

هيئة الاتصالات والفضاء والتقنية Communications, Space & Technology Commission

# Cloud Computing: Technology Overview and Market Outlook





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# **1- EXECUTIVE SUMMARY**

Cloud computing is one of the most prominent technologies in today's global Information and Communication Technology (ICT) scene. It provides scalable and on-demand IT and computing resources where consumers pay as they go and do not need to be concerned with installation and maintenance costs [1, 2]. This makes cloud computing a flexible technology that can adapt to various use cases and consumer needs, and this is evident in its different service-delivery and deployment models. Cloud services can be delivered in the form of Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS), and the technology itself can be deployed using one of three prominent models, which are public, private, or hybrid [1].

The global cloud market is a complex ecosystem with multiple key players and value-chains. A recent study [3] estimates that the global cloud computing market is going to undergo an exponential growth. It is expected to soar from less than USD 400 billion in 2017 to almost USD 1.3 trillion in 2025, sustaining a Compound Annual Growth Rate (CAGR) of roughly 16%. Public cloud, in that study, has the lion's share of the cloud computing market throughout the period from 2017 to 2025, which reflects its dominance in the cloud computing scene. Out of the cloud service-models, SaaS has been the most appealing so far as the study shows. It claims 40% of the public cloud market, leaving 34% for PaaS and 26% for IaaS. However, over the next three years, SaaS is expected to stay the top choice among the delivery models but with stronger competition from its IaaS and PaaS peers. More specifically, the study projects an almost evenly shared market by 2025, where SaaS claims 36%, PaaS claims 35%, and IaaS claim 29%.

The Kingdom of Saudi Arabia (KSA) recognizes the immense potential the cloud computing technology has for digital transformation, and, hence, it has paid close attention to the technology and what promotes its adoption. The Communication, Space, and Technology Commission (CST) has encouraged cloud adoption in KSA by encouraging investments in the cloud market, protecting consumers, and issuing the regulations and requirements to the providers through the Cloud Computing Regulatory Framework (CCRF) [4]. Its efforts are complemented by those of other governmental organizations like the Ministry of Communications and Information Technology (MCIT), the Digital Government Authority (DGA), the National Data Management Office (NDMO), and the National Cybersecurity Authority (NCA). They contribute policies that further bolster the KSA's cloud market, like the cloud first policy (by MCIT) and "whole of government platform policy" (by DGA), among others.

The regulatory and policy-making efforts in the Kingdom has resulted in some interesting trends, which could be summarized as follows:



CST released its Cloud Computing Regulatory Framework (CCRF) [4], which provides the necessary support for cloud companies aiming to localize their services in the Kingdom.



The MCIT announced an expected USD 18 billion [5] data center strategic plan, which set the tone for KSA's future infrastructure development in the data center market for the next decade. The strategy provides direction to develop a network of large-scale co-located data centers across KSA.



Several CSPs, including Oracle, Google Cloud, Alibaba Cloud, and SAP, are setting up cloud regions and expanding the existing ones in Saudi Arabia by entering joint ventures with telcos, resellers, and other local partners to meet the rising demand of cloud services.



KSA is developing a set of incentives to encourage CSPs to invest in the country and make KSA a hub for their operations.



Notable example of those incentives is the competitive power tariff of 18 Saudi Halala per KW.

Such trends, when combined with the policies and regulations, explain the increased adoption of cloud computing in several socio-economics sectors of the Kingdom, such as healthcare, manufacturing, and transportation and logistics. They also hint at a promising, and probably lucrative, future for cloud computing in the Kingdom.



# 2- CLOUD COMPUTING: WHAT AND WHY?

"Cloud computing" or simply "the cloud" has become a ubiquitous term in the digital transformation era; it pops up almost everywhere, from discussions about banking and financial services to discussions about education, transportation, and telecommunications. It also appears in connection to many well-established technologies (e.g., smart phones and e-commerce) as well as emerging ones (e.g., Artificial Intelligence (AI) and Internet of Things (IoT)). Such ubiquity has not materialized out of thin air, but it is a reflection of the influence and importance the cloud computing technology has in the modern world. To understand the technology, its business potential, and its impact, some basic question needs to be addressed first.

## 2.1 What Is Cloud Computing?



Several definitions for cloud computing have been proposed over the years [1]. They are mainly centered around the provision of computing resources. The most comprehensive and widely accepted definition though is the one developed by the USA National Institute of Standard Technology (NIST) [6], which is

**Cloud computing** is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models. The definition above give raise to three important verticals of cloud computing: its characteristics, service models, and deployment methods. The first is discussed in Section 2.2, for it motivates the need for the technology. The latter two, on the other hand, are explored below.

