EXECUTIVE SUMMARY

Market forces and changes in subscribers’ needs and expectations are leading communications service providers (CSPs) to update their entire service delivery and management infrastructure. At the forefront of this digital transformation is the modernization of the systems for managing network services, operations support systems (OSS), and the systems for customer and overall business operations, business support systems (BSS). Current systems were built for a business paradigm that is increasingly outdated; they are rigid, siloed, rely on extensive human involvement and often require esoteric skills. Modernization helps a CSP address the requirements for its transformation into a digital service provider (DSP) of the future: business agility, elastic scale and capacity, service velocity and the ability to continuously reinvent itself.

Managed open source software is essential to modernizing OSS/BSS architecture, providing operators and their vendors with proven tools and technologies as a future-proof base for creating a flexible and automated future.

In this paper, we present a vision for the evolution of OSS/BSS comprising an open operator software architecture, a roadmap of how to get there, the key open source software tools that will power the journey and concrete steps to get started. It should be of interest to CIOs, CTOs, CDOs, and those involved in the planning and operations of OSS and BSS.

KEY FINDINGS

• Future OSS/BSS will be massively automated, minimizing manual effort in moment-by-moment operations. People will monitor and govern the behavior of the systems. OSS/BSS will be built cloud-native, deployed in containers on cloud infrastructure, and powered and managed by open-source systems.

• BSS modernization will focus on automating end-to-end business processes. Open source tools will automate and integrate applications and give them access to data from a variety of sources, so customers have a unified, superior experience from their provider.

• OSS modernization will proceed, first, by automating all the processes within a given domain, then select processes will be automated across domains. As automation becomes more complete, simplification of the domain structure will follow. Providers can rely on open source solutions for this evolution, as well.

• Concrete, near-term steps that pay for themselves can be taken to begin these journeys.
INTRODUCTION

CSPs have been using software for business (BSS) and network operations (OSS) for the last 70 years. During that time, innovations in communications technologies have paved the way to global, instant, mobile internet connections among people, processes and things. The speed of business for service providers is orders of magnitude faster, as the technology has set high customer expectations for personalization and instant digital gratification and for an increasingly complex set of offerings and bundles. These market needs have made continuous change for OSS and BSS the norm. New systems are introduced, versions of existing systems are updated, and old ones are retired. Without modernization, legacy systems make changes difficult and expensive and limit the service provider’s ability to innovate and keep up with competition.

The network infrastructure is transforming from specialized hardware to software running on standard servers at the same time as the software technology itself is quickly changing. The cloud and cloud-native architectures are changing how applications are built and how they can readily run almost anywhere, even distributed throughout the network. Containers and new agile integration approaches facilitate moving to DevOps processes to accelerate development and delivery of new services. Open source is powering this innovation and is a key contributor to OSS and BSS modernization.

This paper outlines the drivers for this modernization and the issues involved. It provides a high-level vision of the OSS/BSS architecture of the future plus the journey to get there, including concrete steps to take that have proven themselves in the industry.

DRIVERS FOR COMMUNICATIONS SERVICE PROVIDER OSS & BSS MODERNIZATION

OSS and BSS provide the operating foundation of the telecommunications business. Together they support network operations, service delivery and management, overall business operations and customer care. OSS are geared towards service and network operations support, while BSS are more customer facing, supporting revenue generation and overall business processes.

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Table 1. Segments of Service Provider OSS and BSS

Legacy OSS and BSS are rigid and often the result of ad-hoc iterations to support new services or capabilities. Many times, when services were introduced, they each came with their own new OSS or BSS. Mergers and acquisitions have added even more into the mix. Each system, with its idiosyncrasies,
demands significant human involvement and time to update, making them impediments to creating the fast moving, continuously evolving service environment needed today.

To achieve increased service velocity with rapid innovation supported by continuous development and delivery, service providers need more efficient, nimbler, and more automated software platforms. They can break down the silos among disparate OSS and BSS and leverage more broadly and commonly the functions and services embedded among them. A modern microservices-based architecture can provide the infrastructure to streamline service creation and operation and help improve competitiveness. Supplanting waterfall development cycles with DevOps methodologies supports even better the shrinking concept-to-revenue demands of their businesses. Open source technologies are leading the way as the foundation for this innovation.

DRIVERS FOR BSS MODERNIZATION
Today, customers expect a unified, omnichannel digital experience, including self-service capabilities. No matter the touchpoint, customers want the same experience across all of them, no missing data, no missing options, easy, intuitive. Modern systems using integration with clearly defined APIs deliver cohesive support across the various elements of service delivery and management. Driving more automation into these systems further smooths the experience, while people still can govern the flows and get involved when a human touch is needed.

