AWS Whitepaper

Autosphere iRPA on AWS for Telecom Enterprise Automation

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Communications service providers (CSPs) are transforming into digital service providers (DSPs) by digitizing their networks, operations, and services. Becoming a DSP requires modernizing a CSP's enterprise IT application, including operations support systems (OSS) and business support systems (BSS) with intelligent Robotic Process Automation (iRPA). Many service ideas in the 5G era are moving beyond just network connectivity to become end-to-end solutions to business problems. This means all installed systems must be adapted and automated to address both business to business (B2B) and business to customer (B2C) audiences, in addition to the business to exchange (B2X) customer base the systems were originally designed to serve. Success for IT depends on great customer experiences, often delivered using complex digital services with deep integrations to cognitive capabilities. This whitepaper outlines how Autosphere used AWS to build their end-to-end automation platform on Amazon Web Services (AWS).

Introduction

Hyperautomation is a business-driven, disciplined approach CSPs can use to identify, refine, and automate as many business and IT processes as possible. Automation bots and intelligent workflows offer the ability to optimize the use of existing staff, processes, and technologies to deliver efficient operations for a sustainable, competitive advantage. Hyperautomation involves the orchestrated use of multiple technologies, tools, or platforms, including but not limited to robotic process automation (RPA), data engineering, and cognitive artificial intelligence (AI) and machine learning (ML) to deliver a seamless experience to customers.

Traditionally, robotic process automation uses programmable bots to automate tasks. Automation bots can be classified as either *assisted* or *unassisted*, depending on the complexity of automations:

- **Assisted** bots use a pretrained set of activities, and complete them as a set of tasks.

- **Unassisted** bots are autonomous; they use ML techniques to solve business challenges.

These bots are programmed to offer intelligent workflows that use existing staff, processes, and technologies to deliver efficient operations and a sustainable competitive advantage. At a macro

level, hyperautomation takes traditional robotic process automation, deeply integrates with data pipelines, and uses the power of AI/ML to drive automation and derive insights.
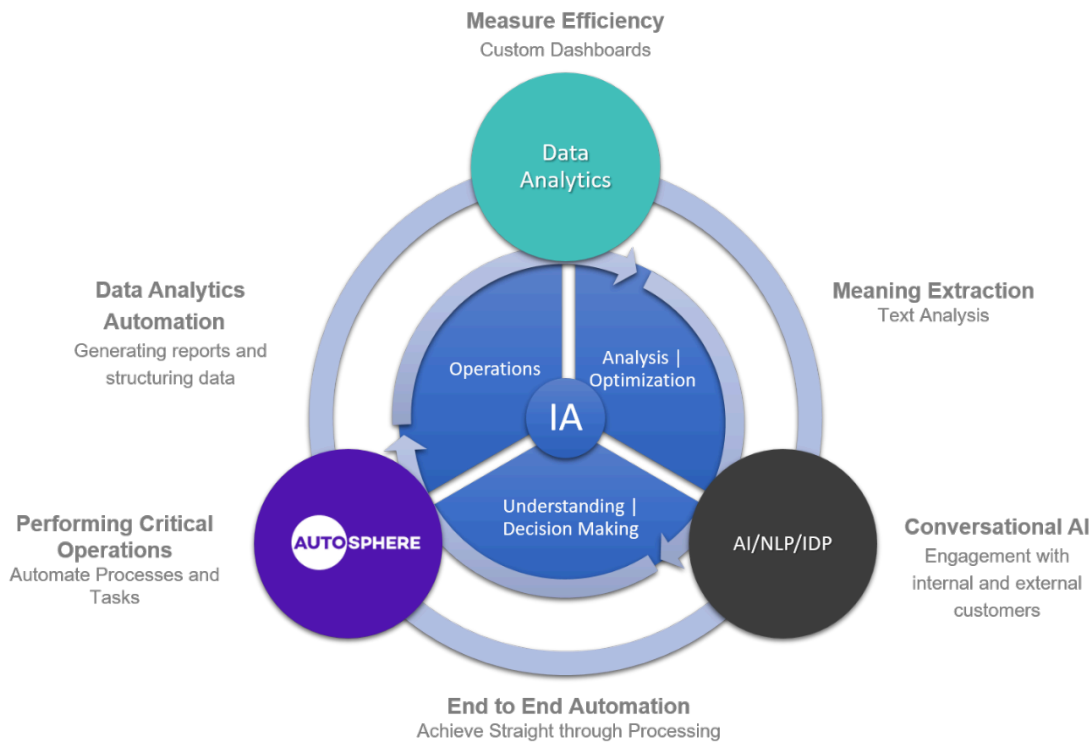
Intelligent hyperautomation core tenets

Hyperautomation empowers robotic bots with cognitive science which use AI and ML to deliver excellence in IT operations. A combined architecture with a solid automation framework team unifies to create automation capabilities that enable scale, and a hyper-efficient and effective operating model. This delivers great customer experiences supporting a wide range of use cases, such as intelligent document processing, virtual agents for contact centers, BSS integration automations, and network-level optimizations for OSS modernizations with measurable business outcomes.

