

Communication Service Providers (CSPs) are rapidly deploying 5G networks. A key objective is to create new services and revenue, which was not possible using 4G and earlier mobile technologies. 5G networks have increased bandwidth and lower latency. They support massive internet of things (IoT) and network slices for private services. 5G networks also use cloud-native technology, which enables rapid deployment of new services. Examples of new 5G services for consumers and enterprises are network slicing, IoT, Private 5G, business AR/VR, smart factories, fleet and inventory management, connected vehicles, cloud gaming, drones, and robots. 5G services will accelerate digital transformation for many enterprises and enable new technologies that will lead to increased growth and profitability.

As CSPs move to 5G, infrastructure, operations, and services are undergoing a massive paradigm shift. Many legacy networks consist of multiple silos, for example, the RAN is typically a closed system provided and supported by a single vendor. Similarly, the packet core is a silo architecture supported by a packet core vendor. 5G networks are moving to a cloud-native architecture that is heterogeneous and highly distributed with many different services sharing the same infrastructure. Many vendors provide software and hardware, and they live in shared cloud environments. For this reason, 5G networks are moving to horizontal architectures with virtual network functions running across hybrid cloud environments.

This transition has created pain points for many CSPs:

1. Managing the transition from hardware network elements to virtual network elements
2. Administering service delivery, service agility, and service creation
3. Achieving operations efficiency through automation

A critical success factor for 5G services is efficient and effective 5G network operations. Operations influence cost, profitability, agility, and service velocity. Effective operations allow profitable services to be rolled out quickly and reliably, enabling revenue growth. The operations challenge is that as the network becomes virtualized and decentralized the level of operational complexity increases.

Network operations must establish a modern monitoring and automation platform that is best fit to contend with new hybrid cloud data center complexity and enable efficient, scalable service delivery. This drives the need for a service-centric AIOps approach to 5G operations, which eases complexity and cost, speeds service delivery, and enables service innovation. Some of the key characteristics of a service centric AIOps platform are:

- Unified data platform
- Analytics providing actionable insights
- Measure service KPIs
- Automation for optimal service assurance
- Integrated DevOps environment

This paper discusses the challenges posed to CSPs in migrating to cloud-native 5G infrastructure and the benefits of adopting an AIOps platform for hybrid cloud network management and service assurance.

Evolution to 5G

The transition from 4G to 5G is a major paradigm shift in three dimensions:

- Infrastructure
- Operations
- Services

At a macro level network infrastructure, operations, and services are moving from a vertical silo architecture to a horizontal architecture, depicted in Figure 1. For example, in legacy networks it is common to have one or more packet cores that are supported by a single vendor and supported by a single organization. The infrastructure, operations, and services exist in a vertical silo. In the new 5G network infrastructure, operations and services exist in a horizontal architecture with virtual network functions running on virtual machines or containers running on a hybrid cloud infrastructure and supported by a common cloud organization. This transition from a silo to horizontal architecture is discussed in the following sections of this paper.

