DSCI
PROMOTING DATA PROTECTION

TATA COMMUNICATIONS

GETTING YOUR CLOUD STRATEGY RIGHT

A DSCI – Tata Communications
Point of View Paper

JULY 2021

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Introduction

Cloud has seen enormous growth in recent years in India and around the globe. Majority of the enterprises are shifting from physical IT infrastructure to cloud, given the benefits it offers - higher scalability, better customer service delivery, optimized business processes, shorter procurement cycle and lower customer acquisition costs. Many digital product companies, with capabilities across sectors and value chain are born in cloud. There is an increase in demand for platform-agnostic digital products, ability to port workloads and API based connectivity that has further boosted the demand for multi-cloud strategy. Across sectors, organizations in India are rolling out Hybrid multi-cloud strategy, as this allows them to work with best of Public and Private clouds. Desktop-as-a-Service (DaaS), Business Process-as-a-Service (BPaaS) and Cloud management & Cyber Security are new trending service models being delivered through the cloud. Largely, the cloud demand is driven by following factors:

1. Increased ROI with lower IT infrastructure and data storage costs
2. Upsurge in demand for remote workspace owing to COVID-19 pandemic
3. Requirement of highly flexible, scalable, and reliable IT infrastructure, which enable high automation and agility
4. Customer expectation for one-stop solution and to get IT infrastructure from anywhere

Chapter 1.

Getting your Cloud Strategy Right

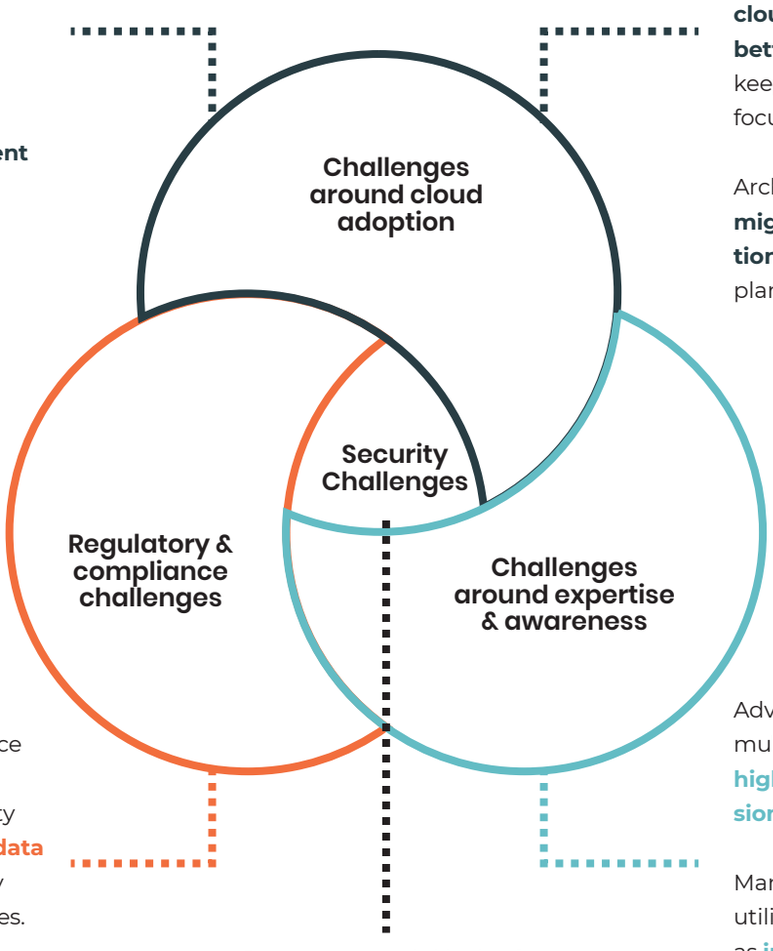
1.1 Understanding the Current Cloud Challenges

While cloud is a proven technology, the scale of cloud adoption has created challenges.

Cloud challenges however are manageable when partnered with experts to deliver the right solution.

Organization often struggle with **visibility over** data flow and associated **lack of controls**, especially in public & hybrid cloud.

Managing cloud environment is complex, given various decision points within multi-cloud journey



Clients often feel the need for MSPs to guide them on **right cloud deployment model to better suit business needs**, keeping security as leading focus.

Architecture involving **complex migration may lead to disruption,** if not assessed and planned.

As cloud ecosystem involves multiple stakeholders - service providers, service brokers, customers, and cloud security provider – **management of data across multiple parties** may lead to compliance challenges.

Evolving regulation and compliance policy landscape across countries makes it tough for enterprises to operate business across the globe

Shared responsibility is often a challenge, as organizations don't understand their share in the responsibility matrix.

Gap in **workload migration and misconfigurations** have resulted in increase in Cyber attacks.

Advanced cloud models and multi cloud ecosystem requires **highly trained & skilled professionals to operate.**

Managing server/storage utilization/peaks need expertise as **inefficiencies may lead to higher billing**

1.2 Recommendations for Overcoming Challenges while Adopting Cloud

Each of the challenges stated above can be overcome by well thought cloud adoption strategy. A holistic cloud adoption strategy must include:

1. Procurement Strategy: Procuring cloud solutions depends on the organizational size, industry type, applications required, and type of data processed. To integrate the cloud and manage their data and solutions, a competent IT Team (in-house or outsourced) is required, with knowledge of cloud infrastructure assessment, bucketizing application bases on their criticality, cloud customization, hands on experience of migration, integration, optimization, and management.

Cloud solutions can be procured mainly from three parties, i.e., Cloud Providers, Cloud Broker and Managed Cloud Providers.

2. Migration Strategy: Cloud migration is a resource intensive exercise and it must be carried out after taking business impact into consideration. Selection of the CSP or Managed partner must be based on the expertise that is required to completely migrate to the cloud. For successful migration, organizations should follow the below five main steps:

Steps for successful migration

Having clear understanding of the need as well as in-house capability of the organization will be helpful throughout the journey. Some of the considerations to be considered are:

a. Rate of migration
b. Cost and flexibility
c. Implementation expertise
d. Security and privacy effectiveness

For instance, if the organization needs to migrate very quickly or needs to migrate only non-critical workloads, the IT department may choose to "Lift and shift" the workload. This may work in short run, however, may lead to performance as well as cost issues in later stages.