Are you Well-Architected?

The AWS Well-Architected Framework helps you understand the pros and cons of the decisions you make when building systems in the cloud. The six pillars of the Framework allow you to learn architectural best practices for designing and operating reliable, secure, efficient, cost-effective, and sustainable systems. Using the AWS Well-Architected Tool, available at no charge in the AWS Management Console, you can review your workloads against these best practices by answering a set of questions for each pillar.

For more expert guidance and best practices for your cloud architecture—reference architecture deployments, diagrams, and whitepapers—refer to the [AWS Architecture Center](#).

Autosphere intelligent automation

[Autosphere](#) on AWS is an intelligent RPA (iRPA) platform used to design, deploy, and monitor RPA bots. It lets you create software-based robots to emulate human interaction with systems to run tasks and processes with more accuracy and efficiency. These robots have capabilities to capture data and manipulate applications just as humans do. With its non-intrusive nature, Autosphere on AWS allows systems to integrate quickly without causing disruptions.

Autosphere on AWS is specifically designed for CSPs to effectively manage [Order-to-Activate (O2A) processes](#). (*O2A* is the process of capturing and processing customer orders, allocating the necessary network resources, and activating the requested service.) CSPs can reduce fallouts and revenue leakages by automating the O2A process. AWS also offers great flexibility, giving you the ability to scale hardware resources up or down as required. With multiple [Regions and Availability Zones](#) (AZs) AWS offers a high level of reliability. When combined together, Autosphere and AWS can help CSPs in their journey to become fully-automated enterprises by guaranteeing best practices and standards for the O2A process. The AWS Cloud enables Autosphere to provide scalable and high-speed automation while using industry-leading cloud services and high-performance computing.

Autosphere iRPA platform overview

Autosphere is an enterprise-grade iRPA platform used to design, deploy, and monitor RPA bots. It lets you create software-based robots to emulate human interaction with systems, to run tasks and processes with more accuracy and efficiency. These robots can capture data and manipulate applications just as humans do. Autosphere is non-intrusive in nature, which means it allows systems to integrate quickly without causing disruptions. You can use Autosphere to automate processes that are high volume, manual, and repetitive. Autosphere can initiate processes in the background and/or in parallel. Unlike other platforms, it provides support on multiple operating systems. The platform drives collaboration between developers, business analysts, and other stakeholders.
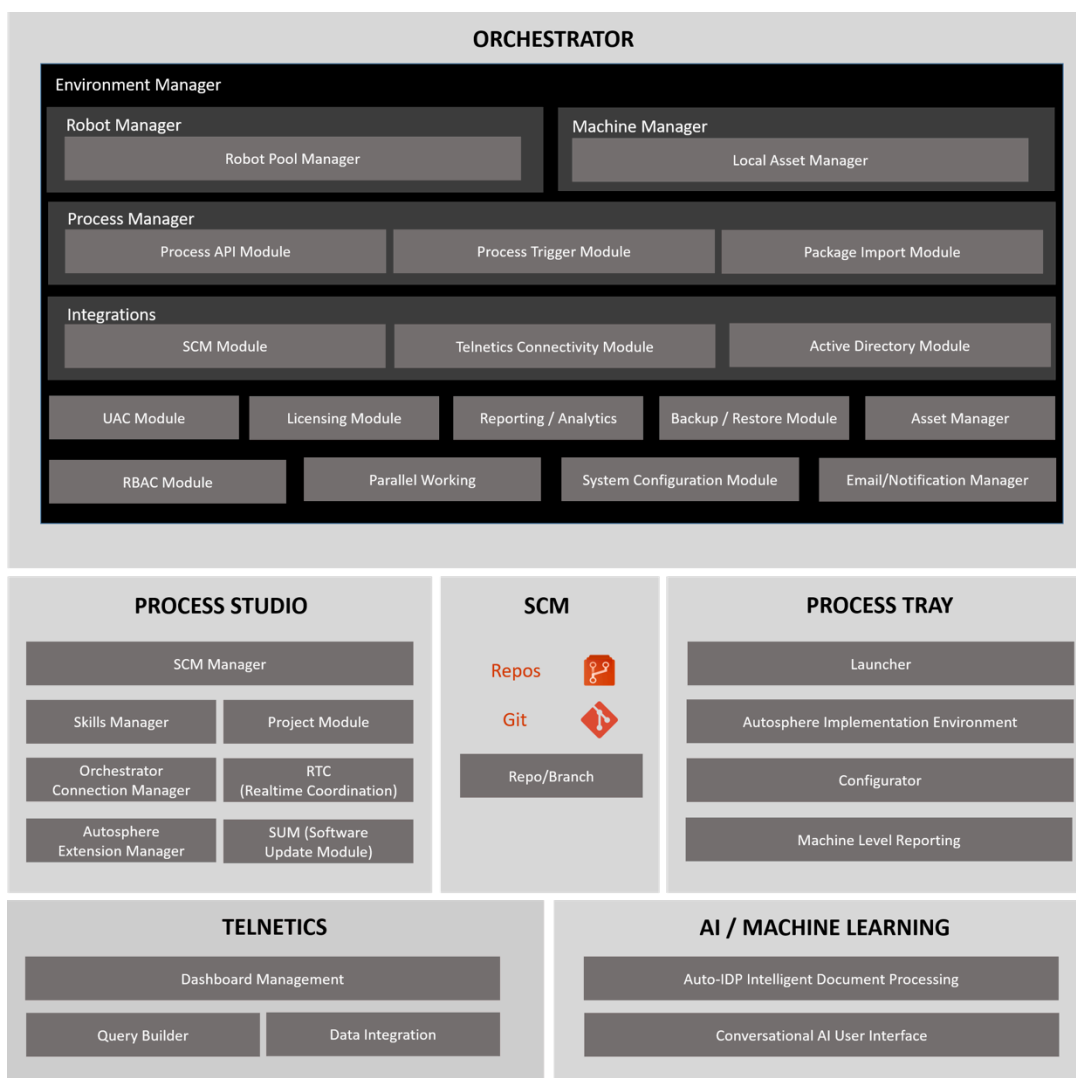
High level functional architecture