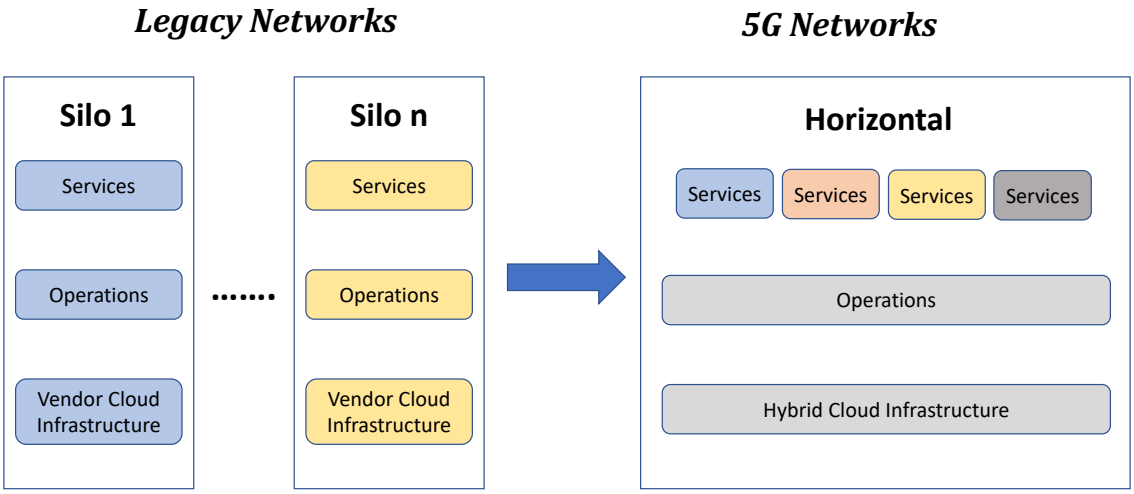

Figure 1. Migration from Legacy Network Silos to 5G Horizontal Architecture

5G Infrastructure Paradigm Shift

5G infrastructure is moving from physical network elements running in traditional central offices to virtual network elements in hybrid cloud environments as represented in Figure 2. Today, telco networks consist of vertically integrated systems supplied and maintained by a limited group of telecom vendors. This is a silo architecture where the network consists of a set of technology silos. The 5G infrastructure consists of cloud-native network elements running in a highly distributed modern data center architecture with a bare-metal layer composed of compute, network, and storage, and a Kubernetes and/or virtualization layer managing a combination of virtual machines and containers.

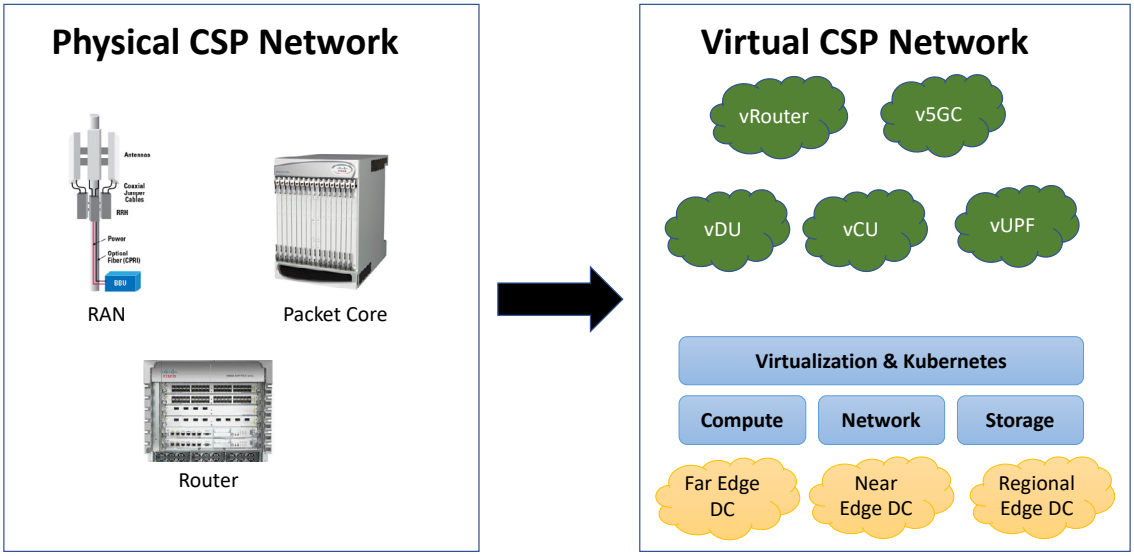

Figure 2. Transition from Physical Network Elements to Virtual Network Elements

The 5G horizontal architecture consists of multiple software components running on hybrid cloud infrastructures in modern data centers. Software can be provided by many vendors and can include open source. CSPs also have to maintain and operate legacy software and hardware along with the newer cloud-native software. In the physical telco network CSPs could rely on a small group of vendors to help operate and maintain network infrastructure. In a horizontal 5G architecture CSPs must take responsibility for systems integration and life-cycle management, which is more challenging in this complex environment. Many components of this architecture will be rapidly changing, and life cycles will be shorter, which creates significant operational challenges.

