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PRESENTS

THE FUTURE OF ENTERPRISE

64 CIOs who successfully steered their organizations through the pandemic-led disruption share technology strategies and frameworks for the enterprise of tomorrow.

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Future of Enterprise (Technology, Business & Management)

CONTENTS

COLLABORATING TO BUILD THE CUTTING 'EDGE'

"Edge is the new core. It is where many of the decisions will be taken, and actions will be performed. HPE India understands that and we will strive to help you to be in the cutting 'edge'."

Som Satsangi
Managing Director
Hewlett Packard Enterprise

I am happy that the program ran successfully with participation of more than 60 senior CIOs in India who took ownership of emerging technology areas to figure out and plan how technology can effectively be used to create business value – from cloud to AI/ML; from data centers to modernized applications.

The result of that labor of their love—the brainstorming sessions, for which I am extremely thankful to them—is this book. It is full of useful insights that should help a far larger base of IT decision makers in India. Because this is the age of insight.

HPE India is committed to help these enterprises in their journey of the future. Cloud is the most fundamental enterprise technology of today. But with significantly increasingly level of digitization that is touching all aspects of our lives, the traditional centralized model will no longer be able to support. Edge is the new core. It is where many of the decisions will be taken, and actions will be performed. HPE India understands that and we will strive to help you to be in the cutting 'edge'.

I once again thank all the CIOs who enthusiastically participated in the program and showed us the path to the future. I thank our partners at 9.9 Group and my colleagues at HPE India for their collaborative efforts to make this program successful.

FOR THE CIOS, BY THE CIOS

A t least for a couple of decades, the realization has dawned upon businesses that the future of enterprise is critically dependent on technology. They defined the future based on solutions to today's well-defined problems and the technology vision was, in turn, dictated by what could get them there. Technology, on the other hand, like any innovation, followed its own path. And often, the marriage was that of convenience. Disruptions was a favorite phrase in the business technology lingo, but few really understood—or cared to understand—what it really could be like.

Then came the disruption. The real disruption. Few of the business continuity and disaster recovery plans were of any use. Yet, the businesses never gave up. Led by the technology managers, the CIOs and their teams, they fought back. They kept the businesses running. They kept the economy running. They kept our lives running. Naysayers notwithstanding, it was a great comeback story. So much so that we are now talking of a New Normal.

What helped them fight so effectively? Technology and their ability to solve complex problems for sure, but above all it was their thorough understanding of business intricacies at any point of time and 'work out' of the future from there. No amount of external knowledge could have given that to them.

The program—and its labor of love, the book—Future of Enterprise is based on that realization. The realization that it is the CIOs who can work out the future for their digitized businesses the best.

I am indebted to the CIOs that they so enthusiastically took it upon themselves to make this possible. Organized as a formal series of three meetings for each of the topics covered in this book, the actual deliberations sometimes were more—as a group, one-on-one and with numerous calls between the CIOs and our editors to supplement the discussions.

My sincerest thanks to our partners, HPE India, VMware, Tata Communications and Netmagic who endorsed this path. They had critical value additions as technology practitioners. In particular, I thank HPE India for supporting us and making the program happen, as presenting partner. I thank my team members who ran the program smoothly.

I sincerely hope you can identify with the content presented in the book and that this will help you in some manner to build your future, leveraging technology.

"Future of Enterprise is based on the realization that the CIOs, not any external forces, are in best positions to visualize and build the futures for their digitized businesses."

Vikas Gupta
Director
9.9 Group

FUTURE OF ENTERPRISE: THE STORY

> "The virtual mode allowed us to do the engagements multiple times. The groups of CIOs met anywhere between two to four times (for different topics) to finalize what they wanted to tell the community."

Shyamanuja Das
Editorial Director -
Enterprise Technology
9.9 Group

F uture of Enterprise is for the community, of the community, by the community.

All that we have done is to facilitate channelizing the knowledge from the section of the community that possesses it to those who are in need of it—while adding a layer of our editorial skills to make it a little focused, concise and presentable.

We used our flagship program, our annual CIO&Leader Conference, to host it.

This is not exactly a new idea. We ourselves introduced it in 2017 with the highly successful Agenda 2020 program, with our annual conference that year. Since then, we have done that every year, focusing on different themes.

Before I get into what made us choose this year's theme, let me tell you the thought that triggered this model. We—and many of our peers in the industry—have been conducting these large conferences for years. We have been capturing the gist of those discussions as editorial content.

But clearly, the coverage was not doing justice to the range and depth of the actual discussions. The larger community—we used to have 100-120 CIOs in our conference—was missing them. That is when we wanted to record them in far more depth and breadth and present them in a consumable manner to the broader community. In the 2017 annual conference, we tried this.

The CIOs did not just like the idea, they endorsed it whole-heartedly. In Udaipur, one CIO quipped to me, "I have never worked so hard in a weekend as I did in the last two days. But at the end, I think it was my best ever weekend in years."

But this year was different. The pandemic did not allow us to get into that kind of gathering.

But the virtual mode allowed us to do these engagements multiple times, instead of just once in the offline mode. The groups of CIOs met anywhere between two to four times (for different topics) to finalize what they wanted to tell the community. Thankfully, some of our partners, too believed in this idea. They supported us wholeheartedly. HPE India, Archon, VMware, Tatacom and Netmagic became part of the program. And 64 CIOs and 13 representatives from the partner companies met multiple times virtually to finalize each of the sections and sub-sections of each of the chapters in this book.

When I thanked them in one of the discussion, a senior CIO protested. "It is our work. Why are you thanking us?" I apologized. So, I am not making that mistake again.

This book is theirs and theirs only—for their fellow community.