3. Data Strategy: One of the challenges that organizations face when moving to the cloud is choosing the data that can be moved to the cloud, given the regulatory compliance requirements for data privacy. The Government of India has released many documents explaining the process for classifying data. Additionally, DSCI has released a thought-paper that discusses the data classification from cloud adoption perspective. The process for data classification follows 3 steps:

For successful implementation and deployment of classification, organizations must identify data classification tiers followed by technology controls for respective classification tiers. Data owners, with the help of business heads must identify any change in business process and/or addition of new application.

Ministry of Home Affairs (MHA) recommends 3 tiers of data classification based on impact level:

Tier 1

Low impact, non-sensitive or public data. This is also called “Unclassified category”. Public cloud is best suited for this tier of data.

Tier 2

Moderate impact, restricted data such as medical records, emails, CRM data. MHA also calls this category “Restricted” or “Confidential”. Organizations can even classify the data as “for internal use only”. Highly secure hybrid cloud arrangement is best suited.

Tier 3

Highly sensitive data, for example strategic plan of an organization, military records for Government agencies etc. MHA calls this category as “Secret” or “Top secret”. Such data must only be transferred to private cloud.

Based on the data classification, the security controls are identified. According to DSCI’s whitepaper, “Security controls-based cloud adoption for Government workloads”.

For tier 1 data, the organization can have basic security in place. This may include adherence to ISO 27001 recommendations or MeitY’s cloud guidelines.

For tier 2, additional controls are often required. For example, MFA controls for access controls.

For tier 3, stringent security controls must be in place. For example, encrypted private link to CSP’s data center, network segmentation etc.

4. Choice of the Cloud Model: The approach to select the right cloud model needs to be based on the type of workload that needs to be migrated to cloud. For some workloads, organizations may choose to "lift and pick", but this is often seen as short-term fix. Hence, organizations must refactor the workloads or re-write to make it cloud native. Often this step requires cloud know-how and expertise. However, in the longer term this step will help organizations to make their workloads efficient and save cost. For example, a bank should map the architecture, extract the logic from the legacy application and recode it to be more scalable. Types of workloads selected will impact the cloud migration progress. Ideal approach that the organization can take is to segregate the workload on the basis of business value, as shown in the table[1] below:

Workload	Description	Business value
Collaboration and productivity	Email, in-house developed messaging system	Medium
Core enterprise app	Customer facing and revenue generating application	High
Internal department app	Non-critical application, specific to any LOB	Low

High value core enterprise app must be re-written so that there is no performance drop.

5. Security Strategy: Organizations will have to plan its cloud security strategy on the following three attributes:.

a. Consistent control: Based on service model the client organization must work with MSSPs to come up with controls that are needed to secure the cloud environment, for example verifying which user sessions are considered valid (by managing policies around subnet), encryption key management, CASB (specially for managing unmanaged devices) and traffic logs, to name a few.

b. Managing issues of misconfigurations: To manage misconfigurations, the organization must work with MSSPs to get the understanding of the following- baseline configuration assessment, results of automated scanning and procuring cloud security posture management

c. Shared responsibility: Tata Communications and DSCI came up with modified shared responsibility matrix in which GRC, Procurement, Implementation of security, Security Operations, Security SLAs and Audits can be owned by MSSPs, while data security, IAM and encryption remain client-organizations responsibility.

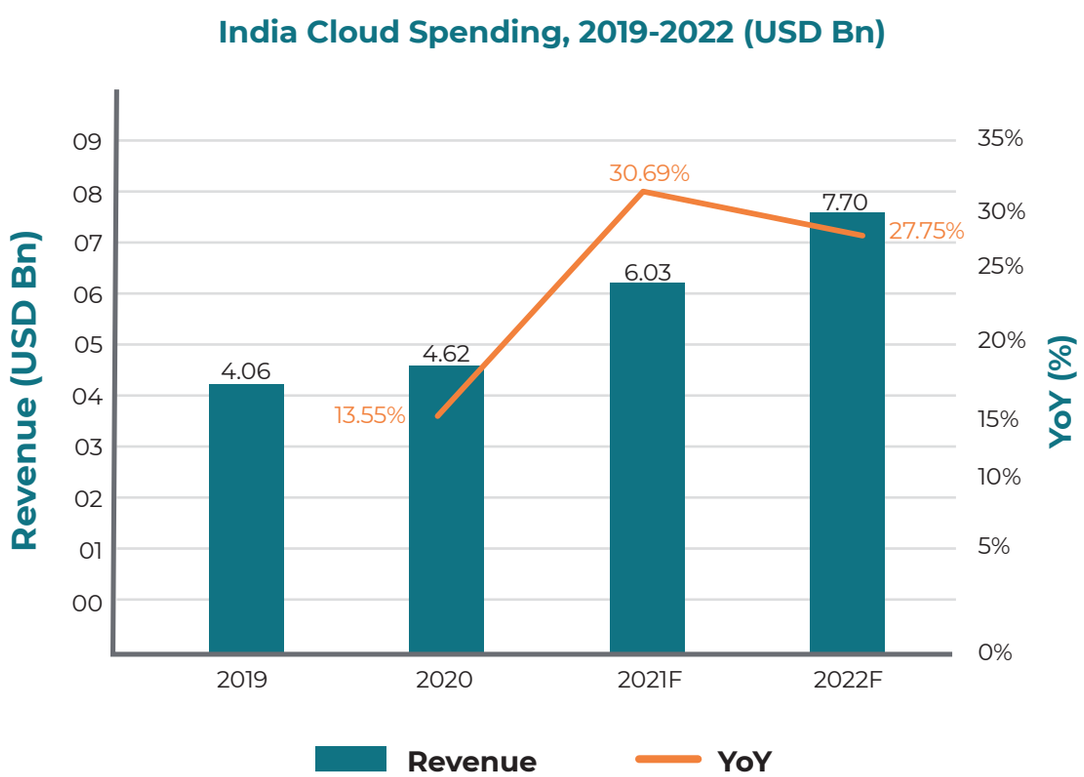
[1]**Bank of the Future, Citi GPS: Global Perspectives and Solutions:** https://www.citibank.com/commercialbank/insights/assets/docs/2018/The-Bank-of-the-Future/83/#zoom=z

6. Compliance and Regulatory Plan: The recent developments around Data protection laws, such as the POPI Act and the GDPR, sectoral regulations such as HIPAA and RBI guidelines require the organization to work with MSSPs to understand where the data is processed and stored, what laws will apply, understand the impact, and then follow a risk-based approach to comply with them. It is important to be cognizant of interception laws or access to information laws, that may allow Governments or other parties to access your data.