#### Service Models -

Multiple Information Technology (IT) resources could be provided by the cloud. They range from basic processing and storage capabilities, e.g., central processing units and graphics processing units (processing) and solid-state and hard-disk drives (storage), to operating systems (e.g., Red-hat and Ubuntu), development and operation (DevOps) tools (e.g., Kubernetes), and software applications (e.g., Quip and Google Docs). The owner of such resources is commonly called a Cloud Service Provider (CSP), and a user of those services is called the Cloud Customer or Consumer (CC). From their names, a CSP aims to offer cloud-based services in a way that meets the IT needs of a CC. The way in which those services are offered is what is referred to as the service model in the definition of cloud computing–another name is cloud-service delivery models.

As the definition states, there are three widely-accepted or mainstream service models, which are briefly introduced below:

1 Infrastructure as a Service (laaS)



In the cloud IaaS model, IT infrastructure is provided as a service to the customer. This includes servers, networking essentials, security essentials, and file system storage. CC commission infrastructure on-demand through the CSP's user self-service tools and Application Programming Interfaces (APIs) and pay only for consumption, not ownership. The CC has control over the infrastructure resources leased from the CSP and can use them for their own purposes. IaaS provides several benefits such as: (i) reduced CAPital EXpenses (CAPEX) as the customer does not invest in the development and maintenance of data centers; and (ii) dynamic on-demand scaling and faster DevOps.

2 Platform as a Service (PaaS)



Platforms are IT capabilities that developers use to develop, deploy, and maintain software applications—for example, integration middleware, notification hubs, databases, and analytics services. In the cloud PaaS model, these capabilities are made available to CCs as a service from CSPs, with the option to configure them to meet customer needs. The use of PaaS removes the dependency on privately managed servers and increases the agility and flexibility of an organization in adapting to business requirements.

# **3** Software as a Service (SaaS)



It is a model in which customers purchase ready to use software solutions rather than building them themselves. The software is available from a CSP over the internet on a pay-as-you-go basis to multiple customers, using a multi-tenant feature, and is mostly available via an internet browser. SaaS adoption results in structural changes to the operating model of an organization. Instead of CAPEX in the form of long-term licensing charges and contracts, software costs become OPEX, which can increase transparency and encourage discipline in IT spending.

The degree of consumer ownership and management are at a maximum in IaaS, moderate in PaaS and minimal in SaaS. IaaS users are commonly responsible for the security of the operating system and software stack required to run their applications and their data. Users' responsibilities normally increase as they move from SaaS to PaaS to IaaS.

#### **Deployment Models** –

The IT resources like servers, storage, and networks are aggregated in different ways, at different scales, with different access permissions depending on an ownership model. This results in various deployment choices for the cloud technology known as cloud deployment models or types of cloud. The definition of cloud computing specifies four deployment models which are briefly discussed below.

#### **Public Cloud**

A CSP in this deployment model provisions IT resources to clients worldwide. Multiple clients share the same infrastructure, and all cloud services are accessible over the internet.

#### **Hybrid Cloud**

Such deployment represents a combination of public and private cloud, or public cloud and on-premises data center capabilities. A hybrid cloud is deployed when an organization wants to maintain control of specific parts of its infrastructure.

#### **Private Cloud**

This deployment model is built by a CSP and is provisioned to a single customer, generally a large multinational conglomerate, for its exclusive access. The parent company, subsidiaries, and departments become the clients of the private cloud.

#### **Community Cloud**

This is a cloud owned by a group of entities that work collaboratively, such as a group of banks or a trade organization. Access is restricted to members of the community.

# 2.2 Why Cloud Computing?



Five essential characteristics of the cloud, mentioned in the definition, are the drivers of its prevalence nowadays. These characteristics are [1]: (i) on-demand usage, (ii) ubiquitous access, (iii) multitenancy and resource pooling, (iv) elasticity, and (v) measured usage. The first four are directly derived from the definition whereas the fifth is an indirect consequence of the on-demand and multitenant nature of the cloud technology. All five characteristics make cloud computing appealing to businesses, government institutions, public institutions, and individuals alike for the following reasons [1] [2]:

- Cloud computing allows for the around-the-clock provision of needed IT resources. Users access exactly the resources (e.g., processing, storage, software, networking, etc.) required to get the job done whenever they need as long as they have Internet access.
- CSPs pool hardware and software resources. This allows them to run different users' jobs efficiently through virtualization and multitenancy. The latter runs isolated instances of a software program to serve different users while the former enables multitenancy by creating isolated and dynamic allocation of hardware resources.
- Commonly IT resources need to be scaled up or down to meet demands, e.g., growing business, increasing number of clients, and emerging new services, among others. Cloud technology offers a way to meet that need swiftly and thriftly (most bang for the buck, in other words).
- The fifth characteristic, i.e., measured usage, is the foundation of the financial benefits touted by cloud computing. Utilization of IT resources could be monitored and measured around-the-clock. This allows for utilization-oriented billing model, which is arguably what makes cloud computing financially viable for both providers and customers.