It is not difficult to explain why we chose Future of Enterprise as the theme. Post-pandemic, that was the most common question among everyone's mind. How would the future look like? This was natural, considering the shift in our lifestyles, working models and our perceptions of what technology could do.

That also explains why there are only a few topics that find their place in this book. These are the technologies they thought could make most of the impact in the New Normal. Digital transformation was now far more inevitable. And its course has been changed by the pandemic.

Ask any CXO what helped them to sail through these extraordinary times, many would credit technology. Ask them a bit more, and they would put the entire credit on 'cloud'—whatever it means to them. 'Whatever it means to them' – that is important and it explains why there are so many topics around cloud. Manufacturing companies who were lagging in digitization realized the value and the term Industry 4.0, hitherto a nice catchphrase became a serious topic of exploration. Artificial Intelligence was seen to be a game changer and the two industries most impacted by the pandemic wanted to embrace it as fast as they could. No prize for guessing – they are Healthcare and Pharmaceuticals, who fought the pandemic from the front.

The book is organized as eight chapters, each capturing the summaries, in terms of business value and justification of a technology, the use cases, the challenges of implementation, while offering tips on both decision making as well as taking the first steps.

The names of authors of each of the chapters are mentioned in the beginning of the chapters.

I acknowledge the contribution of all the CIOs (I do not dare thank them), the representatives of our partners, who participated in the discussions as well as their marketing people who made the program possible. Last but not the least, I thank each of my own colleagues who worked tirelessly behind the scenes to put it all together.

I hope, as a reader, this will help you to chart your path in implementing these technologies. You may use this as a reading material to understand more. Or you may use this as a reference to consult when you need something during your own journey.

Happy reading.

THE AUTHORS

64 senior technology leaders joined eight technology advisory committees (TACs)
to deliberate and finalize recommendations on eight technology areas.
13 representatives from our partner companies provided the industry perspectives.
Three moderators from 9.9 Group moderated a total of 23 TAC meetings.

Below each member name, the name(s) of the TAC(s) of which they were part
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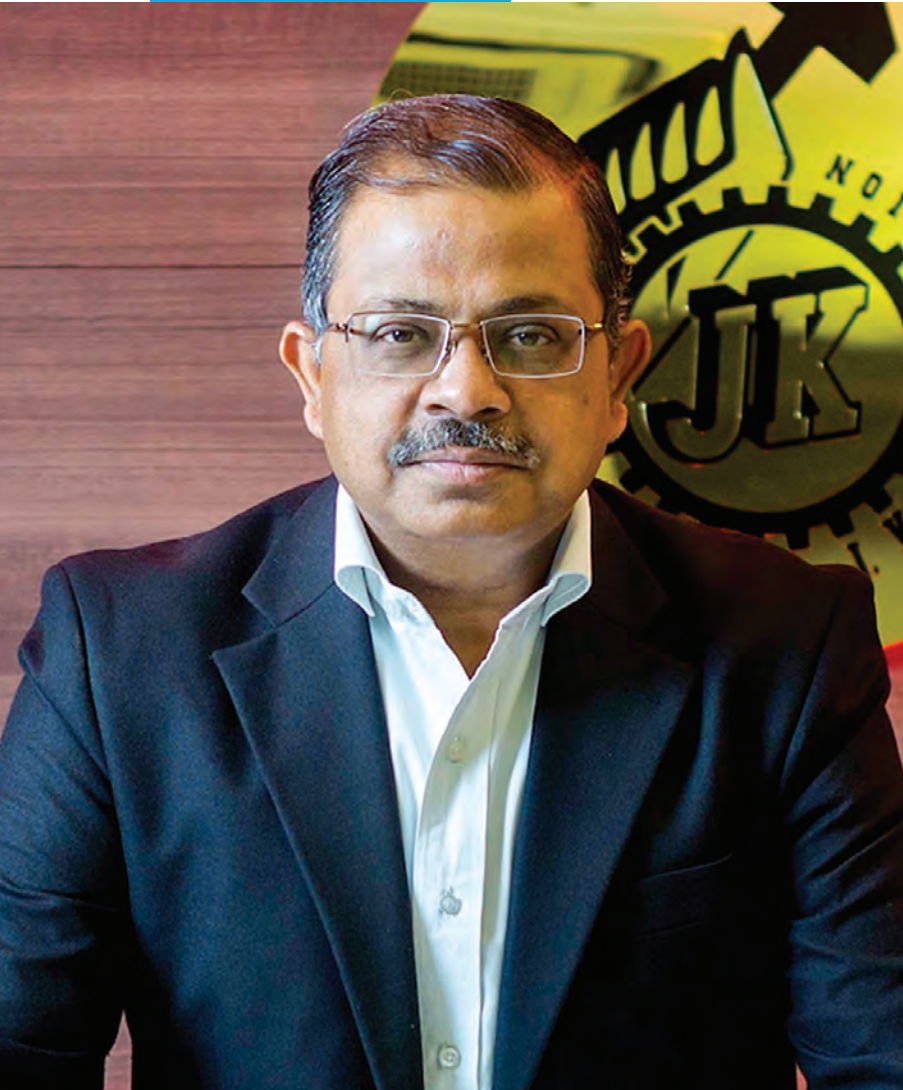
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"To make the future is highly risky. It is less risky, however, than not to try to make it"

–Peter F. Drucker
Management Guru

ACCELERATING DIGITAL WITH MULTI-CLOUD

Multi-cloud is clearly the way forward. The upsides are high. But the challenges have to be managed.

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ACCELERATING DIGITAL WITH MULTI CLOUD

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Operating multiple clouds has become a reality for most organizations. In most cases, this is not by choice but dictated by application requirements, especially modern apps that consume native cloud services. While this model offers choice to enterprises, it can very quickly become an operational nightmare if not planned well. Operational readiness for the multi-cloud environment can be achieved in multiple ways. A couple of them are mentioned here – easing out workload migration projects (with the ability to repatriate) and a common set of management capabilities.