Additionally, network functions are moving to the edge of the network. The packet core forwarding plane is moving from regional data centers to distributed edge data centers. Open Radio Access Networks (O-RAN) components are running in far edge cell sites and near edge data centers. And Multi-Access Edge Computing (MEC) nodes are providing new services and applications at the network edge. Examples of 5G edge services are public safety, fleet and inventory management, smart energy grid, smart cities, cloud gaming, connected vehicles, and IoT solutions.

The scale of a modern, distributed 5G telco cloud is depicted in Figure 3. Some of the key challenges are:

- Massive scalability
- Thousands of highly distributed regional, edge, far edge cloud data centers
- Complexity associated with many vendors, software, cloud data centers, open source, etc.
- Variety of customers, use cases, and services
- Large amounts of data and high data throughput
- Large number of devices (IoT)
- Must maintain high quality of service

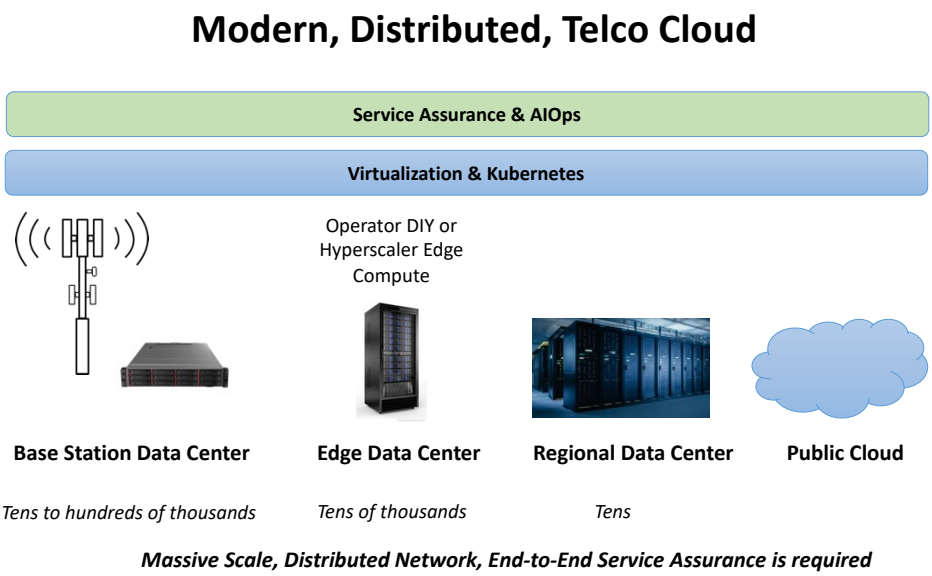

Figure 3. A Modern, Distributed Telco Cloud Architecture

5G Operations Paradigm Shift

Network operations are critical to the success of 5G. The effectiveness of operations can impact cost, efficiency, agility, differentiation, and innovation. Therefore, effective operations have a large influence on profitable growth.

Legacy network operations are usually organized in vertical silos because the technology and infrastructure is provided by separate vendors, and those vendors provide significant operations support to CSPs. It is necessary for CSPs to organize around silos to maintain the specialization required to operate the separate components of the network. In the world of physical network elements this has been an effective way to provide high-availability services. However, this siloed operations model does not work where services run horizontally. Separate silos create visibility gaps between silos, and to effectively deliver targeted 5G service levels, 100% visibility of the interconnected and interdependent end-to-end 5G service environment is required. The operator must be able to see how all technologies work together to enable a 5G services. A siloed approach does not allow for this needed visibility. Examples of operations silos are illustrated in Figure 4.