## 2.3 What Is The Cloud Computing Ecosystem?



Opposite to the dreamy and serene feeling its name invokes, the cloud is a technology with a complex and ever-evolving ecosystem [7]. Such fact stirs up a diverse range of value-chains that depend on the deployment and service models. Since public cloud has the most traction among deployment models<sup>1</sup>, this section will focus on exploring its ecosystem as well as its mainstream value chains. The underpinning of that ecosystem comprises various key players assuming different roles stretching from the supply of hardware, software, and networking solutions [7] [8] to the provision of cloud services and consumption of those services. A break-down of that ecosystem is given below:

• Core vendors: These are the providers and suppliers of the infrastructure of data centers (i.e., hardware, software, and networking components) that host the shared pool of computing resources. Servers and storage units are the main hardware components for a data center. They are commonly provided by either original equipment manufacturers (OEMs) or, in some cases, original design manufacturers (ODMs). Core software like hypervisors and operating systems are the sole that brings the hardware to life—metaphorically speaking. They are commonly provided by software companies. Networking components, e.g., network cards, switches, routers, and gateways to name a few, bring the data center online; they enable the center to communicate with the outside world, and similar to servers and storage units, they are commonly provided by either OEM or ODM.

Cloud Service Providers: These are the providers and bedrock of various cloud services. CSPs follow the three mainstream service models discussed in Section 2.1 alongside other less popular or emerging models, e.g., System Infrastructure Software as a Service (SISaaS) [3]. Hyperscalers are an important subclass of CSPs. They are entities that own and operate large-scale public data centers.

1. See IDC forecast [3].

<sup>2.</sup> Procurement of servers and storage components from ODM is a relatively new trend followed mainly by hyperscalers [28] and enterprises with the "know-how" and "do-it-yourself" mindset. [29].

- Value-added partners: These are entities that constitute a second tier of providers; they mainly focus on improving service offered by and hyperscalers. They could be certified resellers of CSPs services with limited-scope improvements; partners to CSPs who help advance the service offerings of CSPs; or integrators and migration and managed services partners.
- **Supporters:** Like any technology, the cloud ecosystem has a class of players who support the technology and its service provision and adoption. Their support is diverse and depends on who needs it. Main supporters include regulating bodies (i.e., regulators), consultants, trainers, and certification providers.
- Cloud Customers: End-users, such as government and public institutions, businesses, and individuals, are the main audience for cloud computing. They consume cloud services from various service models. However, they are not the only ones; cloud service provision is intrinsically hierarchical, meaning services are dependent and layered. For instance, a PaaS provider needs computing infrastructure to offer its services. Hence, it could be a customer of an laaS provider. Similar thing could be said about SaaS, which could be a customer of both PaaS and laaS.



#### **Cloud Computing Value-chains**

The above list, albeit concise, paints a picture of a complex ecosystem. Players could interact with each other in various ways and create different market opportunities. Analyzing the interactions to understand the market opportunities and dynamics is, as a result, quite difficult. However, there exists a simple way to develop a bird-eye's view of the market and its dynamics and opportunities, through the lens of market main value-chains.



Figure 1: General view of main value-chains of the cloud computing market.

Figure 1 depicts a visual illustration of the main six value-chains and the role of each key player. This depiction is meant to simplify the market dynamics and not meant to restrict it. It does so by focusing on the mainstream interactions that give rise to the six value-chains. All value-chains in the figure are anchored to core vendors and cloud providers, and they only diverge depending on the service model they represent. Their divergence, however, still maintains the layered (or hierarchical) nature of cloud services intact. For instance, a PaaS value-chain (i.e., value-chains 3 and 4 in the figure) has an laaS layer. This is to indicate that a PaaS provider could own and run its infrastructure or be a customer to an laaS provider.



# **3- GLOBAL CLOUD COMPUTING MARKET**

Discussion of the cloud computing market (cloud market for short) first requires identifying the perimeter of that market.

Cloud market comprises all entities that conform to the structure of the cloud ecosystem described in Section 2.3 (player descriptions) and form the five value-chains described in Figure 1.

This report is focused on the public cloud deployment model, for its current and forecasted market share is the largest among others, as will be discussed shortly.