The ability to extend consistent infrastructure from the data center to the public cloud (thereby creating a hybrid cloud environment) helps reduce complexity, speeds up migrations and delivers accelerated value. In addition, it ensures minimal business disruption in case workloads need to be repatriated to the data center. Top hyper-scalers and service provider partners today provide these hybrid environments as an extension to corporate data centers. Planning a successful multi-cloud strategy is easier when you select a cloud service provider who offers services that you know and trust. Being a VMware Cloud Verified partner, NTT-Netmagic fits the bill because they not only offer the complete VMware SDDC infrastructure, which you know and trust, delivered as a service, but also help to deliver a consistent and actionable view into cost and resource management, security and performance for applications across multiple hyperscaler cloud environments.

Traditional management tools haven't scaled well to adapt to the multi-cloud world. Running multiple toolchains to manage individual infrastructure pods leads to operational fatigue. A management layer that provides consistent operations across all environments that span across private & multiple public cloud environments is the need of the hour. Comprehensive visibility, programmable provisioning and cloud cost visibility/governance are the top capabilities that make up an ideal multi-cloud management solution. The cloud management solution itself is offered 'as-a-service' so that IT staff can focus on consumption rather than spending time on install/maintenance activities.

With the concept of 'shared responsibility' in the public cloud, security becomes even more critical. Visualizing cloud resource relationships and associated misconfigurations, threats, metadata, and change activity are paramount activities to keep cyber-incidents at bay. Shifting left on security without compromising the core benefits of speed and agility is a business need. VMware delivers on these capabilities to help customers drive accelerated value in a multi-cloud world with consistent infrastructure and consistent operations with intrinsic security ■

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M ulti-cloud adoption is increasingly becoming an established practice amongst best-in-class organizations. A variety of reasons including the need for agility, flexibility, competitive pricing, risk mitigation, avoiding vendor lock-in and need to leverage geographic presence is pushing its uptake.

Early cloud adopters started with a single vendor but as deployments expanded and gained maturity, organizations realized the benefits of working with multiple providers. The momentum in multi-cloud adoption is evident in several analyst reports. The tenth annual Flexera 2021 State of the Cloud Report found that 92% of enterprises have a multi-cloud strategy with 82% enterprises having a hybrid cloud strategy. The survey, comprising 750 technical professionals from around the globe and across verticals, found that cloud adoption had become mainstream with 61% planning to optimize cloud costs in 2021, making it the top initiative fifth year in a row.

What Is Multi-Cloud?

It is the practice of using multiple cloud vendors to achieve different business objectives. Typically, it means using different public cloud providers, but it also means combining different public clouds with private clouds and on-premises deployment. The second approach is generally referred to as hybrid cloud and is a preferred mode for many companies before embarking on its public cloud journey.

Often large organizations become multi-cloud adopters by accident as different departments may end up using different solutions. For example, the marketing team makes the decision to use AWS, while the HR department, operating in its own silo, decides to deploy Azure.

The Flexera survey found that 76% were incorporating multiple public clouds, while 56% were using more than one private cloud. The most common

combination is a mix of various public and private clouds, with 43% taking this approach.

So, what kind of use cases are used in multi-cloud? According to a 2019 SpiceWorks survey of 450 IT decision makers in organizations across North America and Europe to understand utilization of different public clouds deployment, the two workloads most likely to run fully in public cloud are websites/e-commerce sites (55%) and email (54%). Thanks to the dual, online-and-offline nature of products like Office 365, 41% of organizations reported running productivity apps using a hybrid cloud approach, where some workloads run locally, and some are on public cloud. Disaster recovery emerges as a best practice with multiple copies of critical data across geographies with 46% organizations employing a hybrid backup strategy by storing data both on-premises and on public clouds.

Multi-cloud solution may refer to the combination of models which includes software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS). The big advantage with multi-cloud is that it reduces the need for cloud migration as some data can remain on-premises while leveraging IaaS from one provider and SaaS from another. For instance, the organization may be using Salesforce as CRM and customize it by integrating the platform with Web and mobile while building micro-services to launch campaigns. The Web and mobile applications could be deployed on another cloud such as AWS or Azure as some cloud environments are tailored for specific use cases.

Different types of cloud services have benefits and disadvantages and are ideal for specific use cases depending on the level of flexibility and control the user organization needs. Below is a snapshot of the benefits and challenges of each cloud type.

IaaS: Offered by some of the largest technology companies, such as AWS, Google, Microsoft, Oracle, IaaS allows customers to readily access elastic compute, storage and database resources on a pay-as-you-go model making it an ideal use case for disaster recovery; unpredictable workloads such as marketing campaigns; dev and testing; high computing; and big data analytics. In IaaS, customer has full control over infrastructure provisioning and management of resources. As these services are accessed via public cloud, organizations sometimes do not like to deploy workloads that require high level of security and compliance.

PaaS: Platform as a service enables developers to focus on developing codes without worrying about provisioning underlying infrastructure where customers do not control the underlying resources. Similar to function as a service, PaaS applications are accessed via a browser and customers are charged on the basis of the resources consumed and can be deployed in private, public or hybrid environment. Typical use cases include API development and management; business analytics/intelligence; business process management; delivery mechanism for communications platforms; databases; Internet of Things; master data management. Given that PaaS uses shared resources, security risks are higher. However, large cloud providers are well equipped to deliver secure PaaS services.

SaaS: Software as a service or SaaS is the earliest form of cloud service wherein the enterprise consumes the software without any control or responsibility of managing the underlying infrastructure. The SaaS vendor manages delivery, security updates and software patching. The pay-as-you-go model charges the customer on the number of subscribers on a monthly basis. Common examples of SaaS offering include Salesforce.com and Office 365 comprising services, such as SharePoint Online, Exchange, OneDrive for Business, etc.