7. Management for an optimized and unified Cloud Environment: Enterprises should focus on cloud management strategy from the start and consistently track their cloud service consumption, budgets allocated and ROI as cloud service budgeting helps enterprises track consumption while forecasting future spending. Clearly identifying the quantum of service required is significantly important in achieving operational efficiency. It is interesting to note that, cloud automation enables you to set up resources in a standardized, controlled manner, which in turn offers more control over infrastructures and lesser risk.

1.3 Key Drivers for growth of Cloud in India

The global cloud market was valued at USD 346.7 billion in 2019 and is projected to reach USD 535.6 billion by 2022.[2] While as per DSCI Market Analysis, the India cloud market was valued at USD 4.06 billion in 2019 and is projected to reach USD 7.70 billion by 2022, exhibiting a robust CAGR of 29.21% during 2019-2022. The cloud adoption is also driven by the fact that new technologies like IoT, IIoT, AR/VR adoption has become easier thanks to various cloud models and the ability to employ Hyperscalers for these highly elastic workloads.



The growth is attributed to supportive government initiatives and is accelerated by the COVID-19 pandemic.

National initiatives: The Indian government has identified cloud as one of the major technologies of focus. According to the recent NASSCOM-McKinsey report [3], cloud transformation is one of the three COVID-19 resilient offerings (other two being Cybersecurity and Workplace modernization). Indian Government has adopted many digital initiatives over past few years, such as DigitalLocker, UPI, eKYC, Digidhan Abhiyaan, Poshan Aviyan, GeM, MyGoV, NREGA-SOFT, Openforge, PayGov India, BHIM, Smart Cities and Aadhaar, making India amongst the top two countries on many dimensions of digital adoption such as smartphone adoption, internet subscribers. All these initiatives are encouraging cloud adoption across the country.

[2] https://www.researchandmarkets.com/reports/5136796/cloud-computing-market-by-service-model
[3] **NASSCOM-McKinsey report:** https://nasscom.in/knowledge-center/publications/perspective-2025-shaping-digital-revolution

Enterprise and Industry level adoption: Cloud has become the go-to execution venue as enterprises move corporate resources from data center to cloud to aid borderless growth, product innovations and efficiencies in operations, processes and cost. Besides, the exodus to remote working models has led to demand for scalable, secure, agile, reliable, cost-effective cloud solutions. With increase in cloud adoption, management of multi-clouds are estimated to become both vital and crucial for successful business operation. As per IDC, by 2023, 33% of the India enterprise applications are estimated to be deployed in a containerized hybrid cloud/multi-cloud environment. Another key driving force is the SMEs and startups that are being "born in cloud", they can optimize cost and achieve more streamlined stacks that can help augment simplicity and provide quick turnaround time, delivery and dynamic scaling. With numerous benefits, start-ups are proliferating the cloud model and pushing adoption.

Acceleration due to pandemic: The cloud industry is majorly driven by the transition in the business application during the COVID-19 pandemic, as many enterprises have moved their business applications such as workspace chat, audio/video conferencing, email, customer relationship management, web hosting, and enterprise resource planning, among others to the cloud. Business resiliency and increased demand for e-learning, digital payments, and applications of AI/ML and AR, VR have changed the way business has been conducted during the pandemic. These technologies are becoming scalable and accessible due to the resources offered by the underlying cloud technology. As per Microsoft, two years' worth of digital transformation has happened in two months of the pandemic.[4]

Cloud adoption is growing exponentially across verticals. Cloud has been repositioned from being a business edge to a crucial necessity for maintaining business continuity. The next section deep dives into the finer nuances as to what are the key motivations behind adopting cloud and what are the business benefits realized by each sector. The section will further delve into use cases, challenges in adoption and will help garner a better understanding of what's next, enterprises with a unified ecosystem.

[4] https://www.microsoft.com/en-us/microsoft-365/blog/2020/04/30/2-years-digital-transformation-2-months/

1.4 Sectoral Viewpoint and Trends

Banking, Financial Services and Insurance (BFSI) sector

The focus of BFSI during pandemic was to continue its delivery throughout the country. Serving clients in tier 3 and tier 4 towns, without branches being operational was an additional challenge.

Large banks in India adopted cloud early-on in their digital strategy and they have been the frontrunners of banking services. By focusing on cloud as part of the digital strategy, banks can provide better customer experience, optimize business processes, reduced customer acquisition cost. Cloud adoption also helps banks to quickly launch new services, which otherwise take months because of hardware compatibility and procurement period. Another benefit that cloud offers to the BFSI sector is to manage peak business requirements.[5]

Scalability and Product innovation is driving Banks to adopt cloud computing. Cloud-native applications help banks realize the scalability and flexibility by using multiple and independent microservices.

Some of the examples of banking services that utilize cloud environment are – Credit card acquiring business, merchant services and e-commerce business and prepaid business. Most of these critical banking services avail SaaS based cloud.[6] However, as more and more banks and insurance companies adopt cloud infrastructure, they are understanding the benefits of IaaS. In early days, banks and insurance companies often utilized IaaS for non-critical services such as utilizing advanced analytics and machine learning to understand the change in client demands and application performance.[7] But now, given advantages of scalability, location independence and 24*7 service availability that IaaS offers, the BFSI sector is adopting this model.

The Indian Banking Community Cloud (IBCC) aims to address the financial sector's growing demand for secure cloud-based services. Banks that migrate to Community Cloud can receive end-to-end support for infrastructure management and colocation services. SaaS is supported as a part of Banking Community Cloud, and it provides ready to use Core Banking Solutions, Payment Solutions, Mobile Banking and many more services.

