The telecom industry is entering a new period of profound transformations with the advent of digital services (cloud, 5G, edge, Internet of Things) and virtualization technologies such as software-defined networking (SDN), Network Functions Virtualization, and cloudification (VNFs, CNFs, xNFs). This radically new era is characterized by an explosion of the number of users, devices, applications, and data traffic volumes through a seamless and ubiquitous connectivity. The communications service providers (CSPs) are at the heart of this digital revolution.

There has been a significant change during the past years in the way people communicate, and in particular, in the mobile telecom services. The advent of 3G and 4G/Long-Term Evolution (LTE) connectivity has played a significant role in this. It has been a major catalyst in the shift from traditional telecom services, voice, and SMS, to a more data-centric mobile phone experience.

CSPs are rebuilding their networks using standard IT technologies, moving away from proprietary networking hardware that is unique to the telecom industry. Software is invading the network, which is driving expenses on new types of software technology and leading to a great deal of spending on professional services to put the technology together in new ways. Cloud technology is the largest category of digital networks software spending.

MANAGING HYBRID, MULTIDOMAIN, MULTIVENDOR ENVIRONMENT: A KEY OPERATIONAL CHALLENGE FOR CSPS

CSPs are facing significant challenges to successfully deploy and operate 5G, edge, and digital services. On one hand, they must be able to seize the digital opportunity and transform themselves to digital service providers (DSPs), monetizing their investments in the form of new service revenue, with speed and agility, while being submitted to growing competition, in particular from OTTs. On the other hand, technology-wise, the advent of new technologies is creating significant shifts that will deeply impact the telecommunications market. In particular, 5G Network Functions will be implemented as light-weight, stateless, and containerized web services, leading to an IT-ification of the network infrastructure. As a result, CSPs will have a complex multidomain, multivendor environment to manage, both at the edge and at the core, made of physical infrastructure and virtual functions, plus specific applications. CSPs must be able to operate this new, massive and complex set of infrastructure and services without increasing their human resources: automation is becoming a priority for CSPs.

Another key challenge for the CSPs is that 5G will not be deployed as a brand new, separate infrastructure in one shot. 3GPP has defined many different co-existence scenarios with legacy networks. CSPs will have to operate a hybrid infrastructure made of both legacy radio, transport and core networks and new virtualized networks, data centers, and applications.

INTELLIGENT AUTOMATION: THE ROAD TO ADDRESS SERVICE ASSURANCE CHALLENGES

As a result, CSPs will need a consolidated service management solution that has been designed to address service assurance over hybrid, multidomain, multivendor networks, and data centers. This is driving CSPs to use an assurance solution in the cloud managing Networks Functions in the cloud. We believe at Hewlett Packard Enterprise that only an intelligent, automated, and agile service assurance can allow CSPs to deal with such a volume, dynamicity and diversity of networks and services.

- **Data driven intelligence:** To handle diversity of information (fault, performance KPIs, logs, telemetry, probes, flows, etc.) to detect anomalies and predict failures.

- **Automation:** To monitor, troubleshoot, and remediate with limited human intervention issues affecting infrastructure (data centers, VNFs, PNFs...) services and customers.

- **Agility:** Manage from the cloud, scaling automatically to adapt to the dynamicity of the new services provisioning and monitoring.
DATA-DRIVEN INTELLIGENCE

With the explosion of devices and traffic volumes on the network, the traditional approach to service assurance functions, such as fault management and performance management, with manually defined policies and data loaded topology information, will not be able to address the challenges caused by the volume and diversity of the information to be processed (i.e., fault, performance KPIs, logs, telemetry, probes, flows, social media) to detect any failure or performance degradation.