The services of the future will rely on elements of machine enhanced learning and eventually artificial intelligence, and the modern BSS architecture has the integration tools and APIs to help weave them in. This also means that the right data need to be collected and ultimately mined to create intuitive services and to evolve services based on customers’ usage patterns and expectations.

DRIVERS FOR OSS MODERNIZATION
Telecom operators are also seeking ways to drive efficiencies and lower operating costs by streamlining and automating what is today a rigid, siloed, highly manual operating environment. Increasingly networks are becoming able to automatically detect potential degradation and remediate problems before they escalate into outages. Self-healing requires automation, backed by extensive data analytics. Legacy networks lack such capabilities, and have only limited, largely human-driven monitoring available. The modern OSS architecture accommodates these needs, pulling together many data sources and allowing elastic scaling out of the analytic instances needed to drive automated decisions and actions. In addition, it simplifies provisioning, upgrading, and compliance monitoring across large hybrid environments.

OPEN OPERATOR SOFTWARE VISION
The containerized, microservices-based cloud native software of the future will be organized into layers, Figure 1. At the top are the processes for the management of the network and the business. These are instantiated by applications, policy-driven, AI and ML enhanced software that is developed by the digital

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1 The set of processes are best described in the TM Forum’s Business Process framework (eTOM). See www.tmforum.org/business-process-framework/.
2 The set of applications varies by operator. But one good generic view of the list is from the TM Forum’s Applications Framework (TAM). See www.tmforum.org/application-framework/.
service provider itself or by commercial vendors. These applications are built using a set of microservices that can evolve and scale independently. The microservices run in an orchestrated container environment that automatically scales up or down and even physically moves them to the best computing and storage resources available. Finally, the entire stack is run on a cloud infrastructure, whether private, public, or hybrid clouds.

Figure 2 shows the applications layer in more detail. The layer is wrapped in API gateways that connect the cloud-native world with the other parts of the operator. Physical network elements from the access, edge, and core (bottom) connect to this layer with adapters. Legacy OSS and BSS (right) are wrapped to provide APIs to the new systems until they are refactored or replaced over time, maximally using their data and functions while new functionality is built for the new architecture. User applications and systems (top) deliver direct system-to-system interfaces to the operator’s ecosystem partners through managed API gateway that provides security, governance, and flow control. To the left are the smart devices on the customer’s premises or in distributed data centers.

The applications fit into several categories. **Portals** connect to external systems and customers or to internal operational and governance users. The **OSS** and **BSS applications** provide the business and network management functions while the services are provided by advanced **digital services applications** and by containerized network functions (CNF) and virtualized network functions (VNF). Operations are governed by **policy repository** rules, informed by network and customer data in the **data repository**. Overseeing the entire complex, the **AI, analytics, and security applications** directly control the operations using the rules and governance oversight provided by the operator’s team.

**OSS AND BSS MODERNIZATION JOURNEY**

How does an operator move toward the vision? Re-engineering of large sections of the software infrastructure would be expensive, time-consuming, and risky. Instead, it is best to plan a series of multiple smaller projects, often divided into short, agile subprojects to deliver functionality incrementally. The continuous evolution and innovation in OSS/BSS requires constant integration with changing technologies that need to work together. It is akin to rebuilding the airplane in flight.
The **first step** is to go for quick-hit projects that bring immediate benefit. Chief among these are two basic categories:

- Federating multiple databases to create a single source of truth for the managed data.
- Automating simple tasks, usually using robotic process automation technology, such as the Red Hat Ansible, to decrease costs, increase speed, and standardize processes and equipment configurations.

The older systems that still provide adequate functionality and scalability can be wrapped with APIs for use to integrate databases of record and to provide services to the other parts of the new architecture until they are refactored or replaced. If not already done, these systems can be containerized to gain the efficiencies of running on cloud infrastructure.

The **second step** involves beginning to refactor functions of the legacy systems or add new containerized microservices. These newer elements integrate with the wrapped legacy systems using the APIs, federation and automation from the first step.

In the **third step** service providers are in position to simplify and rationalize the new architecture. This usually involves breaking down the organizational boundaries that grew up organically during the last forty years of OSS and BSS deployment.

The **fourth step** is to adopt a new cooperative development model whereby the CSP moves toward purchasing new microservices from vendors and then integrating them into its overall architecture. This model is in its infancy but showing great promise.