Autosphere Process Studio provides an intuitive interface with a collaborative environment to design automation workflows. Process Studio uses 150+ pre-developed libraries to enable you to access fast and easy automation processes.

Modules within Process Studio work together to provide an ideal environment for users working to develop business processes. Source Code Management (SCM) Manager module within Process Studio is responsible for pushing and updating the Autosphere package on the deployed SCM component. Project Module is responsible for project and dependencies management. As the name suggests, the Orchestrator Connection Manager allows developers to publish their designed automations directly on Orchestrator.

Real Time Control (RTC) supports near real-time sync, which enables users to see all the changes in their workspace in near real-time. Autosphere Process Studio is a modular, extension-based environment. The extension manager is responsible for managing all the extensions, including Recorder, Scraper, Element Locator, and Keyword Explorer for the studio environment. Software Update Module (SUM) is responsible for updating the Autosphere Studio Environment for new releases and updates.

Automation control, monitoring, and tracking

Autosphere Orchestrator manages and controls automation initiation in the form of jobs through central orchestrator. It has the power to provision, deploy, cue, monitor, measure, track, and ensure the security of every bot in organization.

- **Orchestrator** tracks and logs everything each robot and human does to ensure compliance and security. Orchestrator provides easy access to enterprise automation. Orchestrator has many modules working together to manage all the environments, including robots, users, processes, and permissions.
- **Environment Manager** manages the creation, deletion and segregation of these different environments. All the components of the Orchestrator reside within the Environment Manager's jurisdiction. The four major components within this environment are Robot Manager, Process Manager, Machine Manager, and Integrations.
  - **Robot Manager** is responsible for managing robot creation, deletion, and allocating resource pool groups to robots.
  - **Machine Manager** enables the creation of usable assets for development at a local level.
  - **Process Manager** is responsible for managing process operations, managing APIs against every process, and automation package import.

- **Integration modules** allow Autosphere to integrate with SCM, [Telnetics Data Streams](#), and Active Directory for user access control (UAC).

These four major components work with all the remaining components within the Environment Manager to carry out their tasks efficiently. The remaining components are:

- The **User Access Control (UAC) module** controls the different access permissions defined under the role.

- The **Licensing module** controls the assignment and validation of licenses generated by Autosphere. It also controls reporting and analytics at robot, process, job, and machine level.

- The **Backup and Restore module** periodically creates backup snapshots of all the data generated by Autosphere at scheduled instance.

- The **Asset Manager** manages encrypted secure information and creates usable asset for development process.

- The **Email/Notification manager module** generates notifications and emails based on different alert within platform.

