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**SAP on Microsoft Azure**

**Cloud Adoption Framework Enablement Kit**

***SAP on Azure Scenario***

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We look forward to your feedback!

Thank you for your continued trust and partnership. The resources within this toolkit will be iteratively improved upon based on product releases as well as direct feedback from delivered engagements. We encourage you to provide feedback to help us improve our products and toolkits. Please use the feedback process available through following web site: <http://aka.ms/cafenablementkit>

# Introduction

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Description automatically generatedThe Microsoft Cloud Adoption Framework for Azure is proven guidance that is designed to help you create and implement the business and technology strategies necessary for your organization to succeed in the cloud. It provides best practices, documentation, and tools that cloud architects, IT professionals, and business decision makers need to successfully achieve short-term and long-term objectives. By using the Microsoft Cloud Adoption Framework for Azure best practices, organizations can better align their business and technical strategies to ensure success.

## Document Purpose

This document is to provide partners and customers guidance to deploy and manage SAP in Azure in alignment with the Microsoft Cloud Adoption Framework for Azure (CAF). The considerations, decisions, and actions documented herein are broken into the six major CAF stages.

The goal of this document is to guide partners and customers though the CAF stages by identifying the most common considerations and decisions required to deploy SAP on Azure

## Target Audience

This document is primarily intended for the following audiences:

* Azure and SAP Partners
* IT Infrastructure Managers
* Technical Directors, Managers, and Architects
* Decision Makers, Business Owners, and Directors

# Strategy Phase

Documenting SAP on Azure Strategy will assist business stakeholders and technicians in understanding the organizational benefits that entail adopting SAP on Azure. This section will specifically discuss the following:

* Business Motivations
* Business Outcomes
* Business Justifications associated with SAP on Azure adoption
* SAP Azure First Project

This document helps in building your business strategy efficiently. This approach helps you drive adoption efforts that capture targeted business value in a cross-functional model.

## Understanding Business Motivations

Business transformations that are supported by cloud adoption can be driven by various motivations. It is likely that several motivations apply at the same time. The goal of the lists in the following table is to help generate ideas about which motivations are relevant. From there, you can prioritize and assess the potential impacts of the motivations.

|  |  |  |  |
| --- | --- | --- | --- |
| **Cost** | **Security** | **Scalability** | **Business Events** |
| Cost Reduction Lower TCO  Pay as you go Speed to value Business Agility | Resource based access Role Based Access Secure authentication  Hardening the OS Access Control | Ability to resize Hardware on the fly  Scale out on the fly Available on demand | Datacenter exit  Merger, acquisition, or divestiture  End of support for mission-critical technologies |

### Cost

Cost is the most common and a very powerful driver of business decisions and can take many forms. Take for example, the case of deploying an upgraded SAP environment. The costs for the new Hardware configured with enough capacity to meet the expected business demands for the next five to seven years can be significantly less attractive than moving to a Pay as you Go model in the cloud.

### Security

Security of business systems is a constant concern for enterprises of all sizes and security drivers often underly many of the decisions companies make. For example, if a company handle payment cards, they are bound by specific regulations with regards to the handling of PCI data. The existing physical data center security may not be sufficient to meet auditor requirements. In this case, hosting the PCI systems in a PCI Compliant cloud environment would vastly simplify the audit and certification processes of these systems.

### Scalability

The ability to rapidly add capacity on demand can be an asset in many cases. For instance, businesses that see significant seasonal changes in volume are often stuck buying capacity for their peak use case that sits idle the rest of the year.

### Business Events

Significant business events can be very powerful motivators. For example, in the wake of the COVID-19 pandemic businesses look to solve the sudden influx of employees, who would typically work in an office, working entirely remotely.

Common business events that are often cloud adoption motivations include:

* Business Acquisitions
* Business Expansion
* Disaster Event

Each event may spark motivations of other sorts as well. A business acquisition often leads to datacenter consolidation. However, in some cases neither datacenter has the available capacity for the consolidated systems. In this case, migrating some systems to the cloud can be immediately advantageous.

## Business Outcomes of SAP on Azure

It is important to identify and document the expected business outcomes of a cloud adoption so that the results can be measured against expectations. This allows the business to understand if the cloud adoption has successfully satisfied the original motivations.

Common categories of desired business outcomes include:

• Fiscal outcomes • Performance

• Agility Outcomes • Security and Compliance

• Reach Outcomes • Workforce engagement Outcomes

## Quantifying Business Justification for SAP on Azure

Justifying the decision to migrate or adopt SAP on Azure will require somewhat complex calculations. In its basic form, the calculations needed to justify SAP on Azure are:

|  |
| --- |
| **Initial investment** is the capital expense and operating expense required to complete the SAP on Azure initiative.  **Gain from investment** include revenue deltas and cost deltas. |

The difficulty is in accurately assigning value to the outcomes that do not directly involve costs. However, it is important to take these factors into consideration as well.

## SAP on Azure First Project

By considering all the business motivations and desired outcomes, you should be able to choose an adoption strategy and an initial project. As is the case with any deployment, it is recommended to deploy or migrate non-production systems first. This phased approach provides the opportunity to refine the adoption strategies, deployment processes, governance, and management controls to ensure that each deployment improves upon the prior one. Additionally, these non-production environments provide opportunities to measure the business outcomes early in the adoption process to ensure that the strategy meets the needs of the business. The chosen first project should have a clear path to showing justification of the adoption strategy.

# Plan Phase

The following exercises will help you document your technology strategy. This approach captures prioritized tasks to drive adoption efforts. Planning is a crucial step which aids to build a roadmap to transform the strategy goals. For more information about Plan Phase please refer [Cloud Adoption Framework: Plan Phase](https://docs.microsoft.com/en-us/azure/cloud-adoption-framework/plan/)

## Digital Estate

The initial part of planning is understanding your digital estate which is a collection of your IT assets that power your business processes and supporting operations. For more information about Digital Estate, please refer [Plan Phase: Digital Estate.](https://docs.microsoft.com/en-us/azure/cloud-adoption-framework/digital-estate/)

## Documentation of Digital Estate

Cloud rationalization is the process of evaluating assets to determine the best approach to hosting them in the cloud. After you've determined an approach and aggregated an [inventory](https://docs.microsoft.com/en-us/azure/cloud-adoption-framework/digital-estate/inventory), cloud rationalization can begin. Cloud rationalization discusses the most common rationalization options.

### Document the SAP Landscape

The SAP system landscape means an arrangement of SAP servers which consist of Dev (Development Server), PROD (Production Server), QAS (Quality Assurance Server). The current landscape is documented for future reference. Before we start our migration process, we would need to identify the functionalities and dependencies, bindings of systems which makes SAP as a productive environment. Below points will help to gather the details and provide a deeper understanding on current SAP system landscape.

* Inventory of Current SAP Infrastructure

Performing inventory data for a digital asset is the first step in planning phase. This process collects a list of IT assets that support specific business functions.

* **Physical/Virtual Servers:** Identify the current workload where SAP environment is hosted appropriately and document the type of servers and its specification.
* **Discover Hypervisor versions:** Identify the hypervisor versions where current SAP environment is hosted. List out the vendor specific hypervisors and their respective versions i.e. VMware Esxi 6.0, Hyper-V 2012 R2 etc. and their editions.
* **Collect All OS and DB Versions:** Collect the specific information of Operating system editions and versions from servers which can be used to ensure the compatibility during migration. Also capture the information of database versions from database servers.
* **Collect existing OS/DB Licensing information:** Before moving further in cloud adoption journey, gather the appropriate operating systems and database software application licensing information. Be specific while gathering the details about licensing by mentioning the core-based and socket-based licensing architecture and their dependencies
* Document all SAP Landscape Systems (QA, DEV, Prod, etc. Products ECC, BW, etc.)

In this step, document the SAP system Landscape which includes DEV, PROD, QAS environment with products i.e. ECC, BW etc.