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**Figure 3. Infrastructure Modernization Journey**

For BSS modernization, the operator should incrementally automated one selected capability at a time, including a service (for example, video), a target market (for example, residential), and a process (for example, order to delivery). With the underlying wrapped legacy functions and newer microservices, the service provider is paving the way to future cooperative development.
For OSS modernization the incremental steps are different. Instead of automating processes end to end, operators should break down processes into subprocesses and automate those first. Once those are done, service providers can automate at the domain level, stringing together the mechanized tasks into an overall process. (They may be able to source automated domain management systems from the vendors supplying the domain solutions to integrate into their OSS.) At that point, they can begin to orchestrate across the streamlined domains to simplify operations even further.

What are these management domains? They can be technical or service domains, geographic (for example, AT&T’s multiple regions or Vodafone’s multiple operating entities), vendor-specific or even organizational (for example, acquired groups responsible for similar domains that may not yet have been integrated into one). Although it varies among CSPs, the growing list of important technical domains includes:

- Mobile core and RAN
- SD-WAN
- SDN
- IoT devices
- IP-VPN
- Unified Comms Systems
- IP transport
- Optical transport
- Edge computing equipment
- Edge computing applications
- DOCSIS devices

Ultimately simplifying a CSP’s domain structure by collapsing it into fewer domains will be much easier if the various domains use common technologies and architectures.

**OSS/BSS INFRASTRUCTURE MODERNIZATION VISION**

An operator’s journey needs to address the areas of transformation shown in Figure 6:
Infrastructure Modernization Vision
Support systems can be key enablers of business goals and can facilitate collaboration to efficiently and collectively achieve them. Future OSS and BSS need to support a more customer-centric environment with improved digital experiences across multi-modal customer interactions. Infrastructure modernization lays the foundation for modernizing OSS and BSS with an agile integration framework\(^3\) as a major enabler, consisting of distributed integration, well-defined open, interoperable APIs, and a container-based microservices architecture. These are essential for service providers’ OSS/BSS environments in supporting dynamic market needs with continuous development, integration and delivery cycles.

A microservices architecture enables a more agile, modular and distributed approach to evolving support systems, while still adhering to the security and governance that remain a business imperative. By designing and developing new capabilities as independent, smaller, discrete microservices, they can scale elastically each on its own. CSPs can introduce these, or make updates to them, quickly one at a time, isolated in containers, without disruption to other microservices, and CSPs can experiment with new functionality before introducing it into the network.

This framework incorporates a lightweight, flexible integration platform to create API based services and enables development across disparate and distributed internal and partner teams. Replacing hard-coded interfaces between systems with well-defined, reusable, open, and interoperable APIs enables new managed customer and ecosystem partner interfaces. APIs encourage innovation, extend customer reach, help grow the partner ecosystem and speed the development and introduction of new services by exposing capabilities in the underlying systems and assets more securely.

Field-Deployed Use Cases for Infrastructure Modernization
Some operators have already started to migrate their OSS/BSS infrastructure toward a more agile, microservices based environment.

- A North America operator has updated its OSS and BSS architecture to support continuous innovation, to improve digital customer experience, and to reduce costs. Its solution consisted of decentralizing from the existing enterprise service bus (ESB) with Red Hat Integration. It used 3Scale to create API wrappers around legacy systems and started adding new functions as microservices (including Decision Manager, which was used to power advanced business automation).

\(^3\) See, for example, [www.redhat.com/en/explore/agile-integration](http://www.redhat.com/en/explore/agile-integration).
• A major Europe telecom operator wanted to refresh its IT landscape and reduce reliance on current high-cost solutions. The operator wanted to start by modernizing OSS and BSS, then onboard other applications using the same underlying technology. It is adopting a solution developed in partnership with a major OSS/BSS applications vendor with OpenStack and OpenShift at its core, offered as a cloud-based managed service from the vendor.

**BSS Modernization Vision**

Today, BSSs operate as discrete systems that support the various lines of business largely in silos. They support people in their individual roles as they execute the steps in business process flows through various CSP organizations. This cumbersome model often relies on an individual’s specialized skills and knowledge typically acquired on the job.

Service providers must evolve to support self-service, continuous innovation, and other business imperatives. To do so, they need their BSS to move from siloed support to a business operating fabric where the automated workflows, unhindered, through the systems under the governance of teams, who manage changes to business policies and data, Figure 8. In the new environment, the BSS becomes the engine that powers business operations with speed, agility and lower cost, while people focus on more impactful activities for growing the business.

**Field-Deployed Use Cases for BSS Modernization**

• A major North America service provider needed to modernize its fleet management operations. It developed a solution using Red Hat Decision Manager and its constraint solver. The solution optimizes the allocation of the right technician to the right job at the right time and is expected to increase efficiency by 30%.