## 3.1 Market Outlook



Cloud allows organizations to leverage economies of scale and reduce costs. Public clouds charge them based on usage, enabling them to save costs that would have been spent on maintaining their excess capacity. It allows organizations to activate new tools or solutions for customer engagement by enabling faster deployment, offering flexible licensing models, reduced maintenance costs, and continuous upgrade of software features. Organizations are sensitive to cost savings and are making focused investments in digitalizing their operations to improve productivity, reduce operating costs, support remote working requirements, and stay competitive. Thus, they are shifting from the traditional on-premise storage and computing services to the cloud. The volume of data produced is increasing day by day, owing to an upsurge in internet usage and the increased use of diverse computing devices such as smartphones, tablets, laptops, and personal computers. A recent study suggests that the amount of data created each year is expected to increase at a Compound Annual Growth Rate (CAGR) of 23% from 2021 to 2025 [11] positively influencing the demand for cloud computing solutions.



#### Global Cloud Computing Market Size by Deployment Model

Figure 2: Global cloud market size according to [3].



### Global Public Cloud Computing Market Size by Service



The appeal of public cloud manifests in its domination of the cloud computing market in the past 5 years as a recent study shows [3]. The study estimates that the global cloud market is going to undergo an exponential growth, as shown in Figure 2. It is expected to soar from less than USD 400 billion in 2017 to almost USD 1.3 trillion in 2025, sustaining a CAGR of roughly 16%. Public cloud, in that study, has the lion's share of the cloud computing market throughout the period from 2017 to 2025.

The three service models occupy varying-size segments within the public cloud landscape. From Figure 3, it is clear that SaaS has been the dominant service model for 5 years (from 2017 until now). This should not be surprising as SaaS, compared to the others, has the lowest barrier-to-entry, and this could be attributed to the two following reasons: (i) low entry-level prices, which encourage small companies and even individuals to purchase SaaS; and (ii) the absence of any requirement to install or upgrade software, which is accessed entirely online.

However, as the adoption of cloud computing accelerates, the landscape starts morphing. The study estimates that SaaS will stay dominant over the next 4 years despite starting to lose grounds to its two peers. Figure 3 shows how PaaS and laaS are going to grow as businesses become more experienced with cloud computing. The two models are projected to attain CAGRs of approximately 24% and 26%, respectively, over the period from 2017 to 2025 whereas SaaS is projected to attain much less growth with a CAGR of approximately 17%.

## 3.2 Leaders of Global Market

Six major CSPs are dominating the global cloud computing scene. These are Amazon Web Services (AWS), Microsoft Azure, Google Cloud, Alibaba Cloud, IBM, and Oracle. However, they are not the only recognized providers. Table 1 presents a brief description of the major six and one of its notable competitors.

#### Table 1: Well-known providers--overview and services

Well-Known Cloud Providers	Overview	Unique and distinguishing feature	
aws	Amazon Web Services (AWS) is the world's most comprehensive and broad- ly adopted cloud platform, offering over 300 fully featured services from data centers globally and including laaS, PaaS and SaaS offerings. AWS has the largest and most dynamic community, with millions of active customers and tens of thousands of partners globally. The AWS Partner Network (APN) includes thousands of systems integrators who specialize in AWS services and tens of thousands of independent software vendors (ISVs) who adapt their technology to work on AWS. AWS caters to all business sectors.	<ul> <li>Leader in breadth of services: AWS is the CSP with the most number of services worldwide, offering more than 300 services</li> <li>Prolific ecosystem: AWS offers a very strong network of partners an ISVs that prioritize developing on the AWS platform first before other CSPs</li> </ul>	
Microsoft Azure	Microsoft Azure is a platform that enables users to engage in agile cloud computing, and is designed for creating and managing apps through Microsoft's data centers. Microsoft Azure is the fastest-growing cloud computing platform being adopt- ed by businesses and includes IaaS, PaaS and SaaS offerings.	<ul> <li>Solutions-oriented: The Microsoft Azure Cloud environment offers numerous differentiated solutions in different industries such as telecommunications, healthcare, manufactur- ing, retail &amp; financial services</li> <li>Hybrid Cloud &amp; Multi-cloud: Microsoft places significant focus on offering hybrid &amp; multi-cloud capabilities to continue to support enterprises who want to keep hybrid environ- ments</li> </ul>	