* + - **Review EWA Report from the Existing Landscape:** EWA (Early Watch Alerts) monitors solutions in SAP and non-SAP systems in the SAP Solution Manager. For more details please refer [EWA (Early watch alerts)](https://help.sap.com/saphelp_scm70/helpdata/en/2f/de3316e1fc425080f83c718bec41de/content.htm?no_cache=true)
    - **Azure Migrate Assessments:** Azure Migrate provides a hub of tools to discover, assess, and migrate applications, infrastructure, and data to Azure. For more information, please refer [Azure Migrate](https://azure.microsoft.com/en-us/services/azure-migrate/) & [Azure Migration Program](https://azure.microsoft.com/en-us/migration/cost/?&ef_id=Cj0KCQjwirz3BRD_ARIsAImf7LM8Q66MAxzAk42ix_xdmJjRPKdsNphFJYuTNikGYJ1_X0iW9pCpf04aAhKAEALw_wcB:G:s&OCID=AID2000676_SEM_Cj0KCQjwirz3BRD_ARIsAImf7LM8Q66MAxzAk42ix_xdmJjRPKdsNphFJYuTNikGYJ1_X0iW9pCpf04aAhKAEALw_wcB:G:s) which is an initiative of Microsoft.
    - **Current SAP Landscape:** System Landscape of SAP is very important part to document before migrating the workload from current environment to cloud. It is defined as an arrangement of SAP servers. For brief information please refer [System Landscape Directory (SLD)](https://help.sap.com/doc/saphelp_ewm70/7.0/en-US/2d/9b82eb86454932a1ba4edacb569de4/frameset.htm)
    - **Identify all custom SAP Critical Business functionalities:** Be specific to identify all custom SAP critical business functionalities and document in appropriate standardized format. This will be a base for the migration to understand the functionalities easily and quickly.
    - **Current SAP Application Licensing:** Gather the details about current SAP application licensing information before performing a migration activity. As we must have this information easily accessible so that it can be used after migration in case to avoid /remediate licensing issues.
    - **Current system design for High Availability:** High Availability system design is one of the critical information in infrastructure which required to appropriately documented. Gather all information about the architecture and configuration of High Availability design of current SAP workloads.

### Non-SAP Applications Dependencies with SAP

Understand third party products which are connected to SAP Systems and Apart from the current functionalities, we also need to identify the third-party systems or applications in discussion with the current landscape.

* Identify Third Party Systems Involved in SAP Landscape (Example – Application or service installed in third party hardware etc.)
* Identify Third Party Business applications (Example – Third party application for PO’s etc.)

### Current Security Policies

Identify current IT Security Policies which are applied to protect data and workloads in existing infrastructure. This policy ensures the compliance and help to make the further migrated infrastructure compliant.:

* **Existing Firewalls, Server/Service Placement (e.g. DMZ for front ends, etc.):** To configure the firewall in cloud during migration, it is recommended to understand the existing firewall configuration throughout the documentation. This will ensure to maintain the configuration standard and avoid unexpected issues.
* **Current Identity Management and Authentication systems:** Identify the current identity management and authentication systems which are responsible to authenticate and authorize the users and devices to the SAP environment. We must consider the below points during information gathering.
* Identify current Active Directory (AD) and Active Directory Federation Services (ADFS) configuration and baseline policies. For more information, please refer [Active Directory (AD)](https://docs.microsoft.com/en-us/windows-server/identity/ad-ds/get-started/virtual-dc/active-directory-domain-services-overview) /[Active Directory Federation Services (ADFS.)](https://docs.microsoft.com/en-us/windows-server/identity/active-directory-federation-services)
* Identify existing [Azure AD](https://docs.microsoft.com/en-us/azure/active-directory/develop/single-sign-on-saml-protocol) configuration details with users, groups, devices , app registrations, roles .
* Identify current SAP SSO Methodologies

SSO (Single Sign-On) functionality enable to configure transparent user authentication for access to AS ABAP systems in SAP GUIs. Based on SSO, SAP GUI users can only select the AS ABAP system to log on to from the SAP Logon Pad, without needing to interactively provide a username and a password.

* + - **SAP Single Sign On:** In SAP, SSO allow to login to one system by providing the valid credentials and then user can access multiple systems in the backend. It allows the user to access software resources across SAP systems in the back end. For more information, please refer [Single Sign On](https://help.sap.com/saphelp_nwes73/helpdata/en/4e/1262e01e3d2287e10000000a15822b/content.htm?no_cache=true#:~:text=%20Single%20Sign-On%20for%20the%20SAP%20GUI%20,also%20install%20the%20SAP%20Cryptographic%20Libraries%2C...%20More%20)
    - **SAML2 Authentication**: SAML (Security Assertion Markup Language) is an open standard protocol which allows identity providers to pass authorization the credentials to service providers (SP). For more information, please refer [SAML](https://docs.microsoft.com/en-us/azure/active-directory/develop/single-sign-on-saml-protocol)
    - **Kerberos/SPNEGO:** Kerberos/SPNEGO is used for Single Sign-On for SAP NetWeaver AS-JAVA application. It works with AD authentication of users for login to SAP portals. Also, this method works when the users are in domain. For more details please refer [Kerberos/SPNEGO](https://blogs.sap.com/2019/12/05/sap-single-sign-on-kerberos-spnego-setup-for-as-java/) Setup
    - **Digital Certificates Library:** Digital certificates are used to set up transport layer security. Please refer for more details about [Digital Certificates Library.](https://help.sap.com/viewer/a89a0a8384f21015b1e7adbeca456f73/16.1.2.0/en-US/3bcc069d6c5f1014b123ba7ba047629d.html)
    - **Mobile Single Sign-On:** Mobile Single Sign-On is used when SAP authenticator is installed on mobile devices which is based on one-time password (OTP) authentication. For more information please refer [Mobile Single Sign-On](https://help.sap.com/viewer/a2ee572048674dd4bef257616560cc94/3.0/en-US/6f027e3a29eb4002ae1ab4cf781b1940.html)
* **Existing Database Access Policies:** Here we need to identify the existing database access policies which are essential to understand which user or group has the appropriate access for database. For more information please refer [Managing Access Policies](https://help.sap.com/viewer/368c481cd6954bdfa5d0435479fd4eaf/Cloud/en-US/18f06d4c8c5244d8927c0e2c5dc1c706.html?sap-outbound-id=037761621A5C0696B1DA6906A12AE8824CFFA730&source=)
  + - **Security/Access controls:** Gather the information about SAP access control software application which is responsible to manage access governance policies and monitor for compliance. For more reference please refer [SAP Access Controls.](https://help.sap.com/saphelp_grcac101/helpdata/en/4e/56dbfdd48028d6e10000000a421bc1/frameset.htm)
    - **Tools used for Backup:** Identify the backup tool used to back up the SAP application configuration and databases. Gather all information about backup schedule jobs, policy, retention periods, backup storage location, credentials, dependencies, recovery step documentation etc. Also, information regarding the backup tool licensing and support contract details with SLA.
* **IT Audit Policies:** IT Audit is performed to ensure the data integrity, security controls, assets inventory, software inventory, licensing, policies, and governance are implemented appropriately in organization IT infrastructure.
  + - **IT Audit Requirements over SAP / Other Applications:** To perform audit over SAP and other applications we require the details about SAP and other applications with the licensing details, support contract details, security upgrade and patches details, access control policies details, data integrity and encryption details etc. This will ensure that SAP and other applications comply.
    - **IT Audit Requirements from Infrastructure Perspective:** To perform IT audit on infrastructure level we need to gather the information about hardware and software assets, warranty agreements, lifecycle details, users access controls, network architecture, logical network diagrams and IP address details, gateway /firewall configuration, licensing, subscription details, Active directory or azure ad users and groups details, policies, plans etc.
    - **IT Audit Requirements from Database Perspective:** In Database perspective we need the information like database software vendor details, editions, licensing architecture, upgrades, security updates, encryption method, user access controls, support agreement, credential store security etc.

### End User Experience

It is constructive to understand the end user experience. This analysis helps us in understanding the requirements of the new solution. End user’s interaction with application will give us an insight further. Following are the list of points that we need to gather from the end user:

* Workstation Inventory
  + List of machines that access SAP
  + Deployed OS versions
  + Deployed SAP GUI Versions
* SAP Application Access
  + Internal/External Access
  + Thick Client, App Virtualization
  + Front End Components (Third Party GUI)
* User Population
  + Geographic Location
  + Logical User Groupings
  + Usage patterns
* Who/What/ When/Where/How

End user experience provides an understanding on client side and server-side work in existing SAP environment. Also, it will provide the details which will help to understand the front side of application in user perspective. By gathering the information, we will get to know about the performance of application and the latency while accessing the application from end user. This complete information will help to identify the gaps and build a strategic plan to remediate the gaps and increase the productivity and performance of the application after migration.

### Existing SAP Maintenance Processes

This section provides the details about SAP maintenance process on multiple level with the objectives. This need to be understood as maintenance plays an important role to keep the environment healthy.