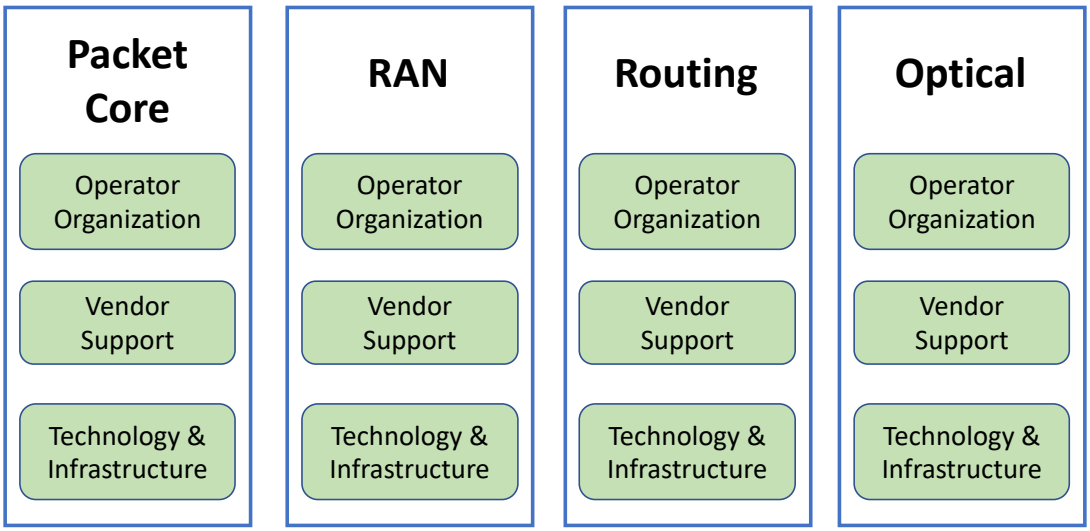

Figure 4. Operations Silos in Legacy Networks

In 5G networks, infrastructure and operations must move from a silo to a horizontal architecture in order to support new services. Organizations must be able to provide support on a cross-domain basis, across applications, network elements, distributed data centers, and cloud infrastructure to enable new services and provide effective service assurance. 5G hybrid cloud networks will require transforming operations, breaking down silos, and integrating modern cloud tools and AIOps into operations.

The reason for this operations transformation is that infrastructure is becoming more heterogeneous and more challenging. CSPs are no longer managing silos with a single vendor's solutions; network functions can be provided by multiple vendors or with open source. 5G is based on open systems versus closed systems, and network functions run in Kubernetes containers or virtual machines, which constitute a horizontal architecture across multiple data centers and geographies. Operations silos can no longer work when the network is based on a cloud-native horizontal architecture, and there are multiple vendors and components that must interoperate. Operations need holistic end-to-end visibility to support horizontal services.

Additionally, skill sets need to change. Current skill sets are based on vendors' technologies, solutions, and tools and are network-centric. Future skill sets include both network-centric skills and modern cloud data center operations skills:

- Managing bare-metal layers: compute, network, storage
- Administering virtualization layer: Kubernetes, OpenStack, hypervisors, orchestration, security, SDN, etc.
- Applying end-to-end cloud and data center skills and management to break down organization silos

Skill sets to contend with the massive complexity of 5G may be tough to find; organizations instead should seek operations tools and processes that simplify complexity and then reduce the skills required. The modern tool and processes (AIOps) will bear the burden of complexity.

5G Services Paradigm Shift

New services are key to 5G business success to grow revenue and profitability. CSPs cannot pay back 5G infrastructure investments with traditional smartphone services alone. Many new services will be needed:

- Enterprise services: Network slicing, IoT, private 5G, Business AR/VR, smart factories, fleet and inventory management, etc.
- Edge services: Connected vehicles, cloud gaming, IoT, drones, robots, etc.