- The **role-based access control (RBAC) module** lets you define different roles and permissions which could be assigned to certain user group.

- The **Parallel Working module** invokes multiple bots at runtime to handle a process with a high number of transactions. It enables the bots to divide the workload and perform tasks in parallel mode.

- The **System Configuration module** is used to configure global settings for orchestrator.

Need-based multi-purpose bots

Autosphere focuses on software-based robots that can learn, mimic, and then complete human interactions in rule-based business processes. Autosphere offers the following three distinctive bots:

- **Superbot** — [Superbot Attended](#) is ideal for use cases where humans work in collaboration with robots, whereas [Superbot Unattended](#) is best for use cases that require no human intervention.

- **Multitasking bot** — Along with additional features, a multitasking bot is capable of doing everything that a superbot can do. It can also invoke multiple bots at runtime to handle a process with high transactions. It enables the bots to divide the workload and complete tasks in parallel mode.

- **Monitoring bot** — Monitoring bots are used on interfaces which require constant monitoring and are dedicated on business-critical interfaces.

The process tray contains different modules to maintain efficiency of these different bots, including Superbot, Multitasking bot, and Monitoring bot. The Process Launcher allows running process from the robot machine (Attended). The Autosphere Implementation environment consists of the core Autosphere engine, automation packages, and dependencies. Configuration is required for connectivity of the bot with the Orchestrator instance. Machine-level reporting is important for the performance monitoring of jobs run on the specific machine.

Integrate data streams, configure metrics, and visualize ROI

Autosphere bring focus on automation visibility with the help of its extension, [Telnetics](). This feature helps telecom businesses visualize return on investment (ROI) and indirect benefits resultant of automation Telnetics provides data streams for pre-automation, post-automation, and third-party integration metrics.

- **Dashboard Management** enables the creation and management of multiple dashboards based on environments, robots, and processes.
- The **Data Integration module** allows for the integration of data streams from third-party tools, Orchestrator, and Process Studio.
- **Query Builder** allows building queries for metrics on dashboards.

Artificial intelligence (AI) and machine learning (ML)

Autosphere uses [AutoIDP]() to transform unstructured and semi-structured data into usable data from documents. AutoIDP is the next generation of automation, able to capture, extract, and process data from various document formats. It is used to classify, categorize, and extract data from different template documents. It can quickly train services for new document templates.

[Human-in-the-Loop]() can ensure that a human supervises a semi-autonomous bot easily. This can be done with the help of a conversational AI, or by training an ML model. Conversational AI can understand the intent of the business user by communicating with them naturally over any channel. Important information is extracted from the text to cue a process, or add value to the process through review and approval.

Integration of Autosphere Platform with AWS services

Autosphere Platform, whether deployed in the cloud or on-premises, can integrate with any analytics platform and AI/ML services. Components such as Telnetics and AutoIDP can be replaced with similar cloud services provided by AWS. Autosphere can integrate with Amazon QuickSight for dashboard management, natural language querying (NLQ), and super-fast, parallel, in-memory, calculation engine (SPICE). Autosphere can also use AWS AI services to add intelligence to its portfolio. Some these services include Amazon Textract, Amazon Lex, Amazon Transcribe, and Amazon Translate.

ORCHESTRATOR		
PROCESS STUDIO	SCM	PROCESS TRAY

AMAZON QUICKSIGHT		AI / MACHINE LEARNING	
Dashboard Management		Amazon Textract (Intelligent Document Processing)	Amazon Lex (Chatbots and Virtual Agent)
Natural Language Querying	SPICE (super-fast, parallel, in-memory, calculation engine)	Amazon Transcribe	Amazon Translate
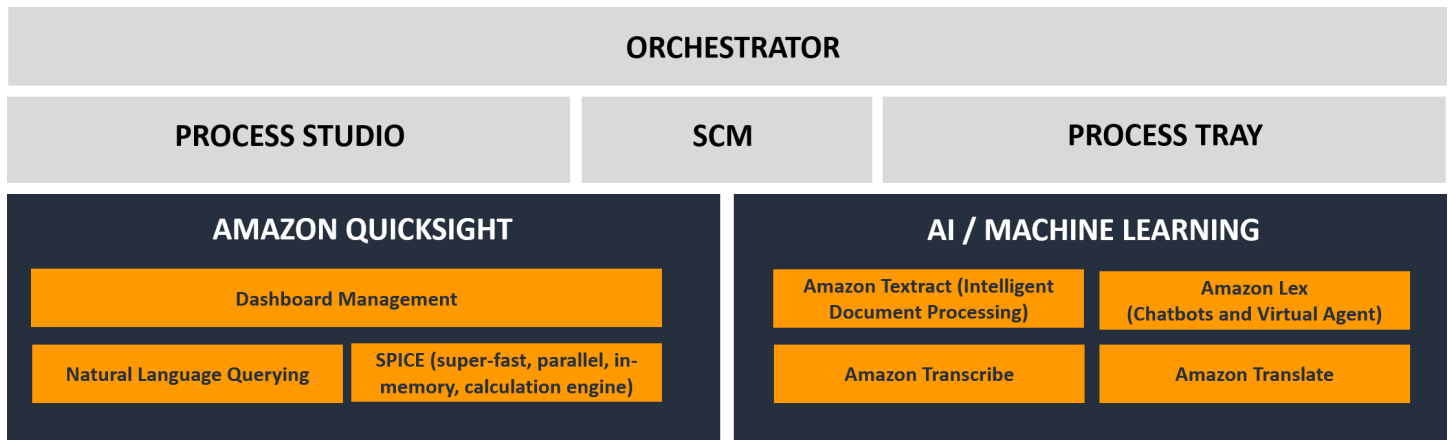
High-level functional architecture with AWS services