• A large North America service provider used Red Hat Integration to federate multiple inventory systems, leading to a consistent view of inventories across multiple organizations, which resulted in reduced errors, faster service delivery and lower cost.

• A Europe Tier 1 operator used Red Hat Integration to synchronize trouble ticketing systems across multiple organizations which resulted in consistency, reduced errors, and streamlined operations, as each trouble ticket is addressed once.

**OSS Modernization Vision**

The OSS applications for operating the network need increased automation and agility. Legacy OSSs were designed to help technicians perform network management operations. They evolved separately
along with the parts of the network they supported and often became incompatible with each other. To overcome this complexity and reliance on esoteric skill sets for managing each type of network element, CSPs need OSS that use automation to orchestrate, monitor, secure, and remediate the software-based network infrastructures they are building. People will govern policies more and execute processes less, as AI helps make networks more autonomous (Figure 8).

Field-Deployed Use Cases for OSS Modernization

- A major North America operator implemented continuous compliance automation using Red Hat Ansible Automation, using playbooks to automate the existing tasks.
- A Tier 1 operator used Ansible Automation to automate existing manual workflows into playbooks for Day 2 moves, changes, adds, and deletes.
- Ansible Automation is also used for security and compliance by encoding the use of tools to compare state and configuration information to expected values and to report conflicts and deviations, enabling timely remediation, compliance, and risk mitigation.

OPEN SOURCE IS THE PRIMARY ENABLER OF OSS/BSS MODERNIZATION

Modern OSS and BSS require an extensive array of solutions that work cohesively together to enable a broad spectrum of capabilities with the flexibility for continuously and efficiently evolving to meet the current and future needs of customers.

For continuous integration, choosing the right integration and automation frameworks is critical. In the past, project choices of proprietary ESB or integration frameworks led to vendor lock-ins and incompatible solutions. Evolving those applications proved expensive and time-consuming to re-integrate. The open source community has addressed this problem with standardized technologies:

- Service meshes for communications among microservices and systems
- Connectors to legacy systems
- Managed, secure API gateways
- Robotic process automation for mechanizing routine tasks
- Sophisticated process control for automating entire workflows
- Management of the containers in which microservices run
- Virtual storage of data
This set of technologies is being continuously enriched by the open source community.

The right open source integration framework helps future proof the entire system architecture, easing the introduction of new technologies, tools and microservices. It enables the agility and flexibility needed to compete, supports on-going innovation, delivers speed to market and is cost-effective. To successfully adopt open source for production, CSPs need to ensure the support model they choose provides the reliability, scalability and security needed for their business.

Extending the framework beyond the OSS and BSS allows DSPs to establish a common technology underlay for powering their services and other aspects of their operations to drive cohesiveness, collaboration and continuity, not to mention cost-effectiveness.

Red Hat is the open source leader with a rich set of solutions, complemented by professional services, support and training, that address the needs of operators for OSS and BSS modernization today and in the future. Red Hat also brings a partner ecosystem with best-of-breed certified solutions.

CONCLUSION

To become digital service providers and to compete effectively in the constantly changing 21st century market landscape, CSPs must up their customer experience game and innovate services more quickly and efficiently, in part, by adding more automation. One requirement is to modernize OSS and BSS. The Open operator software vision is proposed as the best framework to power this transformation of the operator’s digital services delivery and management. Open source innovation via containerized, cloud native software and advanced tools for integration and automation, brought to IT shops in the CSPs and their vendors through the power of the open source community, is reinventing the underlying infrastructure for these systems. AI and ML introduce faster analysis and response for customers and for delivering and managing services over variable network conditions. Finding an open source partner with the right experience and expertise can make the difference in supporting an operator’s success during this transformation.
Dr. Mark H Mortensen (mmortensen@acgcc.com @DrMarkHM) is an acknowledged industry expert in communications software for the TMT sector, with over 40 years of experience in OSS and BSS specifications, software architecture, product marketing, and sales enablement. His work has spanned the gamut of technical work at Bell Labs, strategic product evolution at Telcordia, CMO positions at several software vendors, and as a research director at Analysys Mason. He is currently the Communications Software Principal Analyst at ACG Research.

Liliane Offredo-Zreik (loffredo@acgcc.com @offredo) is a principal analyst with ACG Research. Her areas of coverage include the cable industry, SD-WAN and communications service provider digital transformation. Prior to her analyst work, she held senior roles in major telecom and cable companies, including Verizon and Time Warner Cable (now Charter) as well as with industry vendors and has been an industry advisor in areas including marketing, strategy, product development and M&A due diligence.

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