Due to the regulatory compliance requirements in banking and insurance sector, it may be assumed that private cloud is the only option that BFSI sector has. However, our research suggest that banks and insurance companies are going beyond private cloud and are availing hybrid or multi-cloud approach for their business. One of the operating models, as observed in one of the largest banks in India, is to avail private cloud for centrally managing branch infrastructure, providing security using micro-segmentation and monitoring performance and user experience in every branch, while adopting public cloud for workforce collaboration. Hybrid cloud strategy thus offer benefits of public cloud while maintaining the security requirements offered by private cloud[8] for centrally managing branch infrastructure, providing

[5] https://www.expresscomputer.in/news/sbi-the-rise-of-the-digital-bank/20196/
[6] https://economictimes.indiatimes.com/tech/internet/cloud-computing-is-a-big-leveller-munish-mittal-hdfc-bank/articleshow/55477768.cms
[7] https://bfsi.economictimes.indiatimes.com/news/banking/as-banks-adopt-multi-cloud-strategy-controls-and-regulations-should-be-on-priority-nitin-chandel-bny-mellon-india/75838732
[8] https://www.expresscomputer.in/news/sbi-the-rise-of-the-digital-bank/20196/ **and** https://cio.economictimes.indiatimes.com/news/strategy-and-management/how-sbi-manages-spike-in-digital-traffic/77211566

security using micro-segmentation and monitoring performance and user experience in every branch, while adopting public cloud for workforce collaboration. Hybrid cloud strategy thus offer benefits of public cloud while maintaining the security requirements offered by private cloud. However, there are many challenges that organizations must solve in order reap the benefits of cloud. Below figure highlights some of these challenges[9]:

Additional challenges that businesses face with hybrid cloud strategy are maintaining sufficient security and inadequacy of IT management and governance processes. To eliminate these challenges, banking and insurance companies can avail MSP partner.

Manufacturing Sector (including Automotive)

Over the last few months, the Indian manufacturing industry is majorly focusing on workforce modernization, enhancement of data infrastructure, intelligent automation & robotics, and improving digital capabilities.

Benefits of cloud adoption within this sector are – enhanced agility, flexibility, and most importantly higher productivity. Cloud-enabled solutions are also helping manufacturing enterprises in implementing High-Performance Computing (HPC) in production.[10]

Most of the cloud-based ERP, CRM, and collaboration tools are SaaS [11] based on the other hand business intelligence [12] and factory automation (IoT, AI) tools leverages PaaS/IaaS. In terms of deployment model, the manufacturing sector is moving towards a hybrid cloud environment, as hybrid cloud assist manufacturing companies to modernize legacy applications and services to focus on long term investment for the smart factory (IoT, big data, AI, and analytics), while maintaining business continuity.

Cloud benefits for Manufacturing sector:

1. Completely automate industrial and operational systems.
2. Enhanced Supply chain visibility, improved forecasting .
3. Better system integration of cloud-based enterprise applications.

[9] **Cloud Assured, Cloud Secured – Maximize value of Hybrid Multi-cloud-** https://www.tatacommunications.com/resource/industry-solutions/automotive/cloud-assured-cloud-secured-maximise-value-of-hybrid-multi-cloud/
[10] **Tata Communication blog -** https://www.tatacommunications.com/blog/2020/09/cloud-moments-for-manufacturing/
[11] https://mantec.org/how-the-manufacturing-industry-uses-cloud-tech/
[12] https://www.machinemetrics.com/blog/finding-the-right-cloud-solution-for-manufacturers

The Indian manufacturing industry is implementing industry 4.0 components such as a network of the sensor, 3D printing, AR/VR, big data & data analytics, autonomous robots, and digital twins, among others. Also, digital twin software providers are working towards SaaS [13] digital twin modelling system or cloud-based platform[14].

Healthcare Sector

Public cloud adoption in Indian Healthcare sector is increasing. The biggest advantage of cloud adoption is the ability to integrate the data from various sources – hospitals and 3rd party. Indian Government has recently launched Telemedicine and Teleconsulting (in 2020), which has bolstered the need for sharing health data across different entities. However, tracking of the EHRs is not consistent across the country and people are conservative in sharing their medical history through apps.Some of the technology developments that are disrupting the sector are Internet of Medical Things (IoMT), AI/ML, Big Data, and 3D printing. These trends are further driving the cloud adoption.

The pandemic has increased the need for real-time data sharing and data storage through cloud adoption[15]. For instance, one SaaS based Indian start-up is leveraging AI to improve the accuracy in forecasting bed occupancy and other operational challenges.

The biggest roadblock for cloud adoption in the Healthcare sector is security and privacy. There is also comparatively low awareness among medical practitioners and hence hesitation to adopt new technology [16]. Therefore, in many countries, including India, Healthcare sector opts for private cloud deployment over public cloud and hybrid cloud. In terms of service model [17], Healthcare sector is largely adopting SaaS based service model , as it offers many advantages over IaaS and PaaS, such as security, low cost of ownership and deployment time.

The Healthcare analytics market in India is expected to reach INR 47 Bn by 2025. Migration to cloud platforms helps Healthcare organizations to work on large pool of data sets and draw actionable insights for patient care.

Few examples of cloud use-cases that are being leveraged are apps-based scheduling and reminders of appointments, sharing information across multidisciplinary care teams, improving follow-up care and increasing patient engagement, internet of medical things (IoMT), surgical robots, big data analytics, digital twin, AR/VR/MR, and AI.

[13] https://www.intellias.com/cloud-service-for-a-digital-twin-modeling-system/
[14] https://www.scaleoutsoftware.com/products/digital-twin-streaming-service/
[15] **Interview of Vimal Venkatram, Country Manager, Snowflake -** https://www.expresshealthcare.in/covid19-updates/how-cloud-technologies-and-data-analytics-are-transforming-the-healthcare-sector-vimal-venkatram/424312/
[16] **DQIndia – Public cloud integration could be an answer to India's biggest Healthcare challenges -** https://www.dqindia.com/public-cloud-integration-answer-indias-biggest-healthcare-challenges/
[17] **Markets and Markets -** https://www.marketsandmarkets.com/Market-Reports/cloud-computing-healthcare-market-347.html

1.5 New Technology wave driving the Cloud Adoption

Data Analytics

In today's world, every industry is relying on data-driven actions & insights and with growing trend of data generation, cloud will play a pivotal role in the enablement of business processes by running analytics and providing key insights. With the advancement in Artificial Intelligence, Big Data and Data Analytics the demand for cutting edge analytics that can help strip out layers of complexity and analyse data seamlessly in a Multicloud environment will become the difference between exponential success and gradual growth. In the Banking industry, analytics is used to know customer priorities and customize products as per their needs, it is also used for fraud detection and reducing risks. In the healthcare industry, it can be used to analyse Electronic Health Care Records and predict the next course of tests, provide real time alerts, and enhance patient engagement. By examining and capturing insights from city level analytics projects, the Government can understand how data and tech-enabled innovations affect municipal governance. Also, they can use Predictive analytics to help predict financial crimes such as tax evasion and insider trading.