Value proposition

Autosphere on AWS focuses on bringing value to account management business function. The telecom lead-to-cash cycle is an ideal candidate for process automation, because it involves repetitive and manual tasks performed by humans that are error prone. Generally, these processes involve multiple systems of different functions, which limit visibility into transactions because of silos. The account management business function in made up of multiple processes in which the O2A process involves interaction and integration with multiple layers, tools, and services.

CSPs face fallout and revenue leakage due to inadequacies in their O2A process. Automating this process can bring about great benefits for the CSPs. CSPs can easily adapt the O2A process automation by Autosphere on AWS, because it follows Business Process Framework (eTOM) standards by TeleManagement forum (TM forum).

Autosphere on AWS can scale up to add more processes in the customer journey for CSPs. Autosphere has the power to automate mission critical functions of CSPs, which include account management, contact center, network operations, and business support functions.

Autosphere deployment architecture on AWS

Autosphere on AWS helps customer-centric businesses in improving their efficiency, productivity and compliance. This leads to a better customer experience in all aspects of the customer journey. Autosphere on AWS is an intelligent robotic process automation platform deployed on the AWS Cloud. Using AWS Cloud services, the platform can provide scalable and secure high-speed automation at a reduced cost.

Technical architecture
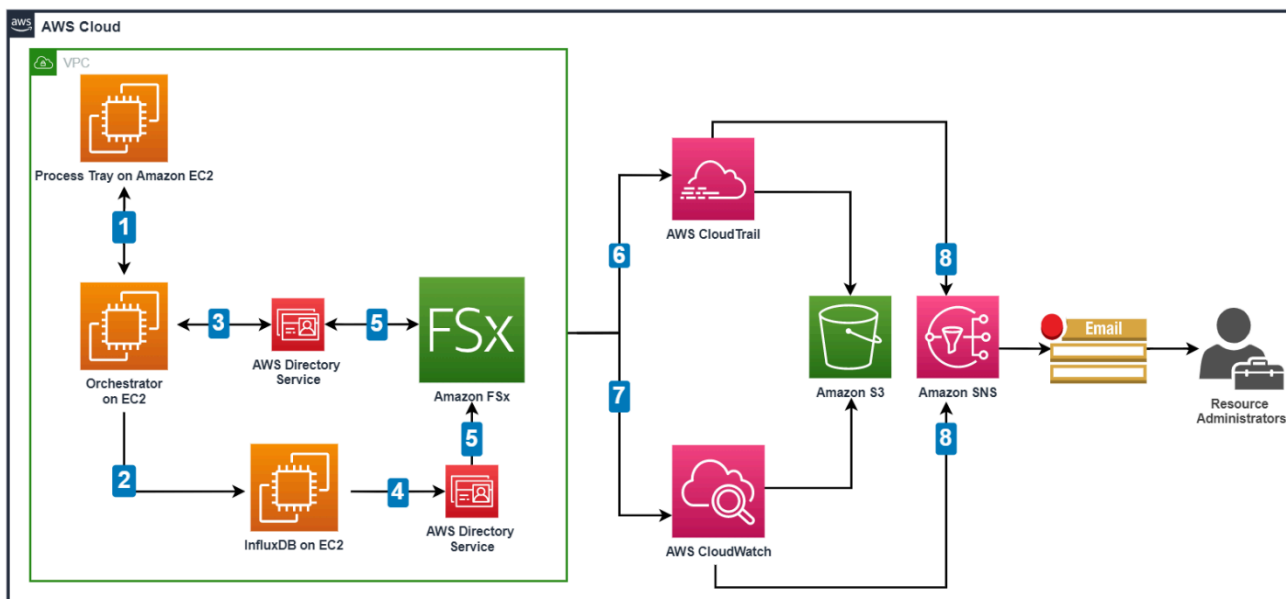
Technical architecture diagram of Autosphere on AWS

The following is a list of steps to explain the flow of technical architecture for Autosphere on AWS:

1. Process tray is a direct end-user application running on Amazon Elastic Compute Cloud (Amazon EC2), intended for running automation process, that communicates with the central orchestrator.