To introduce new, profitable services quickly and successfully, CSPs must have both:

- Service agility: Ability to rapidly deploy new services and implement fast fail for services that are not successful
- Service assurance: Ensure that all services provide end-users with high availability and performance

Additionally, CSPs need to move to intent-based services to provision and operate services based on end-users' intent and requirements. Intent-based services are services that can be created and managed without excessively complex configuration, fault management, and performance management processes. To reduce this complexity CSPs should use machine learning and artificial intelligence to provide a robust AIOps infrastructure.

Pain Points

As CSPs roll out 5G there are several key pain points that need to be addressed.

Pain Point #1: Managing the Transition from Hardware Network Elements to Virtual Network Elements

Network elements, including the packet core and RAN, are moving to cloud-native architectures. Today, CSPs rely on a few vendors and systems integrators for network maintenance, and in some cases, they outsource operations to a large vendor. As RAN, packet core, and MEC edge services move to cloud-native architectures there are multiple problems that need to be solved:

- Traditional telco central offices are transitioning to modern data centers; new skills, tools, and processes are needed
- A large telco network can have tens or hundreds of thousands of mini data centers; this is a complex scalability, management, and operations challenge
- The new environment has multiple vendors, open-source software, white-box solutions, and it is all running in a modern data center environment in containers orchestrated by Kubernetes
- CSPs must support multicloud environments, including private clouds, public clouds, and private/public edge clouds
- The CSP needs to take responsibility of systems integration and life-cycle management of an extremely complex distributed, multicloud environment

These factors lead to increased network complexity. Some of the questions that need to be answered are:

- How do I manage that environment?
- How do I monitor it?
- How do I do service assurance?
- How do I roll it out?
- How do I make all those things work?

Pain Point #2: Managing Service Delivery, Service Agility, and Service Creation

The paradigm shift from a hardware-centric telco network to a cloud-native network with highly distributed edge data centers means that service delivery processes and procedures will need to completely change. There is also a need to deploy more services, faster to many different types of customers, including new enterprise and edge services.

The key problems that need to be addressed are:

- How can services be rapidly and efficiently deployed?
- How can CSPs consistently maintain service level agreements (SLAs)?
- Building and deploying services at rapid scale and rapid frequency requires a mature DevOps model, how do CSPs implement and maintain such a DevOps model?
- How to support applications developers and third-party service providers with a modern DevOps model?
- What data center architecture and software tools are required to accomplish these goals?

Pain point #3: How to Achieve Operations Efficiency Through Automation

Bad news travels fast so it is essential to minimize service problems, especially with large enterprise customers because service performance problems and outages can adversely affect future business. The key problems that need to be addressed are:

- How to reduce manual tasks and workloads?
- How to speed incident response, reduce MTTR, and maintain SLAs?
- How to automatically diagnose problems before they are detected by customers?
- How to automatically remediate problems as they are occurring?
- How to create a self-healing network?

Lack of 5G service infrastructure visibility and employing manual brute force are two common reasons for pain listed in the three points previously mentioned. To achieve service agility and assurance, critical success factors will require an intelligent monitoring/automated approach that can quickly adapt to changes within a dynamic 5G environment.

Solution to 5G Pain Points

These pains points must be addressed using a transformational methodology that is focused on 5G business outcomes:

- Shift from siloed operations organizations to unified horizontal organization.
- Support operations with unified, end-to-end service assurance powered with AIOps.
- Implement a modern DevOps model.

These pain points cannot be solved with manual brute force. Automation is a critical success factor for 5G network service agility and service assurance, and it is necessary to employ an intelligent monitoring solution (unified AIOps) across the diverse 5G environment:

- Private/public cloud in 5G centralized data centers
- Private/public cloud in 5G edge data centers
- 4G Legacy hardware and software

AIOps is a journey from human-powered to machine-powered operations that will incorporate constantly increasing levels of automation. Figure 5. The key dimensions necessary for highly efficient and scalable network operations are:

- Data
- Analytics
- Automation

As CSPs progress from Level 0 manual operations to Level 5 fully autonomous operations it is necessary to break down data silos and create 5G services topologies and self-organizing data sets, apply machine-learning based analytics to learn, predict, and correlate 5G service behaviors, and automate network operations driven by actionable 5G service insights.