We thus believe that machine learning and more generally, artificial intelligence, are the right foundation to effectively allow CSPs to automate the detection, prediction, and remediation of network issues and service degradation. An intelligent monitoring, including aggregation, prediction, and correlation techniques, becomes mandatory. The assurance system must be capable of learning over time and getting smarter, moving closer to the paradigm of a robot that leverages artificial intelligence, and ultimately delivers Zero-Touch automation. This data-driven intelligence approach relies on several pillars:

Pattern Discovery
This function provides a powerful way to transform vast amounts of network and service fault data into actionable information, using probabilistic and statistical techniques. Big Data platforms and techniques, including machine learning algorithms and data mining, are leveraged to increase insight and optimize network assets, identify frequent patterns and take proactive actions, to remediate the issue before it affects services and tenants’ or customers’ QoE commitments.

Anomaly detection
This function detects unusual patterns that do not conform to expected behavior, and are often referred to as outliers. It takes into account trends, seasonal day-of-week, and time-of-day patterns. It quickly alerts monitoring systems or the orchestrator about any deviation of slice quality metrics.

Prediction and early warnings
This function implements policies and procedures designed to predict ahead of time, and mitigate failures and other undesirable events, forecasting and signaling disturbances that adversely affect the delivery of services in order to either completely avoid or at worst minimize the impact.

FIGURE 1. HPE service assurance aligns with CSPs’ digital strategy
AUTOMATION TOWARD ZERO-TOUCH OPERATIONS

HPE has, for many years, offered a comprehensive integrated portfolio of assurance solutions and services that help DSPs meet business and customer expectations while providing sophisticated features that improve service and network operations efficiency. These integrated solutions provide visibility of the actual customer experience and its relation to the health of telecom, IT, and IP network and services, and automatically trigger incident and problem management processes to handle any customer, service, or network issues.

Those processes are best practices that continue to be applicable to 5G service assurance. They help automate the remediation of issues in combination with data-driven intelligence.

Real-time fault and problem management
This function collects faults from the network (Layer 1 to Layer 3), extended to 5G equipment, and also signals coming from the intelligent monitoring layer. Based on the correlation of these different sources, this function manages the automatic creation and management lifecycle of prioritized problems affecting the slice services.

Automation
The role of this function is to enable Zero-Touch operations through the implementation of smart filtering of events and alarm grouping, root cause analysis and service impact analysis, automatic problem detection, automatic remediation, preventive maintenance, and dynamic platform scaling. This can be operationalized automatically from the AI/ML assistant Intelligent Assurance Pattern Discovery and Operationalization.

Customer and service experience
This function gains insight into how users use services and applications, in order to get visibility on what is the actual, real-time user experience of the services, understand traffic, usage and how network, services and devices interact and affect one another. It supports troubleshooting across services and network layers.

SLA management
This function is important to monitor and guarantee the slice QoS and QoE commitments. It includes automatic creation and monitoring of new tenant and provider commitments, compliance calculation of committed ultra-reliable low latency (uRLL) metrics such as latency, bandwidth, availability, reliability, security, and financial risk control (service credits and penalties), with real-time calculation and monitoring of SLAs compliance status.

AGILITY: AUTOMATE OPERATIONS TO MANAGE NETWORKS FROM EDGE TO CORE, FROM THE CLOUD

With the explosion of a new generation of digital services, HPE OSS has to adapt and support new networks and services of any size and complexity. It has to cope with sometimes the explosion of the traffic and sometimes decrease of load. HPE OSS has to be agile at any layer (network and management functions), reliable (high availability and disaster recovery), and the time to productize a new network or service has to be reduced to the minimum.

The Assurance cloud must:
- Containerized microservice architecture deployed in any cloud environment using any hypervisor
- Flexible delivery: on-premises, private cloud, public cloud (including as a Service)
- Open
- Secure
- DevOps and CI/CD support
DEALING WITH 5G SLICE SERVICE ASSURANCE

The telecommunications market expects 5G to bring huge enhancements in terms of bandwidth, latency, and number of devices supported, with the first commercial offerings starting late 2019. But in addition, 5G is expected to support a wide range of new services that will be offered by the CSPs, the Mobile Virtual Network Operators (MVNOs) and growingly, the OTTs. Those services will serve consumers, of course, but also enterprises and governments. 5G services will range from consumer mobile broadband to some very specific use cases such as highly secured government networks and highly reliable, low-latency remote surgery services.