Impact of IoT

IoT data has opened a new avenue for the cloud. According to IDC[18], by 2025 there will be 55.7 Bn connected devices worldwide; 75% of which will be connected to an IoT platform. IDC further estimates, data generated from connected IoT devices to be 73.1 ZB by 2025, growing from 18.3 ZB in 2019. The data generated through IoT devices is humongous and requires the cloud for storage, which further drives the demand for cloud. IoT end-users are leveraging the benefits of the IoT platform to remotely collect data, compute data and execute sensor management, and most of the IoT platforms are delivered to end-user over cloud. For instance, an autonomous car generates 40 terabytes of data for every eight hours of driving. The data can be stored and processed over the cloud for impactful analysis and insights.

Impact of Edge Computing

In edge computing, the data is processed and analyzed at the edge by levering edge devices. When large amount of data is gathered, it is sent to the cloud for big data analytics. In order to reduce latency and increase bandwidth, several industries are adopting edge computing, and increase in edge devices. Many B2C/consumer services companies operating with digital platform driven services and have key performance indicators as “time-to-value”, “transaction-time” are demanding edge computing which is further boosting cloud adoption.

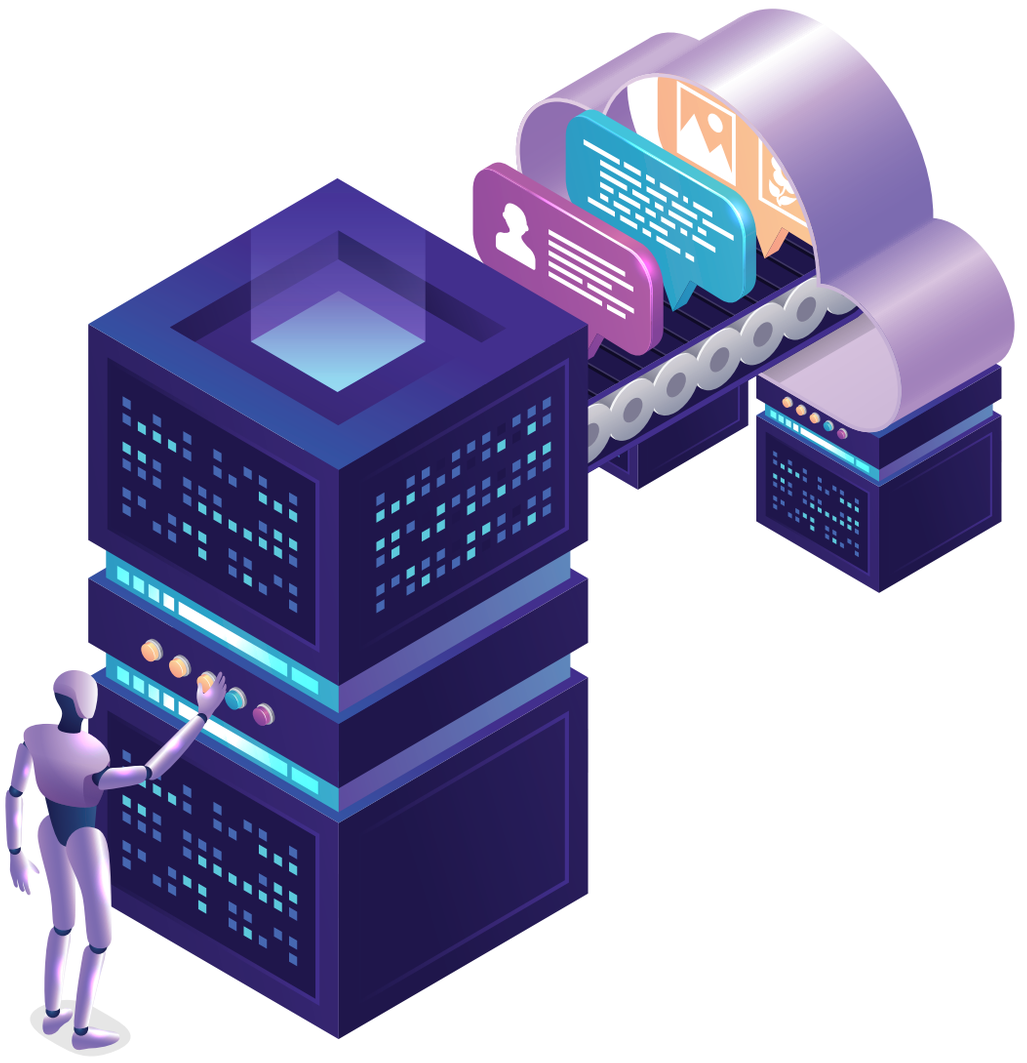
[18] **IoT growth demands rethink of long-term storage, strategies** – IDC: https://www.idc.com/getdoc.jsp?containerId=prAP46737220

AI PaaS

With the advent of the next generation technologies, enterprises are moving from conventional AI services to AI PaaS. Enterprises leverage the benefits of AI and ML platform services through AI PaaS to build, train and deploy AI-powered functionalities. AI PaaS offers prebuilt ML & DL algorithm and API. The convenience of AI PaaS over conventional AI Models is contributing towards the cloud adoption.

Serverless Computing

This enables enterprises to build an application on a serverless architecture where all infrastructure management operations such as capacity provisioning and patching are handled by the CSP. Serverless computing assists enterprises to focus only on developing codes and building applications without concerning about strain on storage and processing capacity. Also, with serverless computing, the infrastructure dynamically scales up and down to meet the demand of workload required by application.



Chapter 2.