In the SaaS model, the vendor manages the entire solution, and the customer has little control over the software delivery and management and limited scope for customizing application.

Formulating A Multi-Cloud Strategy

The benefits of adopting a multi-cloud strategy are far more rewarding than partnering with a single vendor. Although the prospect of managing multiple vendors is daunting, it is worth the effort as a risk mitigation strategy. Having instant access to more than one cloud provider allows to take advantage of the most appropriate features without having to migrate complete workloads.

Making the correct multi-cloud choice is fraught with challenges as there are a many vendors offering a range of services and an in-depth assessment of each one's capability aligned with the unique customer needs will allow to make the right decision. According to the 2019 SpiceWorks survey, AWS earns top marks for maximum uptime, Microsoft Azure for compatibility, and Google Cloud Platform ranks highest for manageability.

Some things to keep in mind for a successful multi-cloud strategy include the following.

Identify Use Cases: Other considerations such as what kind of applications you want to run on which cloud and what specific business objectives you want to achieve are equally important. If you need your cloud applications to seamlessly integrate with various Microsoft tools that you already use, Microsoft Azure would be an ideal choice. If you are heavily reliant on running artificial intelligence (AI) and machine learning (ML) applications, you might opt for Google Cloud's AI open-source platform. If you are looking for breadth of offerings and an international network of data centers with minimal latency and privacy compliance in specific geographies, AWS is a good choice.

Cost Analysis: Service providers offer complicated cost structures, so it is important to understand which services are correctly aligned with your use case, adopt deployment best practices and leverage automation for continuous optimization. Detailed ROI analysis is important during the decision-making process to avoid costly migration of workloads at a later stage.

Cloud Adoption Strategy: After identifying the workloads to be migrated, identifying the best fit is important. Based on immediate and long-term goals, the migration strategy could be lift and shift; re-platform on the most appropriate cloud platform; refactor application to equip with cloud-native capabilities; re-purchase and use different licensing options by different cloud providers; or retire the application and build it from scratch to achieve different objectives.

Partnering Strategy: Selecting the right partner with requisite experience to help with the design, migration and deployment of cloud is critical. Selecting different cloud platforms may mean working with specialized partners in specific cloud platforms. Evaluating the partner carefully on the basis of use cases, talking to reference customers and examining the skill sets of individual team members are also important.

KPIs and Metrics: Working out KPIs and performance metrics is critical for the initiative's success. Since each cloud platform comes with different strengths, metrics must be designed likewise. It keeps the initiative on track and enables to take corrective measures in time. As the deployment matures and objectives change, these indicators must be updated to align with new realities.

Exit Strategy: Having a Plan B is always important, particularly in an initiative that has significant business

The big advantage with multi-cloud is that it reduces the need for cloud migration as some data can remain on-premises while leveraging IaaS from one provider and SaaS from another. For instance, the organization may be using Salesforce as CRM and customize it by integrating the platform with Web and mobile while building micro-services to launch campaigns. The Web and mobile applications could be deployed on another cloud such as AWS or Azure as some cloud environments are tailored for specific use cases.

impact. However, embarking on multi-cloud minimizes risks as workloads can be spread across cloud and if one platform does not work out, workloads can quickly be migrated to another cloud environment.

Selecting Cloud Service Providers And Services – Best Practices

Choosing a cloud service provider requires in-depth evaluation and critical examination on several fronts. Creating a detailed checklist and evaluating providers systematically based on the checklist are critical. Some

things to consider during evaluation include the following.

Cost: Pricing is a key criterion in evaluation and understanding each service provider's way of calculating cost is important—make efforts to understand how the compute, storage and network utilization is priced. Find out more about the compute resource – memory, speed, and other features; what kind of hot and cold storage services are available.

Performance: Application performance is dependent on the proximity of the data center, network performance within the cloud and in-and-out of cloud, I/O speed between compute and different layers of the cloud. Evaluate all these aspects while deciding which workloads to host on which cloud.

Technology Stack: Identify your needs and decide which provider's offering aligns best. If you are looking to leverage scalability and ease of managed platforms, you may want a PaaS provider. Whereas if you are looking for greater control and flexibility, go for IaaS.

SLA Guarantees and Reliability: Compare SLA of different providers. Read the fine print and figure out the uptime and availability guarantees. In most cases SLAs kick-in when the service fails and is not an indication of actual reliability. Do the groundwork to know the actual reliability of the provider by talking to customers and analyzing the vendor's dashboard which display health of critical services.

Check out API Compatibility: Evaluate whether the APIs exposed by the vendor are supported by other vendors, developer and partner communities to reduce dependency and lock-in. The more APIs that can be integrated, more flexibility, ease of use and better experience can be achieved while deploying workloads. The size of the developer community and the ecosystem working around the vendor's services are critical indicators of the maturity of the cloud service vendor's offerings.

Security & Compliance: Check the security and compliance accreditations of the cloud service provider and understand your role as a user. Security is a shared responsibility in the cloud wherein the user is largely responsible for allowing and managing access to resources and data. As a user, it is important to know and understand the security offered in different categories of

cloud services and what exactly is the user organization's role. Check out the tools and automation for monitoring, alerting and auto-remediation capabilities.

TCO Calculator: Do a TCO calculation by evaluating your business requirements and mapping it with the best resource of the provider. Most providers offer a TCO calculator to assess the cost of an approximate workload. But there are hidden costs, such as the cost of managing the deployment, manpower and expertise required for new technologies. Understand different pricing methodologies of the vendors and take advantage by combining spot pricing with other pricing mechanisms.