* **Identify current Maintenances Policies for Operating System (OS) / Databases (DB):** Understand the current maintenance policies for operating system and database in existing SAP environment. Also ensure the documentation are available which clarify the details.
  + - **Identify current Patching Policy / Tools:** Gather the information about current patching policy and tools which are used for patching. Validate the existing document or create a document.
    - **Identify current Operational Health Monitoring:** Identify the health monitoring method for existing SAP environment and capture the data and retain the data. Health Monitoring will ensure about the health status of infrastructure, network, databases, and application components.
* **SAP Application Maintenance Process:** SAP application maintenance process is performed under the best practices recommended by SAP. Document this process which will help to identify the critical gaps of the maintenance process and can be used as reference to mitigate or remediate the issues.
  + - **SAP Kernel Upgrades:** SAP kernel is the core component of SAP system. Upgrade of SAP kernel is critical and requires appropriate documentation in place before starting the activity. Ensure the specific process documentations are in place which can be used as reference further to perform SAP kernel upgrade seamlessly. For more details, please refer to [SAP Kernel Upgrades](https://blogs.sap.com/2015/05/29/information-on-sap-kernel-and-upgrade/).
    - **Support Pack Upgrade Process:** The Support package stack is a list of ABAP and Java support packages which is compatible for all software components. Gather the appropriate process documentation which must mention the clear steps and methods of upgrade of support pack. For more details, please refer [SAP Support Pack Upgrade Process.](https://support.sap.com/en/my-support/software-downloads/support-package-stacks.html)
* **Identify existing Backup and Restore Procedures:** Understand existing backup and restore procedure to ensure the business continuity in case of any disaster or unexpected failure issues.
  + - **Gather information about exiting Snapshot Policies:** Gather the information about existing backup snapshot polices which includes type of snapshot, schedule, retention, encryption, etc. Snapshot are used to take backup of data and restore in case of any issue occurs.
    - **Identify current Database (DB) Backup tools used.:** Identify the backup and restore procedure used to backup database in current environment. List out the tools which are used to back up the database and build the documentation which clarifies about backup tool configuration and working method, backup policies, credential stores etc.
* **Identify and document existing Replication Policies for SAP Workload:** Replication of Data ensures the High Availability and business continuity of SAP application and database workload in case of any disaster occurs on primary site. This is also called as Business Continuity and Disaster Recovery plan.
  + - **Identify the tools being used for Replication:** Identity the information about tools which are used for replication of data from primary site to secondary site. This document will help to failover the application workload easily on any unplanned occurred event.
    - **Gather information and document the Disaster Recovery Scenarios:** Document the disaster recovery scenarios i.e. datacenter outage, power outage, hardware failures, natural disasters etc. and the steps need to be performed on the disaster recovery event.
* **Identify existing Technical Monitoring:** Identify the process of technical monitoring in existing SAP environment and document appropriately which can be used further as reference base to build the monitoring strategy.
* **Identify existing Business Monitoring Area (BPM):** Business Monitoring and Reporting provides information for management which includes insights around spending, growth, and profits. This can be used to project future cost analysis, budgets, and plans.

### Creating SAP on Public Cloud Central of Excellence

A cloud center of excellence (CCoE) is a function which creates a balance between speed and stability. Plan to migrate to S/4HANA on hyperscale cloud platforms like Microsoft Azure. There is a need for a [Center of Excellence](https://blogs.sap.com/2019/12/15/sap-customer-center-of-excellence-for-azure/) for SAP and Azure

* Multi-cloud model consisting of SAP and Microsoft Cloud Services
* Capability model of a Unified SAP Customer Center of Excellence for Azure
* Role Mapping of a typical SAP SME to Microsoft training and certification

#### Multi-cloud model consisting of SAP and Microsoft Cloud Services

SAP CCOE has always been on-premise centric point of view, but SAP now recognizes the growing reality of cloud deployment models which SAP terms as Hybrid Cloud and emerging trends in DevOps. For more information, please refer [Multi-cloud model consisting of SAP and Microsoft Cloud Services](https://blogs.sap.com/2019/12/15/sap-customer-center-of-excellence-for-azure/)



#### Capability model of a Unified SAP Customer Center of Excellence for Azure

* Design Authority and Governance Owner
* Strong alignment and collaboration with business
* IT Strategy and Roadmap to support business needs and requirements
* Corporate standards for enterprise security and integration
* Legacy IT tasks are redundant (datacenter, legacy software)
* SaaS Application solutions provides opportunities for standardization and continuous innovation
* PaaS solutions provide opportunities for integration between system of record, system of differentiation and system of innovation using [Gartner’s Bi-Modal IT concepts](https://www.gartner.com/en/information-technology/glossary/bimodal).
* New Skills and Role Required (blend of both SAP and Azure skills)

For more information, please refer [Capability model of a Unified SAP Customer Center of Excellence for Azure](https://blogs.sap.com/2019/12/15/sap-customer-center-of-excellence-for-azure/)

#### Unified SAP CCOEA Role Based Mapping to Microsoft Azure Skills

* NetWeaver/Basis/HANA teams would not have an idea of what Azure infrastructure is about. Vice-versa, the Azure platform team do not have SAP NetWeaver/Basis/HANA knowledge
* After migration is completed and as part of steady state run, this is where full benefits of running a SAP workload on Azure can be realized through these unified capabilities

For more information, please refer [Unified SAP CCOEA Role Based Mapping to Microsoft Azure Skills](https://blogs.sap.com/2019/12/15/sap-customer-center-of-excellence-for-azure/)

## Initial organization Alignment

The most important aspect of any cloud adoption plan is the alignment of people who will make the plan a reality. No plan is complete until you understand its people-related aspects. This section focuses on resources that will work on CAF to make SAP on Azure a reality. A set of people are identified who will work on this setup and their capabilities mapped to perform the process.

### IT Operational Processes

* Purchase Processing
* Consider Change Management Processes

### Map People to capabilities

* Ability to decide on the Plan
* Ability to deliver technical changes
* Ability to Estimate the Timelines
* Technical tasks in the cloud adoption plan

### SAP on Azure Skill Readiness Plan

List applicable Skills Disciplines with quick rationale for each. ([Summarize and reference](https://docs.microsoft.com/en-us/azure/cloud-adoption-framework/plan/adapt-roles-skills-processes))

|  |  |  |
| --- | --- | --- |
| * Project Management | * Security | * SAP BASIS Admin |
| * Business Sponsor/Stakeholder | * OS System Admin | * Security Admins |
| * Azure Architect | * DB Admin | * SAP Functional SMEs |
| * Network | * SAP Architect | * Software Testing/QA |

## Cloud Adoption Plan (SAP Implementation in Azure)

Partners and customers can choose the option of Mixed or Only Azure systems to be implemented. This can go with the options of Non-Production systems on-premise and Production systems to Cloud or vice versa.

### Greenfield Implementation

Greenfield Implementation means to start a fresh deployment of SAP environment in Azure whether you have existing SAP workloads in on-premises. This is a new implementation of SAP (greenfield) for customers/partners who are migrating from a non-SAP legacy system or from an SAP ERP system and implementing a fresh system that requires an initial data load will be discussed in this scenario.

### Brownfield Implementation

Brownfield implementation means you have existing SAP workloads and you would like to migrate from on-premises to Azure. In Brownfield migrations there are four main categories listed as below.

#### Homogeneous Migration

A Homogeneous migration is the easiest migration method to execute, as the operating system, database and hardware platform remain the same and no data conversion is required. To accomplish this the simplest form of migration is a backup and restore method or DBMS replication to live replicate the database into Azure. For more information, [please refer Homogeneous Migration.](https://help.sap.com/viewer/6ffd9a3438944dc39dfe288d758a2ed5/CURRENT_VERSION/en-US/f1677053e4960150e10000000a44176d.html)

* **Lift and Shift to Cloud (Rehost)**
* **Migration Using Backup/Restore**
* **Migration using DBMS Replication**
* **Migration using Azure Migrate**

#### Heterogenous Migration

Heterogenous Migration means, whenever there is a change to the operating system or DBMS software or hardware platform then the migration becomes heterogenous. In heterogenous migration method there are several types of method which we can use for migration.

#### Vertical Migration Strategy

In Vertical Migration Strategy, it moves all the environments of SAP application at one time to Azure. This avoids any issues of compatibility between the development, A/Test and Production environments.