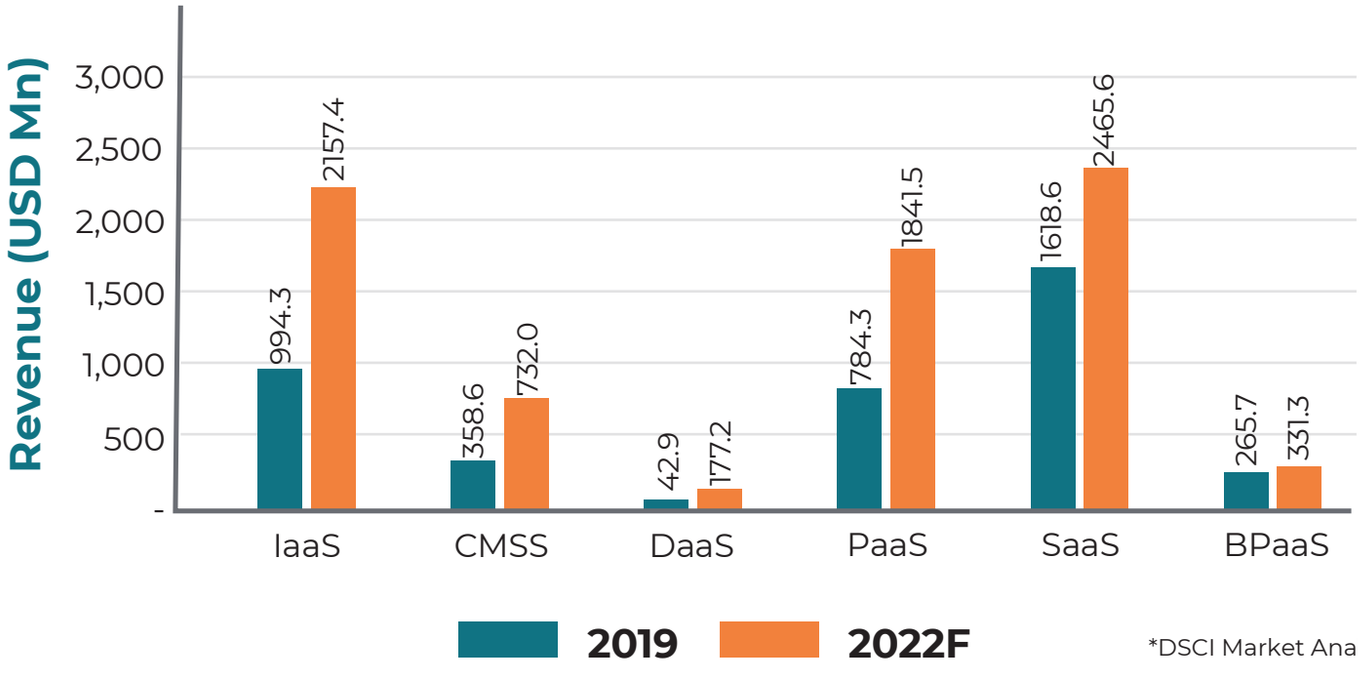
India Cloud Market analysis by Various Models

The following section look at the Indian cloud market from three aspects:

- By Service model
- By Deployment model
- By Industry

2.1 Indian Cloud Market: By Service Model

India Cloud Market Size, by Service Model*
2019 and 2022 (USD Mn)



*DSCI Market Analysis

Infrastructure as a Service (IaaS)

The IaaS market stood at ~USD 1 Bn in 2019 and is estimated to grow at 48% Y-o-Y during 2020-21. Further, the IaaS market is anticipated to grow at a CAGR of 35.37% during 2019-22.

Key Drivers for this growth are - The economic benefits (shift from capex to opex), increased innovation, vibrant start-up ecosystem and connected ecosystem along with improved infrastructure facilities,

exponential data generation, demand for big data analytics, use of storage-as-a-services, DRaaS & backup services are estimated to further bolster the IaaS market.

Post-COVID, enterprises have a particular focus on increasing operational efficiencies by ensuring they are 'always-on and ready' through investing in IaaS cloud services. Also, IaaS is estimated to enable next generation technologies such as IoT, blockchain and AI deployment on a scalable, elastic, and high-capacity cloud platform for data storage & analysis.

IaaS benefits are evident in certain industry verticals. For instance:

- In Manufacturing, IaaS can enable automation in industrial systems due to the computing abilities. Full visibility within the supply chain helps in improving forecasting accuracy. IaaS provides the ability to manipulate the harvested data and adjust the throughput of production lines, in near real time without having to spend in special hardware and analytically skilled resources.

- In Healthcare, IaaS **provides control over the cloud infrastructure**, health sector pays high importance of having control over operating systems, storage, and deployed applications. IaaS removes concerns around interacting with and storing sensitive patient data in the cloud. Additionally, the deployment of some of the Electronic Health Record (EHR) systems need intensive computing, and IaaS can help meet those requirements.

- For Startups and Small-to-Medium sized Business (SMB) needs, having IaaS can help by-pass the need for internal IT expertise to manage the IT infrastructure and focus on core competencies

Cloud Management and Security Services (CMSS)

Cloud Management and Security Services are gaining traction at a fast pace and will reach ~USD 730 Mn by 2022. This segment is driven by the need of organizations to stay compliant to the regulatory norms, secure from cyber-attacks, while minimizing risks. This will require organizations to partner with right cloud management and security services providers.

IDC predicts that by 2022, 30% of enterprises in India will use unified VMs, Kubernetes, and multi-cloud management processes and tools to facilitate multi-cloud management and governance. Automotive, Healthcare, Hospitality, Government and BFSI sectors amongst others, require cloud MSP's as they have unique and special technology needs and cloud management provides a strategic way to better organize, operate, and safeguard business while maintain compliance.

Desktop-as-a-Service (DaaS)

The DaaS market is the fastest growing segment, with a tremendous yearly growth rate of 65% during 2019-2020. Further, it is anticipated to grow by 151% between 2020-2022 and reach USD 177 Mn. Organizations are using desktop virtualization systems to facilitate "remote working" or "work from anywhere" models and ensure business resilience, continuity and growth . DaaS enables enterprises to offer secure VDI for remote and mobile working models, VDI provides optimization of cost and computing resources and it also increases efficiency of provisioning infrastructure. The aforementioned benefits of VDI are propelling the adoption of DaaS by the large and small & medium enterprises.