2. Central Orchestrator manages and controls automation implementation in the form of jobs and coordinates with multiple process trays/bots. Orchestrator runs on Amazon EC2 instance, that is always available and always backed-up.

3. AWS Directory Service provisions and sets up Amazon FSx so that user managed data from Orchestrator is written on it.

4. Influx DB is a central database, running on Amazon EC2 instance, that stores all the process related data from Orchestrator.

5. Amazon FSx stores all data from the Orchestrator and Influx DB.

6. AWS CloudTrail monitors activities happening on the AWS resources and generates related alarms. All the log data of AWS CloudTrail is written to Amazon Simple Storage Service (Amazon S3) buckets.

7. Amazon CloudWatch visualizes, manages and responds to changes happening on Autosphere resources on cloud.

8. Amazon Simple Notification Service (Amazon SNS) is a centralized AWS managed resource that manages data log reports and notifications from Amazon CloudWatch and AWS CloudTrail.

Elasticity

Process automation is carried out through the Central Orchestrator and Process Tray. Both these components are deployed over Amazon EC2 instances to match the current demand at all times as closely as possible.

- Central Orchestrator has the capacity to manage and control automation implementation in the form of job. It has the power to provision, deploy, cue, monitor, measure, track, and ensure the security of every bot in the organization. The resource is deployed on an always available, always backed-up Amazon EC2 instance that communicates with other resources within the same VPC group.

- Process tray is a direct end-user application, intended for running the automation process that communicates with the central orchestrator. Communication between the process tray application and orchestrator is possible within the same VPC group running on an EC2 instance.

Operational performance

- AWS CloudTrail is set up to monitor activities and changes happening on the AWS resources, and generate alarms on fixed thresholds. All the log data of AWS CloudTrail is written to Amazon S3 buckets which are highly secured, and inaccessible to the public with versioning and multi-factor authentication (MFA) delete support.

- Amazon CloudWatch visualizes, manages, and responds to changes happening on your resources. Synthetic canaries of Amazon CloudWatch monitor the working of all Autosphere modules.

Alarms are generated to send reports to the administrator, in case any rules or policy violations or resource outages occur within your ecosystem.

- Amazon SNS is a centralized AWS-managed resource which can manage data logs, reports, and notifications from Amazon CloudWatch and AWS CloudTrail. Different types of alarms and log information are grouped together in Amazon SNS and forwarded to administrators using email protocol when needed.

High availability

- Amazon FSx makes it easy and cost effective to launch, run, and scale feature-rich, high-performance file systems in the cloud. Amazon FSx also ensures that file systems are synced and always available across multiple machines with concurrent backups. Amazon FSx stores all user managed data in Orchestrator, and data from InfluxDB. The setup includes backups and support of multi-AZ deployments.

- AWS Directory Service is used to provision and set up Amazon FSx so that user-managed data from Orchestrator can be written on it. AWS Directory Service provides a gateway to the Amazon FSx file system for Amazon EC2 instances running Windows Server.

- Data related to process completion, including time taken to run processes, number of tasks run, failure/success rates, and active machines is pushed from Orchestrator to a central database on InfluxDB. To make this database highly available, the data from InfluxDB is also written on Amazon FSx. InfluxDB is also responsible to store data for Telnetics.

Security

AWS Identity and Access Management (AWS IAM) is used to separate workloads and secure the AWS account. Amazon CloudWatch is used by Autosphere for event logging:

- **Compute resources** — Autosphere uses EC2 to implement and automate compute resources. AWS CodeCommit is used for validation of software, code and libraries.

- **Data in transit** — AWS IAM roles are used to provide private and secure endpoints for encryption of data in transit.

- **Data at rest** — IAM is used for secure key management. AWS facilitates encryption and decryption through its different services.

- Autosphere uses [Amazon CloudWatch](#) to monitor and alarm in case of anomalies. The incident management is then automated using Ansible. You can also use CloudFormation for forensic capabilities.