# Table 1: Well-known providers--overview and services

Well-Known Cloud Providers	Overview	Unique and distinguishing feature
Soogle Cloud	Google Cloud is a provider of computing resources for developing, deploying, and operating applications on the Web. Although its cloud infrastructure does serve as the host for applications such as Google Workplace, GCP is mainly a service for building and maintaining original applications, which may then be published via the Web from its hyper- scale data center facilities.	• <b>Sales execution:</b> Google Cloud is consistently focused on perfecting their sales strategies with the recent increase in market share specifically from enterprises
C Alibaba Cloud	Alibaba Cloud offers a comprehensive suite of cloud services (+100 services) mostly based on a flexible pay-as-you-go model. Alibaba is mostly a native provider of laaS and PaaS services (among others). Alibaba is the leading cloud provider in China and Asia, currently conducting efforts to expand into other geographies with a large footprint of datacenters and regions coverage.	<ul> <li>Engineering leadership in Asia: Alibaba cloud offers leading engineering skills in China and the overall Asia pacific region, allowing them to create differentiated products</li> <li>Data &amp; Analytics capabilities: Alibaba Cloud offers partners access to numerous digital transformation opportunities given its data &amp; analytics expertise</li> </ul>
نظر IBM <b>Cloud</b>	IBM cloud computing is a set of cloud computing services for business that includes IaaS, PaaS and SaaS offered through public, private and hybrid cloud delivery models, in addition to the components that make up those clouds. IBM cloud has a full stack of 170 products and cloud computing services for business to business (B2B) organiza- tions around the world. IBM cloud services are positioned under three umbrellas namely SmartCloud founda- tion, SmartCloud services and Smart- Cloud solutions for improved productiv- ity and efficiency.	<ul> <li>Focus on regulated industries: IBM has outlined its focus on regulated industries such as financial services which has allowed them to create innovative solutions based on their computing technology</li> <li>Container Management: IBM's OpenShift container management software is the dominant software in the market and supports IBM in extending its service offering via other software solutions</li> </ul>
CRACLE Cloud Infrastructure	Oracle Cloud Infrastructure (OCI) is a set of complementary cloud services that enables customers to build and run a range of applications and services in a highly available hosted environment. OCI provides high-performance compute capabilities (as physical hardware instances) and storage capaci- ty in a flexible overlay virtual network that is securely accessible from on-premises networks. Oracle covers a wide range of products within laaS, PaaS and SaaS.	<ul> <li>Global standard pricing: Oracle offers a unique pricing model that is standard in all regions across the world</li> <li>Innovative multi-cloud: Oracle offers innovative multi-cloud architecture that leverages their database &amp; data warehousing technologies</li> </ul>

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# 3.3 Notable Trends in The Global Cloud Computing Market



The emergence of new capabilities, evolving trends in deployment models, and the strategic alliances between the CSPs will provide organizations across sectors with a wider spectrum of cloud options and help them make the most out of their cloud investments. The following six trends are expected to shape the global cloud computing market on the medium-term.

#### The rising adoption of serverless -

Serverless is a rising cloud computing service model which targets application developers. It allows them to build applications, henceforth referred to as serverless applications, without having to factor in how those applications scale up and down with demand. Serverless, in other words, is a way to abstract the provisioned cloud computing resources from the application development process; the applications run in containers and the CSP is responsible for providing the computing infrastructure necessary to run the applications as well as scaling that infrastructure up and down according to demands. One of the major advantages of the serverless model, aside from the abstraction, is its pricing flexibility. It allows a CSP to charge users per application use, i.e., a user of the serverless model pays a CSP only for the number of instances of an application and the period for which those instances run.

The serverless architecture market size is expected to reach US\$21.1b by 2025, growing at a CAGR of 22.7% from 2020 to 2025 [12]. Demand is high among start-ups and SMEs, who are leveraging serverless architecture solutions to achieve their business goals without significant capital investments in cloud infrastructure.

#### Convergence of cloud with AI or ML –

CSPs are optimistic about the convergence of cloud and Artificial Intelligence (AI)/Machine Learning (ML) capabilities facilitating a decreased need for traditional infrastructure and operations roles for the public cloud. In addition, the CSPs are expecting a better scope for automation at scale for Cloud management, although it is currently pacing towards large-scale implementation.

There is a need for sophisticated and real-time data analysis and supportive tooling (real-time, lambda architecture, AI/ML, etc.) in the market. In addition, relevant cloud skills and experience are required for implementation. Modern cloud data solutions can scale according to needs and are ready to use, while on-premises solutions require significant up-front investments and protect against security breaches in an automated way.

#### Increased adoption of SaaS \_

New world-class, business-grade software is now by default developed 'cloud-ready' rather than for on-premise installation. The SaaS software market is expected to increase by over 49% by 2025 compared to its size in 2022 [3]. while the non-cloud-ready software market shrinks further. Organizations that want to use modern software with embedded AI/ML capabilities will need to adopt cloud-based SaaS software platforms. The largest Customer Relation Management (CRM), IT service management, and marketing automation providers are following this development model.

#### Emergence of Open-API economy \_\_\_\_

Cloud-based API development and orchestration platforms enable open-API economies that provide uniform control, security measures, and scalability. Enterprises, banks, fintech, and government organizations are opening their services and data to others. They are adopting the API-first policy to shed organizational silos and leverage their services, competencies, and assets more effectively. For example, banks want their services to be interoperable to integrate with an e-commerce platform and offer access to preferred payment options. Through APIs, organizations can integrate or re-use services or data for new purposes with no marginal cost for each additional API call.