Designing Cloud-Native Applications

Just migrating legacy applications will not yield the benefits of cloud like scalability, availability, high performance, and continuous compliance. To truly achieve transformational benefits of cloud, applications must have cloud-native capabilities with the following attributes.

Leverage APIs: Cloud-native applications expose APIs for faster integration and extension capabilities.

Micro-Services Architecture: Applications have a micro-services architecture wherein services are loosely coupled, making applications agile and scale independently.

DevSecOps Practices: Using DevSecOps practices, applications are continuously enhanced in an automated manner, enabling faster innovation. Development and security teams work in unison to design and test codes continuously to release secure and quality software at high velocity.

Serverless: Applications leverage serverless technologies to design and develop high-quality code at speed and scale.

Containerization: Applications leverage containers to achieve application portability across environments, higher resource utilization, enhanced security and easy manageability.

Managing And Optimizing Workloads In Multi-Cloud

Managing multi-cloud environment is challenging and requires expertise and experience. From ensuring visibility across cloud platforms, optimizing resource

The beauty of cloud is that it enables continuous improvements with tweaking and increased automation. This can be achieved via close monitoring of resource utilization and application performance to analyze and understand whether a particular resource is running on the appropriate resource.

utilization, adhering, and achieving compliance, guarding against security breaches to avoiding a cloud sprawl, the task of managing workloads across clouds can turn into a nightmare and dimmish the benefits altogether. Managing multi-cloud is not for the faint-hearted but it is achievable with a systematic approach and equipping the organization with tools and technologies to provide visibility and automating management of key parameters.

Central Cloud Management: Organizations must leverage a cloud management platform centrally to monitor and manage workloads across environments. Visibility on the central dashboard will track resource utilization and help prevent cloud sprawl. You can tag resources to specific workloads to keep track of utilization and mark out underutilized assets. A central platform to provision resources and turn them off when not in use, record events for audit and analysis and monitor performance, latency and compliance requirements from the same dashboard significantly reduces the complexities associated with managing multi-cloud.

Automate Configuration and Deployment: Launching environments via code helps standardize environments while allowing greater control over compliance and resource allocation. Any deviation will lead to launch failures, send alerts to the concerned administrator and deny access to the user. Automating configuration helps in resource allocation and restricts the use of specific resources to individuals.

Benchmark Service Levels: To effectively manage multi-cloud environments, organizations must design and develop a set of benchmarked SLAs that are consistent for all resources. When service levels are non-standard, it becomes extremely challenging to provide a uniform set of services consistently to business stakeholders.

Optimizing Deployment: The beauty of cloud is that it enables continuous improvements with tweaking and increased automation. This can be achieved via close monitoring of resource utilization and application performance to analyze and understand whether a particular resource is running on the appropriate resource. Sometimes this may require right-sizing of resources to add or subtract compute power or move to a different service that offers faster network performance. Sometimes, it may call for re-architecting the deployment using different strategies, such as auto-

Multi-cloud is an exciting proposition for organizations looking to ride the heady benefits of cloud to innovate continuously at speed and at scale. While many organizations are drawn to multi-cloud for obvious benefits, it is important to calibrate adoption with caution, in a measured manner with meticulous planning and understanding of the services and tools.

scaling, load-balancer, and adding a caching layer to enhance application performance.

Governance, Compliance And Security In Multi Cloud

Security challenges in multiple clouds are significantly enhanced as there is a larger landscape to secure. Management challenges such as absence of visibility across clouds and inability to synchronize security policies across environments as each vendor has its own set of controls further complicate security goals.

Providers use different methods to protect cloud resources. For instance, AWS utilizes security groups and policy-based access, Microsoft Azure uses network security groups on interfaces and subnets and Google uses firewalls but none are comprehensive security mechanisms so it is important to understand what technologies providers employ and design security methods that fit in with individual business requirements across multiple clouds.

User organizations must understand that security in the cloud is a shared responsibility wherein the user has a significant role to play in terms of controlling access and security settings. Gartner estimates that by 2022, at least 95% of the cloud security failures will be due to misconfiguration, which is the customer's responsibility. Gartner says an important question while using the cloud must be, 'Am I using the cloud securely'. The bottom line is that customers must protect their own networks and applications by taking advantage of the tools and services the provider offers.

Operating in a multi-cloud environment increases the risks as customers must not only understand different provider security mechanisms but also play catch-up as new services, such as serverless, Kubernetes and containerization are being offered which require different approaches to secure workloads.

Having a consistent security policy across multi-cloud helps to standardize best practices and enforce better adherence. It is better to manage and monitor security policy from a central platform with the help of a managed service provider. Role-based access to resources combined with multi-factor authentication, code-based launch configurations, encrypting data in storage and data in transit are some best practices that must be uniformly enforced across different cloud environments.

Use more automation to ensure compliance and build in security processes for continuous compliance. Leveraging code-based policy and launching configurations, tracking logs and monitoring tools that track security and governance policies, enable holistic compliance. Third-party tools with advanced monitoring capabilities can identify anomalous behavior and raise alerts when deviant behavior is detected and take auto remediation measures, such as blocking access to the deviant user, prevent traffic flow from a specific port, etc.

DevSecOps practices, wherein security is continuously tested along with codes testing, is necessary to release high-quality secure codes at speed. As a practice, DevSecOps not only secures the organization but also reduces technical debt as security flaws are detected early in the development chain and rectified continuously. ■

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"Most organizations adopt a multicloud strategy out of a desire to avoid vendor lock-in or to take advantage of best-of-breed solutions. We expect that most large organizations will continue to willfully pursue this approach."