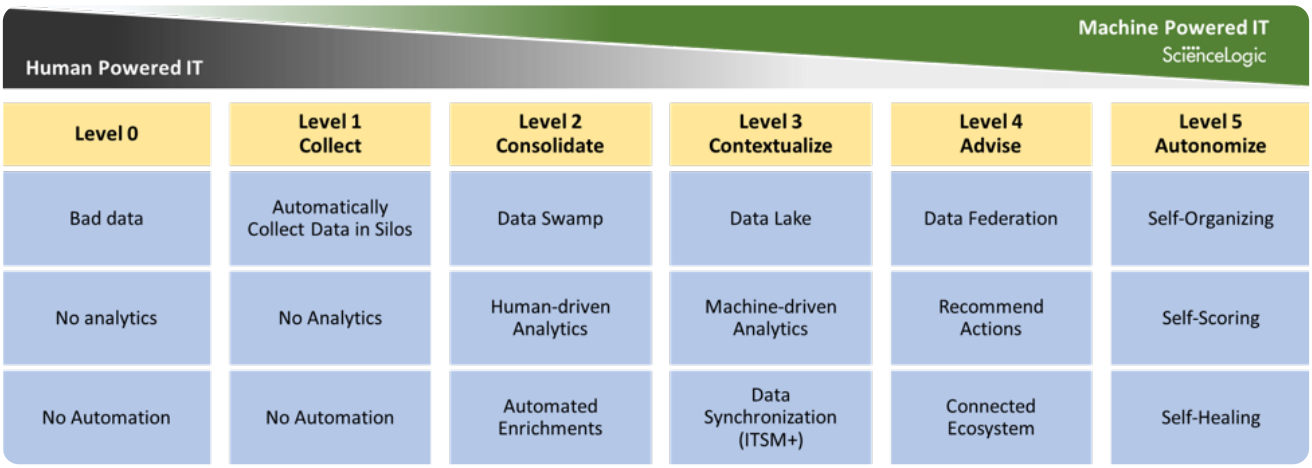

Figure 5. Journey from Human to Autonomous Systems

AIOps Process and Architecture

The AIOps journey flow and architecture is depicted in Figure 6. There are four central components in the architecture:

- Monitoring and data collection
- Contextualize data
- Automate IT workflows
- Unified DevOps environment

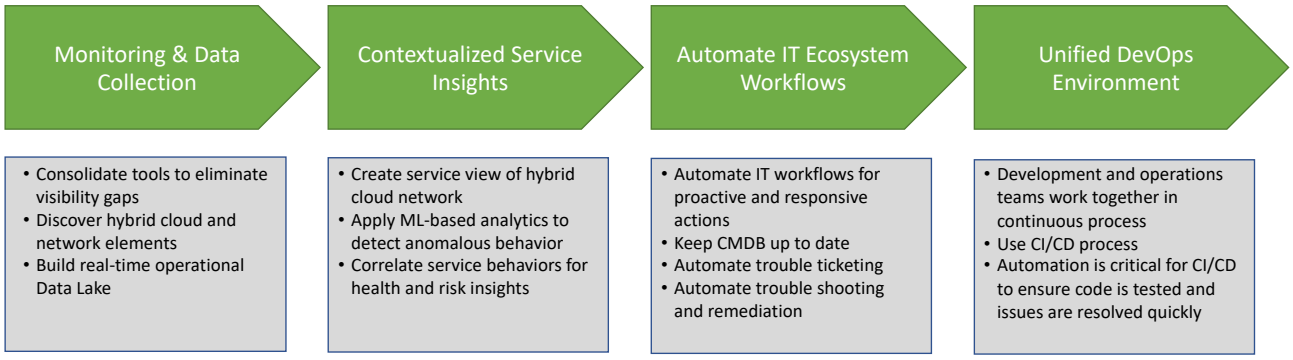

Figure 6. AIOps Architecture and Process

5G Network Monitoring and Data Collection: Build a real-time operational data lake

The first problem that needs to be addressed is how to get visibility across a large, distributed heterogeneous network. This is a challenge because many of the network elements and technologies have traditionally existed in silos, and in 5G networks they are moving to a heterogeneous horizontal architecture.