In a survey conducted by Google Cloud, 56% of the respondents believe that APIs help them build better digital experiences and products. In addition, about 36% of the respondents believe that APIs are strategic assets for creating business value [13]. Banks and the new growing fintech market have excellent examples of establishing a new business ecosystem based on API channels to build services beneficial for both groups.

#### The emergence of joint cloud providers –

CSPs are striking strategic partnerships with each other to offer co-engineered solutions to meet specific customer needs:

• Microsoft and Oracle's strategic alliance allows their clients to transfer and run enterprise application workloads across Microsoft Azure and Oracle Cloud [14].

• Microsoft created its License Mobility program with AWS that lets customers of either company choose between data centers owned by both [15].

#### The emergence of microservices

A microservice is a service-oriented application component that is tightly scoped, strongly encapsulated, loosely coupled, independently deployable and independently scalable. Microservices enable cloud customers to use multiple services from different CSP's. Giving the services the agility and the flexibility to

expand and to grow. Beside its ease to deploy, it provides the users the freedom to select different services from multiple vendors and provide the resilience needed to avoid complete application failure if one service failed. In addition to the ability to reuse the services in multiple purposes [30].

#### Regional and vertical cloud platform ecosystems -

Regional regulatory and industry compliance requirements have led to the emergence of vertical cloud ecosystems and data services that are specific to a region. Regions that have been unable to develop or sustain their platform ecosystems are forced to rely on platforms designed for other regions as limited market size make them unattractive to CSPs. This means that they rely on clouds that follow the legislation and regulation of other regions. Concerns among legislators, academics, and technology suppliers over the erosion of sovereignty have prompted projects such as GAIA-X in European countries [16].

#### **GAIA-X programme**

GAIA-X is an initiative by the EU protected by European data laws, envisioned to create a unified ecosystem of cloud and data services. The objective of GAIA-X is to create an interoperable data exchange acting as a repository of cloud service providers. It aims to link existing cloud service providers, make domestic cloud providers more visible, and assist local business to exchange data more easily



# **4- KSA CLOUD COMPUTING MARKET**

The Kingdom of Saudi Arabia (KSA) recognizes the immense potential the cloud technology has for digital transformation and economy. Through its master plan "Vision 2030", the Kingdom is striding towards having a vibrant economy. A strategic objective to its plan is the development of the Kingdom's digital economy, and, to a large extent, this rests on the availability of advance cloud computing services. To achieve that goal, the Kingdom has paid close attention to the cloud technology itself. This is reflected in the regulatory efforts and market dynamics within the country, glimpses of which are provided in the following few sections.

#### 4.1 Regulatory Landscape in The Kingdom

Communication, Space, and Technology Commission (CST) along with other government institutions has been working relentlessly toward building a robust cloud ecosystem, fundamental to enabling a digital economy. CST has encouraged cloud adoption in KSA by encouraging investment in the cloud market, protecting consumers' interests through the Cloud Computing Regulatory Framework (CCRF) [4]; by providing the necessary support for cloud companies aiming to localize their services in the Kingdom, the CCRF allows CST to focus on regulating the cloud market, strengthening existing partnerships, and enabling new partnerships in the Cloud Computing and Data Center fields. In addition, CST has put in place the Cloud Computing ServicesPortal. The portal addresses the need of companies and institutions to take advantage of the electronic services provided by the Commission. Through the unified login (SSO), businesses can view the list of CST's e-services available. The services provided in the portal include:







#### Figure 4: Illustration of all CSP classes in the Kingdom

CST registers cloud providers based on classes such as A, B, C, or Qualifying, and each class can serve different data levels, see Figure 4 for more information on the classes. The 'qualifying category' track is launched for cloud computing service providers to enhance competitiveness and attract investment [4]. It targets any

#### Portal is accessible at this link

entity that is willing to provide cloud computing services according to the Cloud Computing Regulatory Framework through a data center in the Kingdom but does not meet any or all requirements of the three categories associated with registration to provide cloud computing services. The registration process for CSPs in the Kingdom, which includes the qualifying category, is graphically illustrated in Figure 5.



#### Figure 5: Illustration of the registration process of CSPs in the Kingdom

The regulatory efforts of CST are complemented by the efforts of the Ministry of Communications and Information Technology (MCIT), the Digital Government Authority (DGA), the National Data Management Office (NDMO), and the National Cybersecurity Authority (NCA). MCIT has put forth and implemented the government's Cloud First policy and assigned roles and responsibilities to different authorities and offices [17]. The policy outlines several requirements for the adoption of cloud computing by government and semi-governmental entities in the Kingdom. The policy is supported by DGA and its Whole of Government Platform policy, which encourages the government entities to adopt cloud solutions for their digital platforms – aligned to the Cloud-First policy and the CCRF. The NDMO and NCA consolidate the MCIT and CST efforts by setting regulations for, respectively, data governance and security controls for cloud technology. Table 2 summarizes the current key regulations that defines the cloud regulatory landscape of the Kingdom.