AWS Well-Architected Framework

For designing and running workloads in the cloud environment, the AWS Well-Architected Framework has described key concepts, design principles and architectural best practices. Just by answering few fundamental questions, you can learn how well your designed architecture aligns with cloud best practices, and achieve guidance to improve the already built architecture. There are six pillars in the AWS Well-Architected Framework: Operational Excellence, Security, Reliability, Performance Efficiency, Cost Optimization, and Sustainability. The AWS Well-Architected Framework has helped Autosphere to build an efficient, high performing, secure, optimized, and cost-effective infrastructure. The Autosphere on AWS architecture is capable of supporting business functions and run workloads effectively.

Following is an overview of the six pillars of AWS Well-Architected Framework, with reference to Autosphere architecture on AWS

Operational excellence

This pillar focuses on the process of determining organizational priorities, along with the culture and structure of the organization to support business outcomes. The pillar also focuses on the overall process of designing workloads, understanding the health of the workload, reducing defects, easing remediation, and improving flow into production to run and monitor system to deliver business value.

Autosphere is compliant with enhanced Telecom Operations Map (eTOM) and IT Infrastructure Library (ITIL) best practices to evolve and improve all operations. Autosphere uses Jenkins for DevOps and GitLab for source code management. Amazon CloudWatch is used to gain visibility to workload events and raise relevant alerts. It is also used for events logging, and detecting and reacting to any changes in operations metrics and KPIs. Business level view of operations can also be provided through Autosphere Telnetics. Autosphere uses a combination of Amazon CloudWatch and Telnetics to perform all these operations.

To learn more about AWS best practices for operational excellence, refer to the Operational Excellence Pillar whitepaper.

Security

The primary focus of this pillar is to securely operate the workload, manage the identities and permissions of people and machines, and manage risk assessments and mitigation strategies. This pillar gives prime importance to the capability of security of data at rest and in transit.

Autosphere uses AWS IAM to separate workloads, secure the AWS account, and secure key management. Role-based access control (RBAC) is established using AWS IAM to manage identities and permissions for people and machines. Autosphere uses Amazon CloudWatch for event logging and generating alerts for security violation. AWS facilitates encryption and decryption through its different services.

To learn more about AWS best practices for security, refer to the Security Pillar whitepaper.

Reliability

This pillar focuses on the ability of the system to plan for disaster recovery, testing reliability, and data backup strategies, along with the system capability to withstand failures. This pillar also focuses on service quotas, service constraints, network topology, and monitoring of workload resources.

Autosphere uses Amazon Elastic Load Balancer to implement elastic load balancing with Amazon EC2 and Amazon CloudWatch for planning network topology. Autosphere ensures idempotency using Amazon EC2. Large and rapid changes in load can be handled by automatic scaling and elastic load balancing in Amazon EC2. Autosphere also uses Amazon CloudWatch for monitoring and alarming. Data backups are created using Amazon FSx. You can deploy Autosphere Orchestrator and Telnetics instances in multiple Availability Zones within an AWS Region when and if needed.

To learn more about AWS best practices for reliability, refer to the Reliability Pillar whitepaper.

Performance efficiency

This pillar focuses on efficiently using computing resources as demand changes and technologies evolve. The architecture of Autosphere on AWS ensures efficient usage of resources by choosing the best performing architecture and most effective method for storage, compute, and database resources to meet the system-changing requirements. EC2 is the compute solution for Autosphere.

Autosphere uses elastic load balancing with Amazon EC2 to ensure elasticity. Amazon CloudWatch is used to measure metrics, re-evaluate compute needs, and review performance efficiency. Amazon FSx is used for storage, efficiency, and cost-effective performance. Autosphere uses and configures EC2, along with other AWS services for optimal networking.

To learn more about AWS best practices for performance efficiency, refer to the [Performance Efficiency Pillar](#) whitepaper.

Cost optimization

This pillar involves monitoring usage and cost. Autosphere uses [AWS Cost Explorer](#) and [AWS Cost and Usage Report](#) to monitor usage and cost. Autosphere uses the rightsizing recommendations in AWS Cost Explorer to minimize costs for Amazon EC2 and other AWS services. Autosphere performs cost analysis, using the [AWS Pricing Calculator](#) and AWS Cost Explorer. Autosphere can use Amazon CloudWatch to implement alarms that can end Amazon EC2 instances to decommission resources.

To learn more about AWS best practices for cost optimization refer, to the [Cost Optimization Pillar](#) whitepaper.

Sustainability

This pillar focuses on utilizing user behavior and usage patterns, data access, software, and architecture patterns to support sustainability goals. Autosphere does that task by constantly monitoring the workload. Autosphere follows the best practices of data lifecycle management to create, store, and delete data. Hardware management is ensured by making use of AWS Shared Responsibility model to use managed services such as Amazon EC2.