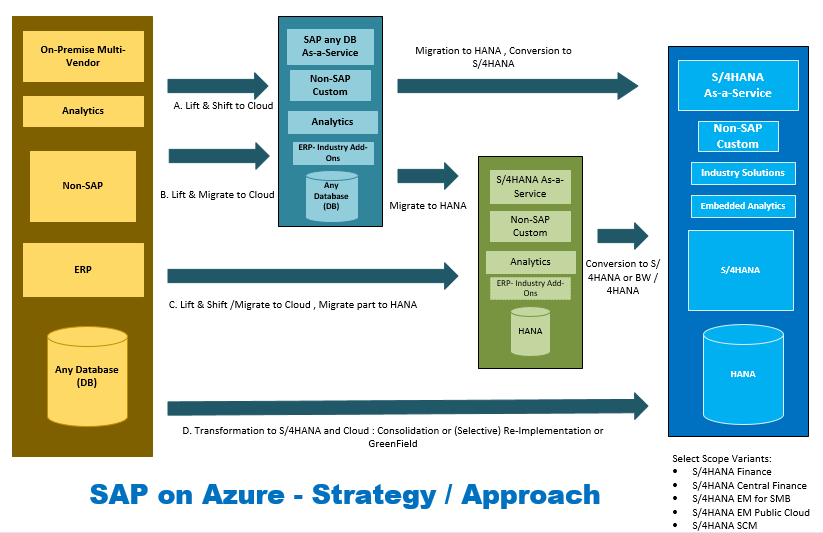
#### Classical Migration

* Lift and Shift /Migrate to Cloud, Migrate part to HANA
* Near-Zero Downtime Migration with DMO
* Oracle Database

### HANA Conversions

You have an existing ERP/SAP Business Suite system, and you want to leverage your previous investment in  
the business processes that you already have implemented your SAP. You want to bring them to the new world of SAP S/4HANA, B/4HANA and C/4HANA. Then HANA system conversion is perfect option for you. For more details

### Choosing the best Deployment Scenario

The following exercises will help establish the iterative processes to assess, migrate, optimize, secure, and manage those SAP workloads. Any enterprise-scale cloud adoption plan will include workloads that do not warrant significant investments in the creation of new business logic. Those workloads could be moved to the cloud through any number of approaches. Each of these approaches is considered a migration.

## SAP Workload on Azure - Supported scenarios

In Azure there are lot of different opportunities for various architectures and tools to use to get a scalable, efficient and highly available deployment. In this scenario, there are some restrictions when we consider operating system or Database Management System. This section will ensure and clear the supported scenarios for the SAP workload in Azure.

## Migration Timeline

Planning the migration with a specific measurable estimated time will help to organization to make a broader view on migration activity. Below is the different migration scenario from that identify the suitable scenario and estimate the timeline.

The different migration scenario is below:

* **Greenfield Implementation:** In Greenfield Implementation, included pre-requirement, network deployment, greenfield implementation, post configuration activities to estimate the migration timeline.
* Consider below points to estimate migration timeline in different migration scenario as **Rehost Migration, SAP OS/DB Migration to Azure, HANA Conversion.**
  + Pre-Requirement
  + Migration DB to Azure
  + SAP to Azure (Lift and Shift)
  + Post Validation

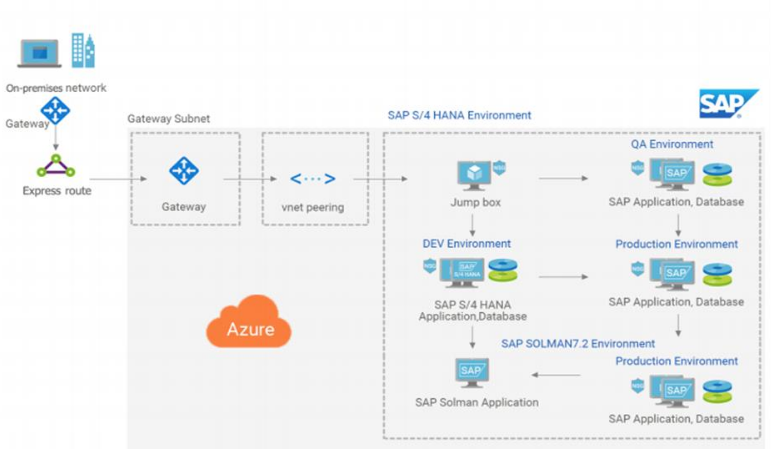
## Key Assumptions and Risks

In this section, you must document key assumptions and risks related to migration activity. Assumptions are the first place to start identifying the risks involved in migration.

# Ready Phase

In Cloud adoption journey we are on ready phase which state how to prepare the landing zone for SAP deployment or migration. In this section we will cover the points which illustrate the architecture design, SAP workload, best practices and first landing zone.

## High Level SAP Architecture Design

High level SAP architecture design provides the information of the components of existing SAP workload and about SAP 3-tier architecture layer, which are presentation layer, application layer & database layer. We have provided details about below points in SAP on Azure Deployment Guide. Please use it for reference.

* **List of Servers for single SAP environment** 
  + **Operating System with Specifications:** Ensure selected Operating System is compatible and certified from SAP to host the SAP workload
  + **Hostnames:** Identify the hostnames which used in current sap environment. This can be used as reference in new deployment or migration.
  + **Specifications:** Collect the information of hardware specification among the servers. This can be used as reference further.
* **Server Roles**
  + - **DB Server, inc DB type and Version**: Database server in SAP environment is used to store the data in a standard format. Identify the current DB Server (Database server) specifications including the hardware, operating system, database type and its version.
    - **PAS server**: Presentation Servers works on presentation layer in SAP 3-tier architecture and known as client layer. This server is used as SAP-User interaction with GUI.
    - **Application Server**: Application server is the dispatcher distributes the workload to the different work processes to make the job done.
* **SAP Application / Product Version**
  + - List out the SAP application version, licensing, support pack from current existing SAP environment.
* **Any third-party System Details (only showing interaction points)**
* **Network Load Balancers:** We must use Application Gateway with WAF for Gateway level firewall and load-balancer which will work on OSI Layer 7 and internal load balancer which will be placed to balancer to request between application and database servers.
* **End User Access Points/methods (high level):** End user access points for SAP application are desktop, mobile devices, laptop etc.

### Assessment & Capacity Planning

Assessment and capacity planning are an important step before moving further in deployment or migration the workload. performing an assessment in environment provides a deeper understanding on the architecture, hardware specifications, operating system compatibility, dependencies, etc. The results are based on the data gathered during assessment. With the help of assessment results, we can perform capacity planning which defined as to provide appropriate IT resources for workload so they can perform efficiently with performance. Below are the points which we need to consider during assessment and capacity planning. For more information, please refer SAP on Azure Deployment Document.

* Infrastructure Assessment
* Azure Migrate Tools- Azure Assets
* [SAP Sizing Reports](https://www.sap.com/about/benchmark/sizing.html#sizing-types)
* Sizing Reports for SAP HANA Environment
* Storage Requirements for SAP HANA

Based on recommendation, organization must use a storage which provides High IOPS. To achieve this goal, we need to use Premium SSD or Ultra SSD

* + - Premium SSD:
* Ultra-SSD:
  + Azure NetApp Files
  + Utilize results from above to determine correct [OLAP/OLTP Azure VM Size](https://docs.microsoft.com/en-us/azure/virtual-machines/workloads/sap/hana-available-skus)
  + SAP HANA
* Different Sizing Methods & Approach Guidance

Sizing methods are most important part when we plan to move the workload in cloud. Sizing of servers and other components are directly integrated to cost, performance and other functionalities. Following are the important points which need to be considered during sizing.

* + Consider Non-Production Systems Sizing Methods:
  + Consider Production Systems Sizing Methods:
  + Consider HANA and Non-HANA Systems:
  + Consider Windows / Linux Operating System:
* Plan Update/Upgrade and Migration Requirements
  + Identify Business Applications that needs to be migrated:
  + Identify Technical Systems to be Migrated/Upgraded
  + Meeting the Operating System-Specific Requirements:
  + Third Party Application dependencies (SAP Supported):
  + Assess with SAP Software Provisioning Manager
  + Assess with SAP Software Update Manager

*For detailed information please refer* ***SAP on Azure Deployment Document****.*

### Understanding Non-Functional Requirements

In this section we need to understand the Non-Functional requirements in ready phase and the overview of resources system’s ability to recover from failures and continue to function. It’s not only about avoiding failures but also involves responding to failures in a way that minimizes downtime or data loss.

* **Resiliency:** Resiliency ensures the availability of the resources with an SLA aligned with shared responsibility model approach which ensures the reliable infrastructure for production environment. Below are the points which clarify the requirements to ensure the availability of production workload in azure.

*For detailed information please refer* ***SAP on Azure Deployment Document****.*

**High Availability (HA) requirements:** For SAP HANA High Availability, there must be minimum two virtual machines in Azure with SAP HANA Installed. Data replication can be performed by using HANA System Replication. For more details please refer [SAP HANA High Availability Overview and Configuration](https://docs.microsoft.com/en-us/azure/virtual-machines/workloads/sap/sap-hana-high-availability#:~:text=To%20achieve%20high%20availability%2C%20SAP,use%20a%20virtual%20IP%20address.)