Regulations	Published by	Descriptions
Cloud Computing Regulatory Framework (CCRF)	CST	CST Issued the Cloud computing regulatory framework in the Kingdom based on the best international practice, which includes the rights and obligations of the service providers, individual customers, government entities and enterprises.
KSA Cloud First Policy	MCIT	KSA's "Cloud First Policy" is a policy that covers Governmental entities (as specified in the "Scope of the policy" section). The goal is to accelerate the adoption of Cloud computing services by directing these entities to consider Cloud options when making new IT investment decisions. In addition, the private sector is encouraged to follow the same exercise with an internal CFP.
National Data Governance Interim Regulations	National Data Management Office (NDMO)	NDMO, as the national regulator of data in the Kingdom, has developed the framework for national data governance to set the policies and regulations required for data classification, data sharing, data privacy, Freedom of Information, open data, and others in anticipation of necessary legislation.
Cloud Cybersecurity Controls (CCC)	National Cybersecurity Authority (NCA)	The CCC is a comprehensive document specifying security controls for the Cloud. The CCC has controls for CSP and customer and is developed as an extension of the ECC.

#### Table 2: Key regulations

## The Cloud Computing Special Economic Zone (Cloud SEZ) -

On 13th of April 2023, HRH The Crown Prince has launched four new Special Economic Zones in Saudi Arabia, opening up New gateways to growth for Investors worldwide. One of those zones is the Cloud SEZ, where CST became the relevant entity of the Zone.

The zone will create an appealing investment environment for leading global cloud computing companies to begin their commercial operations in Saudi Arabia, and to promote the use of Cloud Computing across the Kingdom. The zone has a unique flexible model that allows CSPs to provide various cloud computing services from the zone, with the ability to build and operate data centers from all over the Kingdom [32][33]

#### **Emerging technology sandbox**

In line with the Vision 2030, CST has launched the Emerging Technology Sandbox in order to increase investments foster innovation and encourage the introduction of new ET products and services into the Saudi markets like cloud computing. The main objectives of the Emerging Technology Sandbox are to enable new services to benefit both customers and the Saudi economy, as well as to maintain effective consumer protection. Through the Sandbox environment, CST also increases legal certainty and cross-government cooperation, as well as driving knowledge sharing through collaboration [31].

#### Important regulatory resources

CST provides a collection of regulatory resources to support the cloud market in the Kingdom. The following lists the most important resources available for the public:

- 1 To refer to the Cloud Computing Regulatory Framework from CST, please visit this link
- **2** To get more information about the Guide for Cloud Computing Service providers, please visit this link
- **3** To Register as a cloud provider, please visit this link
- **4** To get more information about the qualifying category, please visit this link
- **5** To see KSA Cloud registered Providers, please visit this link
- **6** To meet your dedicated team to clarify and answer any queries, please reach out to CST on the following address Cloudcomp@cst.gov.sa

# 4.2 Key Trends in The KSA Cloud Market



Over the last five years, the adoption of the cloud has increased significantly amongst large organizations, SMEs, and government agencies. Some of the key trends for the KSA cloud computing market are:

#### Investments to build the digital infrastructure

The MCIT announced an USD 18 billion [5] data center strategic plan, which set the tone for KSA's future infrastructure development in the data center market for the next decade. The strategy provides direction to develop a network of large-scale co-located data centers across KSA, laying the foundations of a globally recognized digital hub and attracting localized talent, skills, international investment, and a pipeline of sustained growth opportunities.

#### Global CSPs enter KSA cloud market

Several global CSPs, including Oracle, Google Cloud, Alibaba Cloud, and SAP, are setting up cloud regions in Saudi Arabia by entering joint ventures with telcos, resellers, and other local partners. This gives them easy access to the Kingdom's market knowledge and customer relationships – enabling them to scale up fast and build demand for their products and services.

- Oracle, a leading cloud provider, was the first tenant to set up a hyper-scale data center at the Tech Digital facility in the smart city of Neom. Oracle is also supporting government efforts to foster cloud engineering skills through Oracle University and by collaborating with the Misk Foundation, Ocean X, and other domestic KSA educational institutions [18].
- Google is partnering with Saudi Aramco through a joint venture to bring its cloud services to KSA [19].
- SAP and the MCIT signed an agreement to explore collaboration areas regarding SAP's cloud services and software solutions, as well as training and knowledge transfer initiatives.
- Alibaba Cloud and Saudi Telecom Company established a partnership in 2020 to provide cloud services in KSA. It plans to invest USD 500 million in the next five years to support the roll-out of cloud services and the localization agenda of the Kingdom [20]

# 4.3 Adoption of Cloud Technology in Key Sectors



The regulatory efforts as well as key trends have resulted in a spike in interest in cloud technology, which, in turn, has led to accelerated growth in technology adoption across different socio-economic sectors. Below is a brief overview of that adoption.