5G slicing poses a specific challenge, because while slice instances will be set up on demand, the customers who will require a slice for their end-users will expect to get the level of low latency and quality of service they pay for. This means that CSPs will have to be prepared to manage slices in every aspect, including service assurance, i.e., monitor events/alarms, topology, traffic, metrics and performance related to the monitored slices and the underlay networks.
AGILITY FOR THE DYNAMIC, CLOUDIFIED 5G NETWORKS

In order to bring the service assurance functions at the same level of flexibility, simplicity, cost-efficiency, and agility that NFV brings to the network, the solution must offer a digital-ready scalability, flexibility, and high availability, thanks to a microservice architecture. The service assurance should align with CSPs’ emerging interest in integrating VNF and VMF (Virtualized Management Functions) orchestration.

Given the 5G network criticality, the reliability of the service assurance solution must support high availability and disaster recovery functions across different data centers.

The flexibility of the solution to move rapidly from development or preproduction environment to production (DevOps) must also reduce long cycle times and turnaround defect fixes and enhancements faster.

HPE OSS SOLUTIONS, DESIGNED TO ADDRESS 5G’S OPERATIONAL CHALLENGES

HPE is one of the leading vendors in orchestration and OSS. HPE has been investing significantly in NFV, NG-OSS and deployed quite successfully solutions for operators moving to software-based networks and transforming themselves to DSPs, with agile and automated management processes.

As mentioned earlier, 5G is leveraging SDN/NFV and a number of IT technologies and processes that HPE OSS solutions have been managing for years. For the management of 5G, HPE can combine a set of existing solutions including:

- E2E service orchestration (HPE Service Director)
- NFV MANO (HPE NFV Director)
- Intelligent, automated, and agile service assurance (HPE vTeMIP, HPE Unified Correlation and Automation, HPE Intelligent Assurance, and HPE uSLAM)

All those HPE solutions are open to support either HPE or third-party platforms, or a combination of both, including open source platforms.
OVERVIEW OF HPE OSS ASSURANCE SOLUTIONS

HPE offers a comprehensive integrated portfolio of assurance solutions and services that help DSPs meet business and customer expectations while providing sophisticated features that improve service and network operations efficiency. These integrated solutions provide visibility of the actual customer experience and its relation to the health of telecom, IT, and IP network and services, and automatically trigger incident and problem management processes to handle any customer, service, or network issues.

HPE OSS Assurance solutions is a rich set of software and services:

• A software portfolio that fits customer’s innovative technology requirements
• A consulting-led approach, delivered by HPE Business Transformation Services, to help translate your strategic drivers to measurable business outcomes
• Design, implementation, and support services, delivered by HPE Pointnext Services professionals all over the world

HPE OSS Assurance portfolio is proposing a set of applications to address automation and Zero-Touch Network Operations Center (NOC) operations at several levels—resource, service, and customer.

FIGURE 4. HPE OSS Assurance portfolio summary

FIGURE 5. HPE OSS Assurance self-driven, zero-touch operations
**Orchestrated HPE vTeMIP Suite**

HPE vTeMIP Suite brings innovation and agility to the NOC to monitor the next generation of services, thanks to the new HPE vTeMIP Suite microservice architecture. Its elasticity allows to automatically scale when the monitoring of the network requires more capacity, and comes back to normal, when the load decreases, with no operation disruptions across data centers.

This multivendor and multitechnology solution provides off-the-shelf mediation components (+400), for the main telco vendors on the market.

**Automatic correlation detection**

HPE Intelligent Assurance uses AI/ML techniques to automatically discover issues that are not yet handled by the automated operations stack, and could be translated into a useful correlation and automation rule, replacing manual discovery by automatic process. The productization or operationalization of a discovered rule could be reduced and should allow to proactively detect problems before impact on services and customers, and operate a DevOps lifecycle.