* + Acceptable downtime
  + Host Auto – Failover ([Failover Custer](https://docs.microsoft.com/en-us/windows-server/failover-clustering/failover-clustering-overview))
  + Hana System Replication as High Availability (HA)
  + HANA High Availability (HA) for VM Deployment
  + HANA High Availability (HA) for HLI Deployment
  + Any Database (DB) High Availability (HA) Option
* **Performance:** Performance means end-to-end response time and throughput. The end user performance is corelated to End-to-End response time. Please refer for more details [End User Performance](https://blogs.sap.com/2020/07/23/sap-s-4hana-end-to-end-performance/).
  + **End user experience expectations:** From the perspective of end user, the application performance should not be a sluggish and must be low latency which will increase the productivity with consistency.
* **Security:** To ensure the security on perimeter level we need to apply the solutions on network level. We have mentioned some best and recommended solution for network security. For more information about the mentioned points please refer **SAP on Azure Deployment Document**.
  + Network and Access Points
  + Azure Firewall
* **Management and Monitoring**

Management and monitoring are a base to handle the deployed workload and maintain it properly. To ensure the production workload is running without any issue we have mentioned the solution in SAP on Azure Deployment Document. Please refer it for more details.

### SAP Supported for Azure: Certification & VMs

SAP provides the SAP HANA Hardware and Cloud Measurement tools (HCMTs) to vendors to validate that their platform meets the required key performance indicators (KPIs). Microsoft Azure has successfully certified a wide range of virtual machines and bare-metal servers to run SAP HANA which ensures all hardware components are compatible and offer the required performance.

* Identify SAP Systems for Cloud Migration
* SAP S/4HANA Azure Cloud
  + Single Tenant ([Single Tenant](https://docs.microsoft.com/en-us/azure/virtual-machines/workloads/sap/sap-hana-scale-out-standby-netapp-files-suse)) : SAP S/4 HANA Single Tenant edition is provisioned to a single customer in a dedicated landscape, which offers the full scope of S/4 HANA. For more details please refer on [SAP S/4 HANA Single Instance.](https://blogs.sap.com/2018/11/26/sap-s4hana-cloud-single-tenant-edition-ste/)
  + Multi-Tenant ([Multi-Tenant](https://docs.microsoft.com/en-us/azure/app-service/manage-scale-up))
    - HANA Multitenant Database Containers (MDC)
  + Scale Up ([Scale up](https://docs.microsoft.com/en-us/azure/virtual-machines/workloads/sap/sap-hana-scale-out-standby-netapp-files-suse)): In scale-up, the whole HANA instance must fit into a single HANA node, and as the database grows we will need to scale-up the host, be it a VM or a physical bare-metal server.
  + Scale Out (Scale out): In scale-out, in theory you can scale the size of the HANA instance as the database grows, by adding extra nodes
* Unsupported Scenarios: Not Supported means SAP and Microsoft will not be able to support these configurations and need to defer to an eventual involved third-party that provided software to establish such architectures. In this there are two categories as below.
  + Storage Soft Appliances
  + High Availability Frameworks

*\*For More details please refer* ***SAP on Azure Deployment Document****.*

### Decide Azure Region

Azure regions are global datacenters where Azure computes, networking and storage resources are located. This is key factor to be specific while choosing the Azure regions as all regions does not have all range of Azure products and services. Please refer for more details [Azure Regions](https://docs.microsoft.com/en-us/azure/virtual-machines/regions)

* **Proximity of DC & Users:** Azure Proximity placement groups improve the overall performance by reducing network latency among virtual machines.
* **Product Availability in Region:** In Azure all products are not available in all regions due to compliance and other limitation concerns. There are some global services which are available to all datacenter like Azure AD, Azure DNS etc., but for other products we need to identify the availability of product in specific region.
* **Paired Region for DR check:** Paired Region is a set of data centers deployed within a latency-defined perimeter and connected through a dedicated low-latency network. A regional pair consists of two regions within the same geography. This azure Paired region are useful during configuration of Business Continuity and Disaster Recovery planning.
* **SAP VMs availability per region :** To ensure SAP VMs availability based on region we recommend to refer link [SAP VMs Availability Per Region](https://azure.microsoft.com/en-us/global-infrastructure/services/?products=sap-hana-large). This will provide appropriate details about certified SAP VMs SKUs.
* **Azure Supported VMs for SAP:** For best and reliable infrastructure in azure cloud SAP has provided some recommended and certified VMs SKUs. Which must be used for SAP deployment to avoid any unexpected issues in production environment.

*For detailed information please refer* ***SAP on Azure Deployment Document****.*

## Designing SAP Workload on Azure

In this section we will go through the components which are required for designing SAP workload on Azure infrastructure. Understanding the components deeply will help to design the workload more efficiently and robust on Azure.

### Design Network, Compute, Storage

#### Design Network

In designing the SAP workload on Azure, Network will be the first component which has to setup in Azure Infrastructure with appropriate network strategy. Below is the Hub-and-Spoke network model which is recommended as a best network design to host SAP workload.

* **Network address spaces & subnets:** A Network address specifies as identifying a network node or device in a network and used to communicate with each other. A subnet enables you to segment the virtual network address space into one or more sub-networks and allocate a portion of the virtual network address space to each subnet.
* **Multi Network- Vnet Peering consideration:** VNet peering is a mechanism that connects two separate virtual networks (VNets) in the same region or other region through the Azure backbone network. Once peered, the two virtual networks appear as one for all connectivity purposes.
* **Single Network Vs. Multi Network Consideration:** A network interface enables an Azure Virtual Machine to communicate with internet, Azure, and on-premises resources. Virtual machines (VMs) in Azure can have multiple virtual network interface cards (NICs) attached to them.
* **Azure Network Load balancer:** Azure Load Balancer operates at layer four of the Open Systems Interconnection (OSI) model. It's the single point of contact for clients. Load Balancer distributes inbound flows that arrive at the load balancer's front end to backend pool instances.
* **Hybrid Network Consideration:** Communicate between applications that exist on-site and in Azure (Azure SQL/PaaS, IIS front end to back end, and legacy applications) Create security zones on-site and through Azure (DMZ in Azure, and development networks)
  + - * + **Best Practice - Azure Network**
  + **Azure Accelerator Networking:** Accelerated Networking enables single root I/O virtualization (SR-IOV) to a VM, which improves its networking performance. This high-performance path bypasses the host from the Datapath, reducing latency, jitter and CPU utilization.
  + **Standard Load Balancer (LB) Recommendation:** In Azure, load balancer operates at layer 4 of the Operating Systems Interconnection (OSI) model. Load Balancer distributes inbound flows that arrive at the load balancer's front end to backend pool instances. This works on based of load balancing rules and health probes.
  + **Consider Proximity Placement Group for DB latency:** A Proximity placement group is a logical grouping used to ensure that Azure Compute Resources are physically located close to each other. This will help to achieve the requirement of low latency.
  + **For Hybrid Network Speed & Security: Consider Express Route (ER):** In Azure, Express Route extend your on-premises networks to Azure Cloud with a private connection which facilitated by a connectivity provider.
    - * + **Enable ExpresRoute Fast Path Feature**: Express Route Fast Path is designed to improve the data path performance between your on-premises network and virtual network. When Fast Path is enabled, it sends network traffic directly to virtual machines in the virtual network bypassing the gateway

**Disaster Recovery (DR) Scenario - Consider**

* **VNet Peering :** Virtual network peering enables you to seamlessly connect networks in [Azure Virtual Network](https://docs.microsoft.com/en-us/azure/virtual-network/virtual-networks-overview). The virtual networks appear as one for connectivity purposes. The traffic between virtual machines uses the Microsoft backbone infrastructure.
  + - * + **Express Route (ER) Global Reach:** ExpressRoute is a private and resilient way to connect your on-premises networks to Microsoft Cloud. You can access many Microsoft cloud services such as Azure, and Office 365 from your private data center or your corporate network
        + **ER can be shared across subscription: Cost Optimization:** ER (Express Route) can be shared across subscription in Azure which will reduce the cost and help to optimize it appropriately.
        + **Multiple NIC Consideration:** In SAP HANA, SAP distinguishes three network zones as below:
  + **Client Zone:** Client applications which connects to database and execute SQL or MDX queries.
  + **Internal Zone:** Internal Communication between SAP HANA instances.
  + **Storage Zone:** The storage zone is used to access data and log files that are stored on storage account tiers.