### Government and public sector -

Cloud Computing is a critical technology in digitalising government operations to drive service quality and operational efficiency and deliver better customer experiences. Furthermore, MCIT published the Cloud First policy - aimed at accelerating the pace at which government entities migrate from conventional IT solutions to cloud-based solutions. As a result, E-government services are undergoing this transition to reduce time and cost and improve the public sector's overall effectiveness and performance, which will result in improved customer experience.

DGA issued a frame agreement to provide cloud services for government entities through "Etimad" platform to facilitate providing cloud services from selected registered cloud services providers in Saudi [21].

Cloud has already made its way into almost all governmental sectors in the Kingdom. For instance, Saudi's Tourism Development Fund (TDF) adopted Cloud solutions to support its objective of enabling investors to drive the development of the tourism sector. In addition, the cloud solutions, which include SaaS, PaaS, and laaS, will help TDF drive automation and integration of TDF's core functions, such as banking, finance, human resources, and procurement. The Agriculture Development Fund, the government's principal credit institution for financing the development of agriculture in the Kingdom, is utilizing cloud applications to use real-time agricultural data to improve support for farmers and innovate new services [22].

#### Healthcare -

With the need for technological modernization, increased focus on digitalization, and the global pandemic pressure, Saudi's healthcare industry is adapting to new ways of working. In response to this need, Saudi's healthcare sector players are leveraging technologies such as cloud computing, AI, and big data for developing tools to become more responsive to the needs of patients.

For instance, the Ministry of Health created a chatbot hosted on Oracle Cloud Infrastructure to respond to all COVID-19 queries and enhance the medical experience offered to citizens [22]. Moreover, the King Abdullah International Medical Research Center (KAIMRC) implemented a Cloud Infrastructure [22] to provide high-performance computing (HPC) to power its complex research into a potential treatment for COVID-19 and other infectious diseases.

#### Manufacturing -

As part of Vision 2030, KSA launched the National Industrial Development and Logistics Program (NIDLP), which is aimed at transforming the kingdom into an industrial and logistics hub [23]. The program focuses on unlocking the full potential of Industry 4.0 to enhance manufacturing operations and generate new job opportunities. Cloud computing is a critical enabler of Industry 4.0 automation solutions, offering substantial advantages for applying AI and other smart manufacturing technologies like IIoT. Under the NIDLP program, USD 800 million [24] has been allocated to digitally transform 100 factories to drive productivity and efficiency gains at a reduced cost of operation. The program will also drive the establishment of Industry 4.0 capability development centers in partnership with universities.

#### Transportation and Logistics —

The Crown Prince of Saudi Arabia his royal highness Muhammad Bin Salman Al Saud had announced the introduction of the "National Transport and Logistics Strategy". The strategy has a significant impact on several areas such as infrastructure, platforms, logistics zones, advanced operating models and systems development, boosting cloud adoption in the kingdom. As a result, companies in the Kingdom are adopting cloud solutions to bring operational and financial efficiency. For instance, the Saudi Railway Company [22] has initiated a major digital transformation by leveraging cloud platforms to enhance business agility, create a robust cyber security infrastructure, automate core-ticketing systems and reduce costs. Hafil Transportation company leveraged cloud solutions to help improve efficiency across its operations in Saudi Arabia. As a result, the company managed its fleets more efficient routes and increase operational competencies.

#### BFSI -

Saudi's banking customers are demanding more digital, real-time, and intelligent services from banks. According to a survey by Backbase with YouGov [25], 88% of Saudi consumers will choose digital banking services over personal visits to banks. Also, 82% of respondents say they use digital banking services at least once a week, and 36% use services once a day or more.

The increase in customer expectations has accelerated the digital transforma-

tion agendas of many regional BFSI players. Also, they recognize the significance of offering digital banking and other innovative services, which is crucial for customer retention and growing revenue streams through personalized services. Banks can leverage cloud solutions to provide a rich customer experience and superior digital banking. For instance, Arab National Bank (ANB) adopted Red Hat's Open Hybrid Cloud Platforms to accelerate its transformation journey in key areas like digital banking, open finance, and customer engagement [26]. Also, the Saudi Investment Bank (SAIB) implemented solutions from the IBM Hybrid Cloud portfolio to facilitate easier integrations with ecosystem partners and deliver new services to market at least 30% faster than before [27].

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