–Michael Warrilow,
VP Analyst, Gartner

AI/ML IN PHARMA/ HEALTHCARE

AI is a great tool. But given its disruptive power, any AI journey should start with preparing the organization culture for it—just as on technical side, the prerequisite for AI is data. Good data today could lead to good value from AI tomorrow.

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AI/ML IN HEALTHCARE/ PHARMA

PARTNER SPEAK

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  Country Manager - AI & Data Services, HPE India

- **Durgaprasad Tantry**
  Director, Archon Consulting Systems

From Data → Intelligence → Knowledge → Wisdom, the famous DIKW Model tried to map this ongoing quest.

"Artificial Intelligence" is the latest technology that has driven Innovation acceleration in most industries and organizations. AI is the new frontier in Healthcare and Pharma and discussing about it can be an interesting conversation!

Escalating demands in healthcare and pharma are rapidly changing the way organizations treat patients, do drug discovery, drug production, support caregivers and staff, and share information and have caused organizations to rethink their clinical and operational processes. The dependency on Data and its availability for all users on time is becoming the corner stone for AI adoption.

In India, technologies and tools like AI are helping Healthcare and Pharma organizations to adapt and improve their operations in several areas. The panel identified some of the key areas as below:

- Pharma Drug Discovery processes like lab applications, decision on clinical trial, Clinical Data Analytics
- Manufacturing processes
- Supply Chain and Corporate processes
- Sales Analytics
- Patient Wellness at OPD for auto sorts diagnoses, investigations and medication prescriptions based on previous documentation (line of treatment)
- Patient Diagnosis for early detection/diagnosis, risk prediction for timely intervention, illness monitoring
- For OT with Robotics in Surgery

To accomplish these goals, organizations are creating a technology environment to boost clinical and operational efficiency, accelerate drug discovery, safeguard sensitive health data, and enhance standards of care. AI as a technology promises a lot of help here, however, the Healthcare and Pharma industries must overcome significant obstacles to succeed with technology.

The views expressed by seasoned industry experts include:

- IT-OT issues in the Drug manufacturing process
- Maturity of technology in the Drug Discovery area
- Data Integrity across Pharma and Healthcare industries
- Ownership of Data/Data interoperability &standards
- Risk aversion/Privacy and Compliance needs
- Culture/Trust and unrealistic expectations of accuracy for AI models
- Availability of skills

Key takeaways during the discussions that helped evolve to a framework to proceed were based on 3 fundamentals:

Key takeaways during the discussions that helped evolve to a framework to proceed were based on 3 fundamentals.

1. **Developing an Intelligent Data Strategy -** understand data sources, normalize data for interoperability and have a single source of truth
2. **Standardization -** for data capture, storage, and with API data-based exchange, open standard based architecture
3. **Process Optimization -** for Data life cycle management and governance, Data access and security framework, Compliance & Audit ■

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Artificial Intelligence (AI) is the single-most important technology disruptor in business today. If Information Technology made its first visible impact in the process layer in business, followed by significantly impacting the product layer, through AI, it has started impacting the strategy layer in businesses.

Still nascent in their applications, AI and Machine Learning (ML) promise to transform all aspects of businesses – from strategic decision-making to shopfloor operations. Almost all industries see AI as a huge value creator. The investments in AI/ML are being driven from the top, unlike most other technology investments. According to a report by Fortune Business Insights, global AI market size is expected to increase from USD 27.23 billion in 2019 to USD 266.92 billion by 2027, with a CAGR of 33.2% during the forecast period.

What differentiates one from the other is their preparedness in terms of data readiness, their historical experience in use of technology and the flexibility that they have for using data the way they like (read regulation).

Both healthcare and pharmaceutical industries stand out from others, when considered on these aspects. Value of data is immense for both, they have not been the most advanced users of technology and both are heavily regulated.

Of course, the last few months have been very different for all businesses. Technology investment, to a great extent, has been impacted by the way the pandemic has impacted a specific industry. According to McKinsey's State of AI in 2020 report, released in November last year, 44% of healthcare, pharma and medical products companies want to increase their investment as an impact of COVID-19, the highest among all industries, and more than one and half times more than the percentage of companies in financial services industry—the most mature IT user—who see doing so.

The global AI in healthcare market size, valued at USD 6.7 billion in 2020, is expected to grow at a compound annual growth rate of 41.8% from 2021 to 2028, significantly higher than the rate at which the overall AI market is growing, according to a report by Grand View Research. The key growth drivers for this market are increase in the inflow of patient health-related digital data, growing pressure for cutting down healthcare spending, and rising demand for personalized medicine are some of the key factors aiding revenue growth in the market.

No surprise, the global AI in healthcare market size, valued at USD 6.7 billion 2020, is expected to grow at a compound annual growth rate of 41.8% from 2021 to 2028, according to a report by Grand View Research—significantly higher than the rate at which the overall AI market is growing. The key growth drivers for this market, according to the report, are increase in the inflow of patient health-related digital data, growing pressure for cutting down healthcare spending, and rising demand for personalized medicine are some of the key factors aiding revenue growth in the market.

Scope
The scope of application of AI/ML will be restricted only by imagination, in any area. Six major factors should determine the AI roadmap of any company. They are:

1. Vision for change through AI at the top
2. Business requirement in terms of priorities/challenges
3. Organizational readiness in terms of culture
4. Technology/Data readiness
5. Prevailing sectoral and data privacy regulations
6. Approach

While the first five are self-explanatory, 'approach' here refers to how to go about executing it, especially the sequence.
Some of the various ways are:
■ Starting small projects whose success can serve as exemplars
■ Starting with low-hanging fruits first, to build confidence and acquire learning
■ Starting with a disruption/value analysis and going with the ones with highest value/lowest disruption ration, or something similar
■ Starting with a business function and
■ Combinations of any two or more

Regulatory requirements are extremely important considerations for both healthcare and pharma industries.