**Automated operations**

HPE Unified Correlation and Automation (UCA) detects automatically known network issues and executes resolution tasks to remediate the problem before it affects customers. It enables end to end visibility of network and services health. It’s coupled with automation of resolution processes, which typically leads to dramatically reduced time to identify, isolate the cause of an issue, and fix it for different network technologies such as radio access networks, mobile backhaul, transmission networks, fiber passive optical networks, IP/VPN networks. Importantly, the solution also determines the impact of a problem on services and customers, providing customer care with insight into outstanding issues, and the ability to provide knowledgeable answers to customer complaints.

**Orchestrated SLA management**

The business impact (like customer credit back, satisfaction, penalties) monitoring is a crucial aspect to control capital expenses and potential loss of revenues when selling customer SLAs. HPE uSLAM automates the implementation, deployment, and monitoring of customer SLAs to prioritize better network issues that are affecting customer contracts and report SLA compliance to customers at each evaluation period. It also provides automatic mechanisms to monitor underpinning contracts with third-party providers and get revenue back from them in the same tool.

**Orchestrated HPE vTeMIP Suite (agility)**

Proven success of IT virtualization and cloud computing is one of the key triggers for the birth of the NFV concept. The goal of NFV is to virtualize and automate network functions so that they can be managed on general-purpose IT servers instead of ASIC-based purpose built appliances. Any network function that is or can be virtualized is called a Virtual Network Function (VNF). NFV also brings in an extensive orchestration capability to enable the dynamic deployment of VNFs, thereby addressing the issue of underutilized network.

NFV allows the migration of network functions from proprietary, physical hardware to less expensive, more flexible commercial off-the-shelf (COTS) servers. While NFV is not a new concept, it has the power to change the way service providers do business forever. The promise of NFV to generate new sources of revenue lies in the ability to quickly roll out services and manage them dynamically, optimizing their infrastructure.
Following are the obvious benefits after realization of NFV concept:

- Low CAPEX and OPEX.
- Elasticity with the realization of NFV—Scale-up and scale-down of network is possible, which will enable CSPs to manage an optimized network.
- Service agility—NFV will support new service rollouts faster.
- Operational simplicity—NFV vouch for open standards-based implementation, which will bring an opportunity to simplify the elements.
- Rapid innovation—Innovation will be made easy since software is governing network.
- Manage dynamicity in real time—Deployment of a VNF will take only a few minutes as opposed to weeks or months.

However, it is difficult for CSPs to fully take advantage of the network virtualization if the management functions cannot be virtualized and orchestrated dynamically like network functions.

The reliability of solution is addressed with built-in functionalities to support high availability and disaster recovery functions across data centers.

The flexibility of the solution to move rapidly from development or preproduction environment to production will reduce long cycle times and turnaround defect fixes and enhancements faster.

**HPE vTeMIP Suite benefits**

- Align with CSPs' emerging interest in integrating VNF and VMF orchestration
- Digital-ready scalability, flexibility, and high availability, thanks to microservice architecture
- Lower platform costs, thanks to virtualized microservices optimizing use of hardware and software
- Lower TCO due to simplified operations, administration, and maintenance
- Smoother transitions from development and test to production with DevOps

**FIGURE 6.** HPE vTeMIP suite key differentiators
HPE Intelligent Assurance (analytics, artificial intelligence, and machine learning)

HPE Intelligent Assurance provides CSPs with the means to take up the challenges they face in terms of service assurance, through ML based intelligence and advanced automation, providing 24x7 software working at extracting value out of huge amounts of historical data and the operationalization of the results to automatically generate process automation.

There are several use cases covered in the context of Intelligent Assurance that will allow operations team to detect operations issues earlier.