*So, there must be multiple NIC for VMs to avoid latency issues and get rapid performance over the network****.***

* + - * + **HANA Network Design Best practices:** While design for migration the most important and critical step is to design and implementation of Azure Networking. The best practices are based on the Azure platform and service features available. Please refer for more details [Best Azure Networking Practices.](https://docs.microsoft.com/en-us/azure/cloud-adoption-framework/migrate/azure-best-practices/migrate-best-practices-networking)

*For detailed information please refer* ***SAP on Azure Deployment Document****.*

#### Design Compute

Compute is a core component for building the infrastructure or migration in cloud platform. Based on specific and appropriate compute resource SAP workload can run seamlessly on azure. To achieve this objective, design the compute considering each aspect listed below.

* + - * + **Finalizing VM SKU Mapping:** Finalize the VM SKU considering the certified VM SKUs provided by SAP and Azure.
  + **SAP Notes & Azure VM Sizing Guidance :**Before finalize the VM SKU sizing please refer to [Sizing Guidelines](https://www.sap.com/about/benchmark/sizing.sizing-guidelines.html) and [Certified VM SKUs.](https://www.sap.com/dmc/exp/2014-09-02-hana-hardware/enEN/iaas.html#categories=Microsoft%20Azure)
    - * + **Best Practices - Azure Compute** :Please refer the reference link for Best Practices -[Azure Compute](https://azure.microsoft.com/en-gb/blog/best-practices-in-migrating-sap-applications-to-azure-part-1/)

We can use max disks limit allow per VM and total Throughput/ IOPS allow per VM. Ensure Secure transfer and secure storage are enabled.

#### Design Storage

After designing the compute section, it’s time to design the storage for SAP workload. SAP workload requires High Performance with low latency storage, so the workload runs with effective performance. Consider below components while designing the storage for SAP workload.

* + - * + **Azure Disks Support for SAP**

Below we have mentioned the various disks options which are supported for SAP environment. Please refer SAP on Azure Deployment Document for more details.

* + Azure Premium SSD
  + Ultra-Disk
  + Azure NetApp Files
    - * + **Best Practices - Azure Storage**

As a best practice, we recommend using Managed disks instead of unmanaged disks. As managed disk provides a seamless architecture in form of scalability and maintenance.

*For more information, please refer* ***SAP on Azure Deployment Document.***

### Design SAP Application Architecture

Consider the below high-level decision-making points in choosing right Azure VM for your deployments:

* + - * + For SAP Workload Migrations Prepare a details design document from the Existing SAP Architecture diagram to represent cloud systems and connections along with access points.
        + For Greenfield implementations prepare a detailed architecture diagram from the scratch.

### Design Business Continuity: High Availability (HA), Disaster Recovery (DR) & Backup and Recovery.

**High Availability**

Each critical production application workload requires a high availability architecture in backend to ensure the service reliability. For the SAP on Azure the same things are going to apply. Based on this we have mentioned below points which covers High Availability for SAP on Azure Environment. For more information please refer **SAP on Azure Deployment Document.**

* + Azure High Availability capabilities
  + Design HA for SAP Application
  + Operating System level High Availability

**ASCS HA Options**

* **Windows: Using file share: Scale Out File Share (Windows 2016 SOFS + S2D):** In this windows cluster we can use server internal storage as a shared stored and create failover cluster. Also, file share can be used instead of cluster disk. For more details please refer [Windows 2016 SOFS + S2D SAP](https://blogs.sap.com/2018/03/07/your-sap-on-azure-part-5-ascs-high-availability-with-storage-spaces-direct/)
* **Windows: Using Azure Net App File (SMB) with WSFC:** In this Windows Server Failover Clustering we can use Azure NetApp File with SMB protocol to build the cluster. We can hos SAP Global Host files on the Shares. For more information , please refer [Windows Server Failover Cluster with NetApp + SMB](https://docs.microsoft.com/en-us/azure/virtual-machines/workloads/sap/high-availability-guide-windows-netapp-files-smb)
* **Windows: Using clustered shared disks (WSFC + SIOS DataKeeper Shared Disk):** In this cluster SIOS Data keeper will provide 'sapmnt' and 'trans' individual/separate file share for multiple SAP environments in the system landscape. For more details please refer [SIOS Data Keeper HA](https://blogs.sap.com/2020/08/04/sap-on-azure-highly-available-file-share-cluster-for-multiple-sap-environments-in-windows-using-sios-datakeeper/)
* **Linux: Clustering by using the SLES cluster framework (With NFS Cluster OR ANF):** In Linux Clustering by using the SLES cluster framework, a highly available NFS server is installed to store the shared data of a highly available SAP system. For more information , please refer to [Linux Clustering using SLES with NFS.](https://docs.microsoft.com/en-us/azure/virtual-machines/workloads/sap/high-availability-guide-suse-nfs)
* **Linux: Clustering by using RHEL GlusterFS framework (With GlusterFS OR ANF):** In Linux Clustering by using RHEL GlusterFS framework, a GlusterFS Cluster is installed and used to store the shared data of a highly available SAP system. For more information please refer [to Linux Clustering by using RHEL with GlusterFS](https://docs.microsoft.com/en-us/azure/virtual-machines/workloads/sap/high-availability-guide-rhel-glusterfs)
* **New Option – Coming Soon: Azure Shared Disks with WSFS & Linux Cluster support for ASCS VMs**: In Azure Shared Disks with WSFS & Linux Cluster support for ASCS VMs, any application that currently leverages SCSI Persistent Reservations (PR) can use this well-known set of commands to register nodes in the cluster to the disk. The application can then choose from a range of supported access modes for one or more nodes to read or write to the disk. These applications can deploy in highly available configurations while also leveraging Azure Disk durability guarantees. For more information , [please refer Azure Shared Disk with WSFS & Linux Clusters.](https://azure.microsoft.com/en-us/blog/announcing-the-preview-of-azure-shared-disks-for-clustered-applications/)
  + HANA High Availability (HA) for Virtual Machine (VM) Deployment
  + HANA HA for HLI Deployment
  + Any DB HA Option

*For more information, please refer* ***SAP on Azure Deployment Document.***

**Disaster Recovery**

Disaster Recovery is one of the most important components which need to concern for production environment. In case of disaster doesn’t matter it is natural or man-made, we need a Disaster Recovery plan and solution in place. In this section we have highlighted the points which need to understand to build Disaster Recovery Plan and Solution.

* Design Business Continuity: High Availability (HA), Disaster Recovery (DR) & Backup and Recovery
* App Server Disaster Recovery (DR)
* Any Database (DB) Disaster Recovery
* Database replication technology for DB DR (like SQL Always On, Oracle Data-guard)
* Network Requirement
* Cost Considerations
* HANA Large Instance (HLI) Disaster Recovery (DR) Approach

*For more information, please refer* ***SAP on Azure Deployment Document.***

**Backup and Recovery**

Backup is essential component for SAP workload environment. It will ensure the data back in place in case of any data corruption or accidental deletion incidence occurs. In Azure, leverage the benefit of Azure Backup which backup entire VM or files and folders easily and store in recovery service vault in encrypted format.

* Backup options for SAP Application Servers
* Any Database (DB) Backup - SQL
* HANA Backup Options in Azure
* HANA backup based on storage snapshots manually

### Design Security

Designing the Security for deployed SAP on Azure Infrastructure a huge and responsible task for team. We have mentioned some recommended guidelines which can be used as reference and design a specific and robust Security solution for SAP Environment on Azure. For more details, please refer SAP on Azure Deployment Document.

#### Architecture Level

In the security, we need to understand the architecture level security layer which is one of the important factors need to concern in this deployment. Architecture Level security ensures about the harden and secure boundary for the resources deployed in Azure. We have mentioned the recommended architecture below and for more information please refer **SAP on Azure Deployment Document.**

#### Network security

Network security is one of the layers which prevents organization infrastructure from intruders and their potential attacks. So, in azure we need to build a robust network security design with the help of network security services provided by azure i.e. Network Security Groups etc. For more information, please refer **SAP on Azure Deployment Document.**

#### Security Monitoring

Only security implementation is not enough to build a full-proof security solution for Azure Infrastructure SAP environment. We need to ensure about security monitoring is appropriate and in place which helps to identify the real time situation about incidents and attacks. For more information, please refer **SAP on Azure Deployment Document.**

#### Data Security

Data protection is most critical and important component in terms of security design and implementation. Ensure to be specific and apply the data protection solutions in place i.e. Disk Encryption, Encryption in Transit etc. For more information, please refer **SAP on Azure Deployment Document.**

#### Identity and Access controls

Identity and Access controls are the essential components to ensure the authentication and authorization for an appropriate and specific person or resource is allowed or denied. We have mentioned the details for below mentioned points in **SAP on Azure Deployment Document**. Please use it as reference.