DaaS is the fastest growing segment and is expected to grow by 151% between 2020-22. VDI is the leading factor that is driving this growth, especially in SMB sector

DaaS ecosystem is trending toward a holistic model that includes support and management services, along with cloud desktops. This "Zero IT" approach reduces strain on IT teams to manage their cloud desktops. Vendors provide operational expertise as part of the DaaS service to further add value to the model.

Healthcare, IT-ITeS, Retail, Education, Legal and Manufacturing sectors aided in surge of DaaS adoption during the pandemic owing to the flexible mode of working in DaaS.

Software-as-a-Service (SaaS)

Indian SaaS market is growing significantly and is estimated to reach USD 2 Bn by 2021. The SaaS market is anticipated to grow at a double digit CAGR of ~22% during 2019-22. According to Bain & Company[19], Indian SaaS companies are projected to reach 7-9% of global SaaS market share by 2022.

The launch of large number of emerging SaaS products and increasing strategic collaboration between SaaS providers are driving innovation in the SaaS space. The rapid surge in SaaS collaboration tools (Zoom, MS Teams, etc.) and CRM tools are supporting the noticeable rise during COVID-19. SaaS offers benefits such as high strategic and operational value, and the bug fixing process and security updates/patches are taken care by the provider. Further, the continuous shift from on-premises license software to subscription-based SaaS models is driving the growth.

The top trends in the SaaS industry that are estimated to pick up in the short and medium term are in the areas of AI/ML, Centralized analytics, Vertical SaaS, White label SaaS, Micro-SaaS, Enhanced mobile optimization and Low-code capabilities.

Globally, the key sectors benefitting from the cloud are Government, Banking, Engineering and Education owing to capabilities such as enterprise and resource planning and analytics to name a few.

[19] **India SaaS Report 2020 – Bain & Company-** https://www.bain.com/insights/india-saas-report-2020/

Business Process as a Service (BPaaS)

The BPaaS market is still in nascent stages and will reach USD ~330Mn by 2022. The BPaaS services sits on top of three different cloud-based services - PaaS, SaaS, and IaaS and offers a turnkey solution. Few examples of BPaaS services are Sales Processes, Human Resources & Recruiting, Operations Management, and Insurance Outsourcing.

The BPaaS market is driven by Product/service deliverability, as it offers number of automated services, from maintaining inventory to organizing customer records and email. Cost Optimization is another major driver as it offers digital tools, advanced technologies, and other resources without laying strain CAPEX.

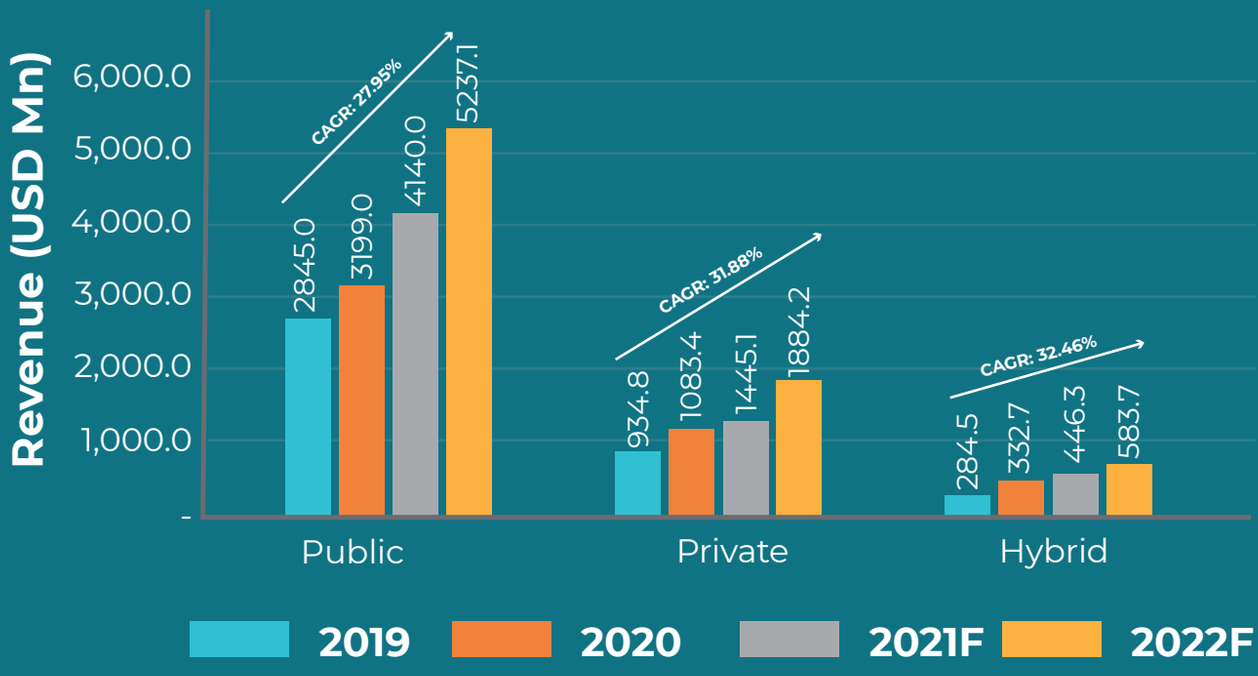
Several industries such as BFSI, retail, healthcare, manufacturing, telecommunication & IT, and media & entertainment are adopting cloud services actively.

Platform-as-a-Service (PaaS)

PaaS market is growing at a healthy pace and is estimated to reach USD 1.8Bn by 2020. PaaS offers multiple offerings such as: Application Platform as a Service (aPaaS), Integration PaaS (iPaaS), API management PaaS (APImPaaS), Function PaaS (fPaaS), Business analytics PaaS (baPaaS), IoT PaaS and database PaaS (dbPaaS), AI PaaS and Serverless computing. The PaaS market is driven by the increasing demand of infrastructure and platforms to support the web application lifecycle. Key industries that are benefit from PaaS are Manufacturing, Consumer electronics, Telecom & IT and SMEs amongst others.