HPE Fault Archival and Statistics provides a powerful way to transform vast amounts of network fault data into actionable information using statistical techniques. HPE Fault Archival and Statistics augments the traditional fault management HPE OSS with powerful alarm reporting and analysis functions achieved by exporting all the incoming alarms into a Big Data platform in real time. This makes all alarms available irrespective of their current state. With an optimized dimensional model, you can quickly access large amounts of fault information for analysis and reporting, thereby extracting knowledge and insight from fault management data.

- Extract, load, and transform the vast amounts of alarm data into meaningful information using the HPE Fault Archival and Statistics Big Data storage platform, optimized for data warehousing and data reporting
- Generate insightful graphical reports that provide a multidimensional view of the fault occurrence history
- Provide reports on how the faults themselves are managed, such as acknowledgement and termination of alarms, and closure of trouble tickets, to identify process improvements in fault management and problem resolution

The overall solution exposes all its information through single-pane-of-glass dashboards.

- Synthesizing information to view service failures, customer issues, and critical resource outages in real time through the involvement of the best resources to address the issue
- Communicating resource performance and service quality/experience to operators, customer care agents, and managers clearly
- Providing visualization to enable insightful management decisions and resolution of complex problems

Automatic Pattern Discovery is a three-phased approach to leverage the capabilities of artificial intelligence and machine learning to address challenges arising in network and service assurance operations.

With Automatic Pattern Discovery, HPE Intelligent Assurance provides CSPs with the means to take up the challenges they face in terms of service assurance, through machine learning and advanced automation, with those primary objectives.

- Work 24x7 at extracting value out of huge amounts of historical data.
- Offer a smart and tight combination with HPE UCA to automate remediation procedures.
- Provide a powerful reporting and analysis tool to dramatically improve operational effectiveness.

The solution supports data lakes based on open source platforms, accelerating return on investment for customers who already created their own OSS data lake.

The results emerging from the application of machine learning techniques are operationalized by implementing an intelligent machine to pinpoint problems, root causes, and incidents. This enables automatic maintenance and repair actions to remediate the problem.
Automated operations

The automated operations building blocks consolidate the traditional operations in order to bring more efficiency and reduce operational costs. The goal is to optimize and automate the trouble to resolution process and capture the manual task to the maximum into an automatic workflow.

The challenges of today's operations:
- Inefficient prioritization of trouble, missing service, and customer impact
- Manual processes to find root cause
- Too many GUIs, no consolidated view across service
- No operations automation (trouble ticketing, automated repeatable tasks)

The value brought by the HPE UCA solution:
- Integrated multivendor and multitechnology fault management and performance management
- Automated correlation root cause and service and customer impact analysis
- Automated trouble ticketing and enablement of RBA
- Consolidated operator console

FIGURE 7. HPE Intelligent Assurance process for Automatic Pattern Discovery and Operationalization into HPE Unified Correlation and Automation (UCA) solution

FIGURE 8. HPE UCA solution to support zero-touch NOC operations
Orchestrated SLA management
The visibility of the customer impact to operations is critical to coordinate and organize the corrective actions. HPE Universal SLA Manager automates the management of obligations between service providers and customers of supported services. It addresses the operational processes associated with defining and managing the SLA compliance to customer contracts as well as SLA modifications and service termination.

The solution allows defining, monitoring, and reporting on high number of SLAs and a wide range of possible SLA clauses such as time to deliver a service, compliance to service performance objectives, or trouble resolution mean time commitments. The solution can be expanded for management of not only customer SLAs but also for management and reporting of the internal SLA/OLA. Thus, this solution can be combined and integrated with the correlation and automation engine to prioritize the operation actions better.

HPE Communications and Media Solutions
HPE Communications and Media Solutions is dedicated to creating vertical solutions for the communications and media industry. With over 30 years of experience in the industry, we have over 50 solutions, over 1500 active contracts, and more than 300 telco customers in 160 countries. We provide software and services that enable your digital transformation, automate your operations, and help you grow your business with innovative cloud-native network solutions and digital, 5G-ready services.
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