* Enable SSO for SAP
* Enable MFA for SAP Applications
* Identity Access Management
* Azure Key vault

### Design Monitoring & Governance Controls

Designing Monitoring and Controls is required for deployed infrastructure in azure. It ensures a proactive approach towards incidents and defense analogy for the hosted resources. For more information please refer **SAP on Azure Deployment Document**.

### Define DevOps, Automation & Management Approach

In cloud Automation in between development and Operations and make them a agile became demandable and required approach to move with technology with aligned. We have mentioned the details in SAP on Azure Deployment Document. Please use it as reference.

### Storage Considerations

Storage Consideration is important as all the workload resides and depend on the storage. With a appropriate and best recommended Storage solution, organization can achieve a great performance, reliability and security for stored data. For more information, please refer SAP on Azure Deployment Document.

## Establish Best practice guidance

Temporarily beefing up the infrastructure to accelerate your SAP migration throughput and reduce the downtime. We recommend you leverage virtual machine accelerators for your SAP application and database layers. Enable Accelerated Networking on your virtual machines to accelerate network performance. For more information, please refer to **SAP on Azure Deployment Document.**

## Conduct Governance baseline discussion

Organization's development and IT departments to be agile by making it easy to create, read, update, and delete resources as needed. However, while giving unrestricted resource access to developers can make them very agile, it can also lead to unintended cost consequences. The solution to this problem is resource access governance—the ongoing process of managing, monitoring, and auditing the use of Azure resources to meet the goals and requirements of your organization

* **Business risks:** Identifying and understanding corporate risks.
* **Policy and compliance:** Converting risks into policy statements that support any compliance requirements.
* **Processes:** Ensuring adherence to the stated policies.

## First landing Zone

Before adoption can begin, you must create a landing zone to host the workloads that you plan to build in the cloud or migrate to the cloud. This section of the framework guides you through the creation of a landing zone.

### Organize Azure Resources

Organize your azure resources appropriately by using Resource Groups and tags. Which will help to identify the resource and enable them for search index.

### Network Setup

Networking is base of cloud infrastructure. Building a best network setup in azure will ensure the reliability and security for production environment. We have mentioned detailed information for below mentioned points in SAP on Azure Deployment Document. Please use it as reference.

* Virtual Network / Subnet
* Network Security Group
* Azure Firewalls
* Configure the Diagnostics Settings

### Hybrid Network setup

This is an optional setup for organizations who wants to connect their on-premises network to Azure cloud. Here are the available options to connect to Azure cloud:

* Express Routes
* Hub-n-spoke architecture
* Forced Tunnelling

**Note**: *For information about the deployment models, see Understanding deployment models. If you are new to Azure, we recommend that you use the Resource Manager deployment model.*

### Domain Controller setup

Active Directory Domain Controller which is used as identity and Access and single-sign-on solution in on-premise and Azure environment. Now we can extend the on-premise Active Directory to Azure Active Directory. For detailed information, please refer **SAP on Azure Deployment Document.**

# Adopt Phase

Adopt phase provides the implementation steps for migration, innovation and testing. Whether looking to migrate existing workloads to the cloud or innovating something new, this phase is where the technology implementation takes place to deliver on the business expectations and align to the cloud adoption plan. In this section we have given high-level overview of adopt phase. For more information, please refer SAP on Azure Deployment Document.

## SAP Deployment Summarization

### Proof of Concept (POC)

Run a pilot before or during project planning and preparation. We assume you've already identified a system that you want to migrate to Azure for the pilot ([Deployment Guide](https://docs.microsoft.com/en-us/azure/virtual-machines/workloads/sap/deployment-guide)).For more information about Proof of Concept, please refer to SAP on Azure Deployment Document.

### Non-production phase

In the production phase, we start to deploy non-production SAP systems into Azure following a successful POC, leveraging all the testing and validation tasks. Additional steps you need to consider during that phase include:

* + Migrate in waves ([White Paper on Azure](https://azure.microsoft.com/en-us/resources/migration-methodologies-for-sap-on-azure/))

### Production preparation phase

Work through necessary SAP release upgrades of your production systems before moving into Azure.

### Go-live phase

Don't accept last-minute changes in configurations and process. There is some recommended consideration which need to understand and apply in Go-Live Phase. Detailed information is mentioned in SAP on Azure Deployment Document. Please use it as reference. Post Go live

## Implementation Guidance

In this section we will be discussing on the special considerations for each scenario to be followed/considered to come up with right decisions.

### Greenfield Implementation

This is a new implementation of SAP (greenfield) for customers/partners who are migrating from a non-SAP legacy system or from an SAP ERP system and implementing a fresh system that requires an initial data load. The new implementation process will be discussed in this scenario. For detailed information, please refer SAP on Azure Deployment Document.

### Test before actual migration Rehost Scenario for SAP

* **Rearchitect (Rehost):** Rehosting means when the current operating system (OS) and database management system (DBMS) that are being used on-premises can be migrated to Azure without the need to change either. We have listed the details in **SAP on Azure Deployment Document.** Please use it as reference.
* **Rebuild:** Use of ARM templates in Azure can be used to rebuild Entire SAP Environment. It Will include all azure resources

### Operating System (OS)/Database (DB) Migration

Operating System and Database Migration can be done by using different methods. Below we have mentioned the best migration methods and detailed information is shared in SAP on Azure Deployment Document. Use it as reference guide while deployment.

### HANA Conversion

HANA Conversion can be done when your existing database is not compatible with new version. We can achieve the migration by using HANA conversion methods. We have elaborated the procedure in **SAP on Azure Deployment Document**. Use it as reference while deployment.

### Best Practice

Best practices are industrial recommended practices which are used by multiple global organizations. You can use recommended best practices to avoid any unexpected issues and achieve your migration goal in a seamless manner. Please refer **SAP on Azure Deployment Document** for detailed information.

## Testing Environment after Azure Migration

Outline typical lift and shift of Dev Environment to Azure. Enables testing the water and aligns with standard business practices to meet the Application Testing Functionalities. Below are the high-level points which let you understand about testing environment after Azure Migration. For detailed information, please refer **SAP on Azure Deployment Document**.

### Operating System (OS)/Database (DB) Testing

Operating System and Database testing is one of the first testing point after migration. You must validate the stability and integrity of Operating system and database after migration.

### Application Testing

After Operating System and Database Testing, validate the application functionality in migrated environment. Application must be in functional state to accomplish the test result.

### Functional Testing

Function testing is a step which validates the functionality of migrated environment. It ensures the all the components are in functional state after migration.

### Performance Testing

Performance testing step is to validate the benchmark of the key resources i.e. CPU, RAM, IOPS and Network by using recommended benchmark tools.

# Governance

Governance specifies the accountability framework and provides oversight to ensure that risks are adequately mitigated, while management ensures that controls are implemented to mitigate risks.

## Govern – Cost Management

Cost Management is a factor which is directly co-related to the organization expenditure and provides the value of ROI. Users need to implement governance for Cost management with the help of information mentioned in **SAP on Azure Deployment Document**. Please use it as reference.

## Azure Governance for SAP Workload

Azure Governance can be described simply as mechanisms and processes to maintain control over your applications and resources in Azure. Particular tasks and processes are required to maintain your business applications and the resources that support them.

## Identity

Identity governance products differ from identity and access management systems by enabling organizations to define, enforce, review and audit IAM policy, but also map IAM functions to compliance requirements and in turn audit user access to support compliance reporting. Several government-mandated compliance regulations --including SOX and HIPAA require organizations to log access management data to maintain compliance

## Resource based access control & resource locking

To ensure that specific person or resource is authorized to access a specific resource then you must need to use RBAC. And to prevent accidental deletion or modification for the production environment Azure Locks are the best feature which prevent the resource data to be modified or being deleted. We have mentioned detailed information for below points in **SAP on Azure Deployment Document**, please use it as reference.

* Role Based Access Control (RBAC)
* Resource Locking (Locks)

## Security Authentication

Azure App Service provides built-in authentication and authorization support, so you can sign in users and access data by writing minimal or no code in your web app, RESTful API, and mobile back end.

## Data Integrity

Data integrity refers to the accuracy and consistency (validity) of data over its lifecycle. Data integrity can be compromised in several ways. Each time data is replicated or transferred, it should remain intact and unaltered between updates.

## Network Security

Network security could be defined as the process of protecting resources from unauthorized access or attack by applying controls to network traffic. The goal is to ensure that only legitimate traffic is allowed. Azure includes a robust networking infrastructure to support your application and service connectivity requirements. Network connectivity is possible between resources located in Azure, between on-premises and Azure hosted resources, and to and from the internet and Azure.