Scope for Pharma
While both pharma and healthcare are regulated industries, pharma is more global than healthcare and hence the regulatory requirements are more similar across the world, if not the same.
The three axes on which the pharma industry practices rest are data integrity, product quality and patient safety. These three axes, at any point are at an equilibrium, created through Standard Operating Procedures (SOPs). Anything that can potentially change that equilibrium will have to pass through the filters of all the three while evaluating the risk/reward from the initiative. AI, which replaces human intelligence through machine intelligence, is no exception. Since often the AI algorithm is opaque and/or beyond the comprehension of the regular stakeholders, it is difficult to ascertain with surety how it may impact any of the three axes.
As such, like in many business, AI can be applied in

various business functions. But being a data intensive business, the value that AI can bring in pharma could be far more. A pharma company business value chain consists of four specific components – R&D, manufacturing, supply chain and front end sales. These are all peculiar to pharma industry. Of course, then there are typical corporate functions, such as finance, HR, IT and marketing which are very similar to other industries and so we do not cover them here.

In each of the four functions, there are multiple ways AI can be applied to create value.

The world has just witnessed a health emergency, where more than anything else, the need was to get a vaccine in a few months, as compared to normal 7-10 years. As new such problems occur, AI may provide a helping hand by accelerating the drug discovery process. For example, AI can be used for accelerating target identification and validation, leveraging advanced AI imaging capabilities that can detect cell morphology changes not detectable by human eyes through microscope. Also, a huge use case can be accurately generating genetic evidence for target identification, thus preventing expensive failures in the later stage of drug development. AI is already helping in molecular design through what is called generative modelling. Clinical trials can be optimized using AI techniques. For example, AI-enabled tools can be used to better understand profile of responses during trials. The whole process can also be accelerated by integrating data from multiple trials. IT services companies are already using advanced analytics and AI techniques for clinical data management. Right from labs to approval, AI can expedite the pharma drug discovery process. Many pharma companies are also using the publicly available data from sources like US Center for Disease Control and Prevention, Dept of Veteran Affairs, IMS Health, etc to decide the next products.

While manufacturing use cases are somewhat similar to other manufacturing industries, there are specific industry-specific use cases. They include predicting and controlling batch quality or proactive quality control/anytime audit, yield predicting and automating processes using RPA to automate batch release, as a low hanging fruit. In addition, in many other industries like chemicals and fertilizers, it can be used to enhance safety of workers.

Similarly, supply chain applications of AI are common with most other industries like expiry-linked inventory management and prediction, self-healing and even prescriptive supply chain optimizations. The second wave of COVID-19 has exposed the vulnerabilities of our medical supply chain. AI can greatly enhance the efficacy. In fact, over a period, with right data, AI can be used for vendor selection too.

In the front-end, the most common AI application is sales planning and forecasting, which were one of the first analytics work to be outsourced to specialists. Since it was left to specialists, the area has seen rapid growth of technology applications. This leads to sales representative effectiveness, enhancing sales in specific regions and even optimizing supply chains. With most medicines now being sold online, the data available is cleaner and analysis and forecasting based on that data could even maximize offline sales in particular regions. Many companies are beginning to use it for doctor profiling too to help marketing representatives more effectively engage with them. All these sales optimization is of course, in addition to, typical marketing optimization for over-the-counter drugs and fast moving healthcare products.

Scope for Healthcare

Like pharma, healthcare is a regulated industry. But the similarity ends there. Healthcare is a highly local and fragmented industry, unlike pharma. In many countries including India, the government-operated healthcare facilities still dominate. So, except for a few large private hospitals, technology maturity in healthcare is still very low.

So, despite very tangible and attractive use cases for AI in healthcare—the research on AI in healthcare is perhaps second only to AI in natural language understanding—they remain mostly on paper, because of practical challenges, biggest being lack of availability of quality data. With data privacy legislation in the offing, it will bring about a whole new set of challenges.

The potential to value-add through AI exists across the healthcare value chain, namely:

- Patient acquisition/Patient enrolment
- Wellness/Preventive healthcare
- Diagnosis
- Treatment & Recovery
- Post-treatment patient care/Monitoring
- Claims & payment
- Administrative functions

In a typical healthcare setup, AI can be used in several ways. A system can learn clinician's documentation patterns and can automatically sort diagnosis, investigations and medication prescriptions based on documentation of previous line of treatment.

It can automatically code from the clinician input and write descriptive narratives using standard medical dictionary. This can dramatically improve quality of prescription with reduced efforts in documentation and will be of great help in reducing medication errors. For a country like India, with such a low doctor to patient ratio, it can dramatically improve both efficiency and quality of healthcare.

One of the biggest unnecessary expenditure that the patients incur in a poor country like India is in carrying out unnecessary tests, most of which may not contribute significantly to the actual treatment. AI models can be designed using volumes of patient information from healthcare systems along with pharmaceutical data to predict likely test results for a given patient.

But where AI can be the big game changers is in early diagnostics. According to medical experts, the emergency situations in Delhi and Bengaluru during the second wave of COVID which led to many deaths due to unavailability of oxygen and beds could have been completely avoided had these patients received early treatment. The hospitals would not have seen the rush situation and the really critical patients could have got far better treatment. Doctors who were struggling to attend to patients could have channelized their time and energy for those patients.

It is said mortality from sepsis increases by 8% for every hour of delayed treatment. AI-driven early diagnosis based on routine vital signs, laboratory results and metabolic levels from EMR can highlight patients at high risk of sepsis.

In operations theatres, robots are in use for surgeries for a fairly long period now and in the near future, AI-enabled robots will further assist surgeons to deliver better surgical interventions by reducing risk and making surgery safer.