To learn more about AWS best practices for sustainability, refer to the [Sustainability Pillar](#) whitepaper.

Significance of Order to Activation (O2A) in customer journey

Order to Activation (O2A) is the process of capturing and processing customer orders, allocating the necessary network resources, and activating the requested service. CSPs face fallouts and revenue leakages due to inadequacies in their O2A process. Automating the O2A process is necessary for increasing customer satisfaction and creating a strong brand reputation, thus directly influencing subscriber growth and retention.

The complete O2A process can be divided into three categories:

Order management

A customer service representative or self-service application captures a request from the customer to create a new order or modify an existing one, while supporting multiple channels, applications, and customers at the same time. Once captured, the order is validated and the missing information is completed to successfully create a customer order. To fulfill this order, a single customer order is decomposed into one or more service requests.

Provisioning

When an inventory system receives a service request, it starts a process called *provisioning*. Provisioning is the equipping of a network to allow new services to its users by allocating the necessary resources. The process also involves ensuring timely completion and correct task order to allocate resources.

Activation

A service request is fulfilled as soon as the appropriate resources are allocated against it. This can result in activation/de-activation of service, based on the actual service request. Information of service activation/de-activation is communicated to the order management system, which then coordinates with the billing system, and notifies the customer service representative or the self-service application.

Order-to-activate business process

Order-to-Activation is a process based on Business Process Framework (eTOM) by TMForum. Sub-processes in O2A process can be categorized within Customer/Business, Services Provisioning, and Resource Management layers. Each sub-process in the Order-to-Activation process can be further divided into a string of activities.

Customer / Business Layer	**Order Capture and Handling** • Order Entry • Authorization • Determine Feasibility	**Issue Customer Order** • Assess Customer Order • Create Customer Order • Update Customer Order	**Track and Manage** • Track Customer Order • Update CO Status • Monitor CO Status	**Complete Customer Order**	**Close Customer Order**
Service Provisioning Layer	**Issue Service Order** • Assess Service Request • Create Service Order • Mark SO for Special Handling	**Configure and Activate Service** • Configure Service • Implement Service • Activate Service	**Close Service Order**		
Resource Management Layer	**Issue Resource Order** • Assess Resource Request • Create Resource Order • Mark RO for Special Handling	**Configure and Activate Resource** • Configure Resource • Implement Resource • Activate Resource	**Close Resource Order**		

O2A process and activity breakdown

Conclusion

BSS and OSS are major enterprise IT applications for CSPs. The support systems can manage complex end-to-end process flows for B2B and B2C customer base. These process flows require human intervention which is a primary cause of bad customer experience. O2A is the process of capturing and processing customer orders, allocating the necessary network resources, and activating the required service. Automating the O2A process can result in massive decrease in fallouts and revenue leakages for the CSPs.

Hyperautomation is the concept of automating processes with the use of technologies such as AI, ML, and RPA. Based on this concept, Autosphere on AWS is an iRPA platform used to design, deploy, and monitor bots. These software-based robots mimic human interaction with systems to automate complex tasks and end-to-end processes like O2A.

For key business processes like O2A, Autosphere on AWS follows the industry-agreed standard of eTOM by TM forum. Autosphere has the power to automate mission critical functions of CSPs, which include account management, contact center, network operations, and business support functions. The AWS Well-Architected Framework has helped Autosphere to build an efficient, high performing, secure, optimized, and cost-effective infrastructure. Autosphere on AWS utilizes AWS services to provide scalable and secure high-speed automation at a reduced cost.

Acronyms

- AI — artificial intelligence

- APN — Amazon Partner Network

- B2B — business to business

- B2X — business to exchange

- BSS — business support systems

- CSP — communication service provider

- eTOM — enhanced Telecom Operations Map

- iRPA — intelligent robotic process automation

- ITIL — IT Infrastructure Library

- MFA — multi-factor authentication

- ML — machine learning

- NLQ — natural language querying

- O2A — order-to-activate

- OSS — operations support systems

- RBAC — role-based access control

- ROI — return on investment

- RPA — robotic process automation

- RTC — real time control

- SCM – source code manager

- SLA — service level agreement

- SPICE — super-fast, parallel, in-memory calculation engine

- SUM — Software Update Module

- TM forum — TeleManagement forum

- UAC — user access control

- VPC - Virtual Private Cloud

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AWS Glossary

For the latest AWS terminology, see the [AWS glossary](#) in the *AWS Glossary Reference*.