The first step is to discover all 5G virtual and physical network elements. These could be hardware, software, cloud native, and could exist in a multicloud environment. Data collection needs to be across the entire 5G network and not restricted to specific vendors or technology silos.

Once the data is ingested it is imperative to build a real-time operational data lake. In order to accomplish this a common platform is needed to ingest, normalize, and format data from many sources. This also involves merging, aggregating, and deduping data. The real-time data lake must allow users to build their own queries and create custom reports and unified dashboards.

Contextualize: Gain actionable 5G service insights

CSPs should be able to create a service view of the network using the data lake to visualize health, availability, and risk of outages for individual network services. Service assurance and fault management automation must be based on services not individual network devices. Given a service view of the network and a real-time data lake it is possible to apply a rich set of analytical techniques and machine learning to detect anomalous service behavior. This allows CSPs to:

- Rapidly identify service impacting issues
- Determine root causes
- Predict service degrading events before they occur
- Recommend remediation actions

Automate IT workflow

After a data lake is created to allow a service view of the network, analytics can be used to automate a wide variety of IT workflows. Workflow automation includes both proactive and responsive actions to troubleshoot and remediate problems to improve service performance and availability. Automation also allows CSPs to keep their configuration management database up-to-date and accurate. This includes automation and routing of trouble tickets to manage IT workflows.

Provide a unified DevOps environment

In 5G networks it is essential to deliver new services to the market. In order to deliver services rapidly it is essential to move to a unified DevOps environment using a CI/CD process where development, testing, production, and monitoring are a continuous integrated process. It is necessary that IT workflows are fully automated and integrated with an AIOps environment for CI/CD to be effective. Automation is critical for CI/CD to ensure code is tested and issues are resolved quickly. This allows for new software supporting next-generation 5G services to be deployed rapidly and reliably.

Solution Benefits

The most important benefits of implementing a modern AIOps service assurance solution are service availability and performance, which result in satisfied customers and which in turn reduce churn and allow operations to grow revenues in existing and new accounts. AIOps enables services to be deployed quickly, facilitating rollout of a greater number and variety of services and for faster time to revenue.

These benefits result in CSPs:

- Maintaining SLAs
- Growing market share
- Minimizing churn
- Increasing service revenue

In addition to improving availability and performance, AIOps also reduces the cost of operating and maintaining the network infrastructure. This is because less time is required for manual operations, and the skill sets required by operations staff is lower due to the help of artificial intelligence and machine learning.

The bottom line is that in a complex distributed 5G cloud-native network it is close to impossible to effectively operate the network without advancing through levels of AIOps. This solution solves the key problems of the evolution to 5G:

- Support massive scale
- Enable customer and service centricity
- Enable autonomous, closed-loop, zero-touch approach to 5G

Conclusion

5G is driving the migration from a physical technology and organizational silos to a horizontal cloud-native network. This transition represents a paradigm shift in network infrastructure, operations, and services. The only viable approach to managing the challenges of massive scale, highly distributed data centers, and rapid delivery of new services is to implement an AIOps architecture.

AIOps allows CSPs to provide network operations and service assurance at scale while reducing the requirements for highly skilled staff to management network operations. This allows CSPs to satisfy customers, introduce new services, and grow revenues. AIOps is a critical tool for CSPs that want to stay ahead of the curve in an increasingly competitive 5G market.