## Security Baseline

Security Baseline defines a set of basic security objectives which must be met by any given service or system. These details depend on the operational environment a service/system is deployed into, and might, thus, creatively use and apply any relevant security measure

### Azure Bastion

Azure Bastion is a fully managed Azure PaaS service which provides secure and seamless RDP and SSH access to your virtual machines directly through the Azure Portal.

### Security and Compliance

Design and implementation of the following services to SAP on Azure setup and configuration.

### Best Practice

Use best recommended practice for designing monitoring and governance controls. This ensures about the deployed solution is according to industry’s standard and help to achieve reliability, security for the resources.

## Business Continuity and Disaster Recovery (BCDR)

Business Continuity and Disaster Recovery solution is important to ensure the production workload of organization is not interrupted in any circumstances and maintain the same productivity without business impact. We have mentioned some recommended BCDR solution and steps which can be used to build own customized BCDR solution. For more details please refer **SAP on Azure Deployment Document.**

## Governance – Resource Consistency

Resource Consistency is one of the Five Disciplines of Cloud Governance. Resource Consistency means establishing policies related to the operational management of an environment, application or workload. For more information please refer SAP on Azure Deployment Document or [Resource Consistency](https://docs.microsoft.com/en-us/azure/cloud-adoption-framework/govern/resource-consistency/).

# Manage

Management refers to the tasks and processes required to maintain your business applications and the resources that support them. Azure has many services and tools that work together to provide complete management. These services aren't only for resources in Azure, but also in other clouds and on-premises. Understanding the different tools and how they work together is the first step in designing a complete management environment.

## SAP Management and Monitoring

To maintain SAP workload properly with real time data we need to deploy a robust SAP management and monitoring system in place. For more information, please refer SAP on Azure Deployment Document.

## Backup Management

Azure backup provides simple, secure, and cost-effective solutions to back up your data and recover it from the Microsoft

### Backup and Restore Strategy

Before implementation of Backup and Restore functionality, we need to strategize it properly to avoid any further unexpected issues. List out the expectations and ensure the proposed strategy ensures to meet your set expectations. For more details, please refer SAP on Azure Deployment Document.

### SAP NetWeaver Components

SAP NetWeaver Components are one of the important in SAP environment and which need to be backed up properly. To ensure appropriate backup and site recovery functionality, we have mentioned the details in SAP on Azure Deployment Document. Please use it as reference.

### Backup SAP SQL Server

In Backup and Recovery section, we must consider Backup and recovery plan for SAP SQL Server to ensure that production environment will be restored properly and continue to deliver the service. For more information please refer SAP on Azure Deployment Document.

### Hana Backup on VMs

Backups plays an important role in the case of accidental data deletion, servers crash or disaster. For HANA Backups we have several methods which has been discussed in deeply in SAP on Azure Deployment Document. Please refer the document for more details.

### HANA Backup on HLI

HANA Backup on HANA Large Instance is one the most critical part in Azure. To ensure the backup integrity we need to build appropriate backup solution. We have listed the details in SAP on Deployment Document. Please use this as reference before building the backup solution.

### Monitor, Retention and Restore

After backups in place we need to monitor the backup schedules to maintain the consistency and ensure the retention rules to avoid disk space issues. Also perform restoration drills in quarterly wise to ensure the recoverability of data. For more details please refer SAP on Azure Deployment Document.

### Leveraging Third Party Tools

Leverage the extra benefits of backup tools which are provided by third party vendor. Apart for standard backup and restore functionality they will provide more features which can be used as per needs. Please refer SAP on Azure Deployment Document for more details.

## Disaster Recovery

### DR Failover Procedures

DR Failover in Azure from primary to secondary region using Azure Site recovery is a simple activity compare to on-premise failover to azure. Failover can be performed as a planned activity (Drills) or unplanned activity (outage occurs). We need to follow step by step process to failover and re-protect the VM after failover process gets completed to secondary region. For more details please refer the link [Azure VM Failover Process.](https://docs.microsoft.com/en-us/azure/site-recovery/azure-to-azure-tutorial-failover-failback)

### Failover and Failback

Failover and Failback are process in Disaster Recovery which are integrated in Azure Site Recovery services. Failover can be performed on planned activity as test drills to validate the latest recovery point is up-to-date and running. Also, Failover can be performed in unplanned activity like outage in primary datacenter or resource disruption to continue the business operations.

## Monitoring

### Application Monitoring

Application monitoring is one of the most critical and important part in any environment. We need to monitor the application performance monitoring thoroughly. For this we must use azure application monitoring service. For more details please refer **SAP on Azure Deployment Document.**

### Operating System Monitoring

By using Azure Monitor, we can collect the metrics from guest operating system as a part of Operating System Monitoring. This will enable the visibility to identity the performance and other issues.

### Virtual Machine Monitoring

For Virtual Machine Monitoring in Azure we have Azure Monitor a robust monitoring tool in place. It will monitor entire virtual machine from tenant perspective and guest-OS perspective to ensure a proper information get delivered for analysis purpose. For more information, please refer **SAP on Azure Deployment Document.**

### Monitoring and troubleshooting from HANA

We have listed several methods of Monitoring and troubleshooting HANA environment. To get deeper details and reference links please refer **SAP on Azure Deployment Document.**

## Patch Management

Patch Management is processed to update the patches to fix the vulnerabilities, bugs, features. This patch is release by OEM vendor of application or hardware. In this scenario SAP vendor will release the patches which must apply to the application and database servers to ensure the integrity and security. For more details please refer **SAP on Deployment Document**

### SAP Notes

SAP Notes provide the update information in SAP which is frequently released by SAP. In SAP Notes below information is published. For more details please refer **SAP on Azure Deployment Document**

### SAP Security Notes

SAP Security Notes are Patch Day Security Notes and Support Package Security Notes which is focused on important fixes on patch days and the rest to be implemented automatically during SP upgrades

### SAP Kernel Patching

The SAP kernel is the core component of any SAP system. It consists of the executable files that run on the server to handle connections to the system and execute the SAP program. To ensure the system runs smoothly we need to patch the SAP kernel as well based on SAP best practices and released Kernel Patches.

### SAP GUI and NWBC Patching

SAP NetWeaver Business Client (NWBC) is a user interface to access all the applications from a single platform. In SAP system, a patch is used to fix bug. Below are the four different types of patches which are also called as support packs.

### OS Kernel Patching

Azure Update Management can be used to manage operating system updates for Windows and Linux machines in Azure, On-prem or in multi-cloud. It will quickly assess the status of available updates on all agent machines and manage the process of installing required updates for servers. For more details please refer to [Azure Update Management](https://docs.microsoft.com/en-us/azure/automation/automation-update-management)

### DB Patching

Database Patching process can be done manually which is totally depends on which database is used in SAP environment. If the database if different than SQL i.e. HANA, Oracle, DB2 then we must manually download the latest patches and update on the database server. If the database server is SQL, then the updates will be received from Azure Update Management and applied on schedule basis.

### DB Upgrade

Database Upgrade process is completely different than patching the database. Database upgrade means changing the version of existing database i.e. from old to latest version. In this process we must download the latest upgrade path from database OEM vendor support site and execute the activity. For Upgrade please refer [SAP Maintenance Planner tool.](https://support.sap.com/en/alm/solution-manager/processes-72/maintenance-planner.html)

### SAP Support Pack & Stack Upgrade

The Support package stack is a list of ABAP and Java support packages which is compatible for all software components. This also included in SAP NetWeaver. This is used to bring each software component of SAP NetWeaver on a defined Support Pack Level For more information please refer [SAP Support Stack Strategy](https://support.sap.com/en/my-support/software-downloads/support-package-stacks/support-package-stack-strategy.html)

### SAP Version Upgrade

SAP Version upgrade refers to the upgrade of SAP release. Support Pack Stack Version have a release number, and a Stack number. In SAP environment each software component has a separate sequence of Support Packages. Below is the list which contains the technical names of several components and the notation for their Support Packages.

### Recommended Patch Cycle

Recommended patch cycle for operating system and SAP software application component is to schedule the patch on monthly basis. This will keep the infrastructure and application in a compliance. Also, we can perform ad-hoc patch which is notified as a critical update on a specific vulnerability. Patch tracker management is recommended to track the patches and release upgrades data, which can be used further as a reference for rollbacks, analysis the performance etc.

Reduce manual intervention using Update Management Feature: <https://docs.microsoft.com/en-us/azure/automation/automation-tutorial-update-management>