2.2 Indian Cloud Market: By Deployment Model

India Cloud Market Size, by Deployment Model, 2019-22 (USD Mn)



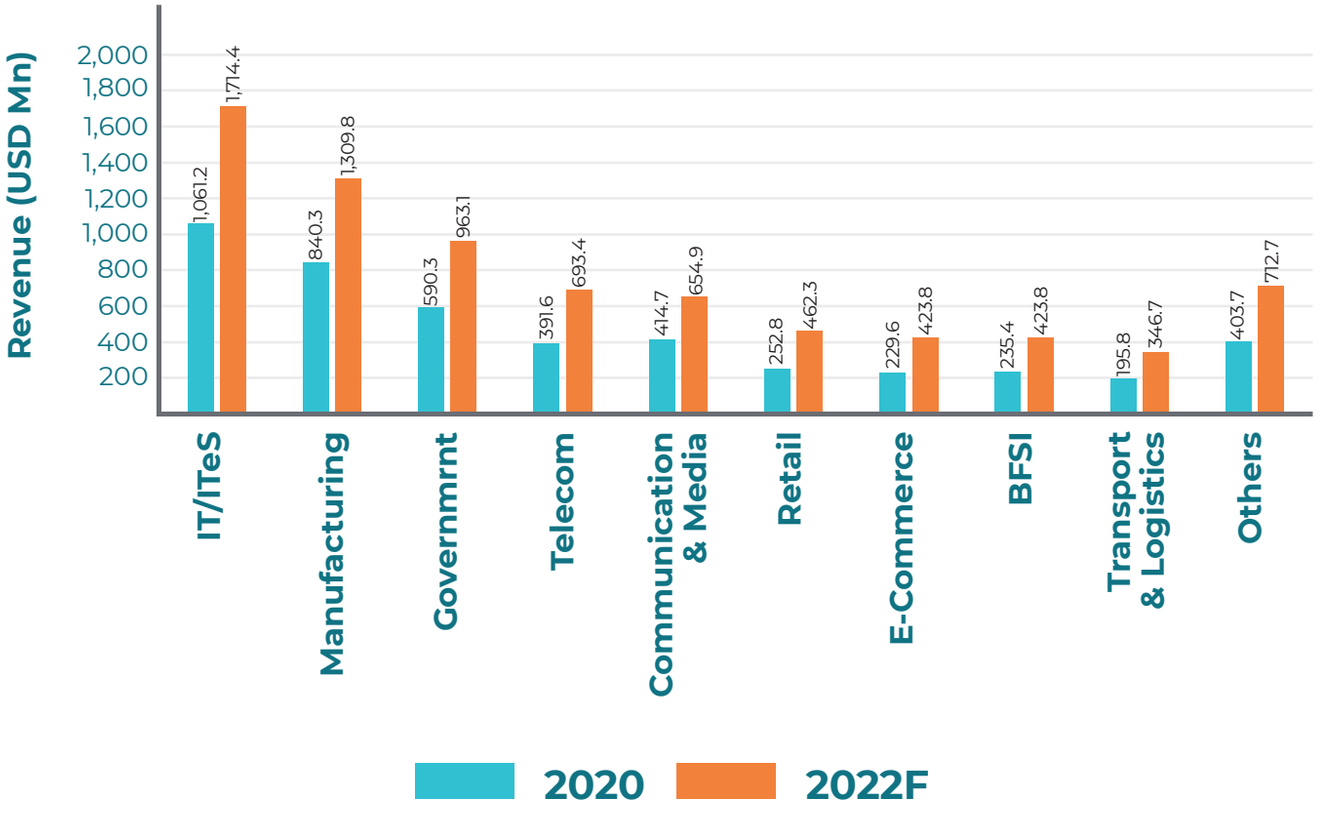
• In 2019, the public cloud segment accounted for the largest share and is anticipated to maintain its dominance throughout 2022. The India Public cloud segment is dominating the Cloud market with a market share of ~70% and is growing at a robust CAGR of ~28%. With the increased investments in enterprise operation mobility, collaboration, and remote working technologies the public cloud market growth is likely to be sustained. Migration from legacy systems to public cloud set by moving critical and dynamic business applications such as CRM, email, HR and ERP that can perform better with public cloud elasticity and leverage optimized SaaS, PaaS models swiftly and with ease is estimated to further propel the market growth.

• Private cloud is known for its control, performance, and ability to implement strict security and privacy guidelines adherence benefits. This makes it ideal for large enterprises and businesses with predictive and high performant workloads, with critical compliance and regulatory requirements. Further the option of customization for precisely meeting the business needs along with the availability of hyper-converged infrastructure is estimated to drive this segment.

• Hybrid cloud is expected to grow at the CAGR of 32.46% from 2019 to 2022. This is mainly due to the benefits that span across advantages of Private, Public and Edge clouds. Hybrid multi-cloud platforms deliver more benefits than a single cloud platform. Also, 50% of the enterprises in India are estimated to operate in a hybrid multi-cloud environment by 2021, according to IDC.

2.3 Indian Cloud Market: By Industry

India Cloud Market Size, by Industry, 2020 and 2022 (USD Mn)



Industry verticals across India are leveraging cloud for various business processes and services.

• The IT & ITeS industry segment accounted for the largest share in 2020, followed by manufacturing and Government. This trend is estimated to continue throughout 2021 and 2022. The IT & ITES sector majorly use IaaS and PaaS for developing software and web application.

• BFSI sector, being highly regulated sector, still lags other sectors in cloud adoption. However, by 2022, cloud adoption is likely to soar and be at-par with other sectors such as Retail, E-commerce, and Transport & logistics .

• The Indian government is relying on the cloud technology for large scale E-Governance programs. The aim is to increase agility, share information, eliminate redundancy, and optimize communication technology at economical costs. This is driving the growth of cloud in the sector. Recent announcements of “AIRAWAT”, a platform to boost AI and cloud infrastructure, launch of “DiGiBOXX”, Indian cloud storage and data management platform points towards active push from the Government.

a. Other examples include implementation of cloud technology by Indian Railways to better analyze the passenger data for managing ticket frauds. Similarly, Kisan Suvidha app for farmers stores complete information on a cloud and helps in data traffic management.

- Across sectors, benefits such as operational innovation, revenue model management can be seen. Cloud enables simpler processes that drive internal efficiency and reduce complexity, improve customer relationships. As a result, the data and other assets can be monetized conveniently, and time taken for GTM can be reduced significantly

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Data Security Council of India

4th Floor, NASSCOM Campus, Plot No. 7-10, Sector 126, Noida, UP-201303

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