Another major area where AI can bring dramatic positive changes is in mental health. A neglected area in India, mental health programs can combine AI and principles from cognitive behavioral therapy to track moods like anxiety and depression by taking cues from person's voice. For example, talking in a monotone can be a sign of depression; fast speech can point to mania; and disjointed word choice can be connected to Schizophrenia. An AI system can assess those sound bites for signs of mental distress, by analyzing how they compare to the individual's previous responses. There are other tools also which are monitoring Dementia, and Parkinson's by using vocal analytics.

In addition to these clinical areas, AI can help healthcare providers in many other business functions.

But areas where it can add significant value include post treatment care, which is a mix of clinical and non-clinical operations and in managing claims and payments from health insurance providers. Of course, long-term decision-making can be facilitated by right use of AI. Diagnostic companies can even use AI for optimizing their marketing activities.

In addition to these examples at a micro level, there is increasing opinion to use AI in healthcare at a macro community/national level to predict, prevent and manage outbreaks of large health emergencies like the COVID second wave horrors that we, as a country, experienced recently. In fact, many experts have recommended using AI for predicting the outbreaks. Sutra, a forecasting system made by an academicians, has been fairly good in forecasting, even with limited data.

Many experts opine that a connected healthcare system and interoperability of data are necessities today which will facilitate seamless data transfer. One positive fallout of that will be there will be significant volume of data which can be anonymized and released

The challenge an organization faces while starting an AI journey stems primarily from three factors - fear, regulations and preparedness.

for research – both medical and for policy making and disease prevention.

Challenges in Implementing AI

Any new technology faces its own challenges. But AI's case is slightly different as it represents a new shift in technology.

The challenge an organization faces while starting an AI journey stems from primarily three factors – fear, regulations, and preparedness.

The fear is fuelled, to a great extent, by the misconception about AI. We have not seen something like this for long – since the first wave of automation, then famously called computerization. Just as people feared job loss because of that, many—and that includes doctors to journalists, business analysts to teachers—fear their skills would be redundant with the advent of AI. While normal resistance to change is seen with all new technologies or practices, there is an element of fear and suspicion about AI and machine learning.

In most regulated industries, introduction of new technologies always is a little cautious. Of course,

First Steps

Here are some suggested first steps:

1. Build awareness/get stakeholder buy-in

- Build realistic expectations about when to take into production
- Validation cycle is fairly longer (could be as long as 2-3 years)
- Build confidence with historical data available
- Accuracy levels (high accuracy) more important than time-based ROI measurement
- The ideal accuracy levels could be different for different applications
- Risk vs Accuracy (a clear map/chart to be shown)
- Current accuracy can be a starting benchmark

2. Be clear about where you are looking for impact

- Cost
- Revenue
- Workforce effectiveness
- Risk & compliance
- Accuracy & speed

3. Assess where you stand in data and getting the data ready/data strategy, with all these considerations in mind

- Data collection
- Data sanctity check
- Storage
- Governance/privacy issues
- Structuring data

4. Think strategic, start with smaller initiatives

- Decide what is the objective - should ROI be the focus in all projects, as that may hamper innovation
- Test & learn - hypothesis and test
- Could be end-to-end in a particular area. Doesn't mean that it can be blindly applied across areas
- Show results

5. Create digital platforms
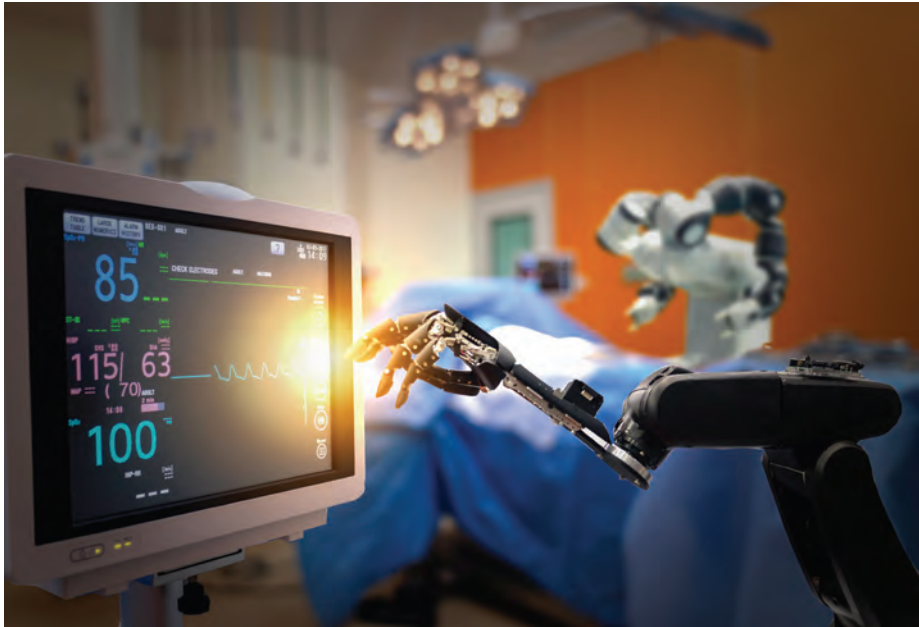
AI is like the mythical brahmastra. It can do wonders at the hand of the right people. Don't forget, with all its greatness, AI is not our master. Human beings are still the master. AI is still a tool. Nevertheless, a tool like we have seen never before.

Pharma and Healthcare do fall among those industries. But what is more challenging now for AI is the horizontal data privacy regulations, which makes the use of data extremely streamlined. In India, the major data privacy regulation is still not legislated, but no one wants to take a big chance and sink in investments.

The third—again common to both these industries—is preparedness, read data readiness. While the first one is clearly beyond the CIO's sphere of influence and the second only partially their responsibility, data readiness is completely a CIO's responsibility. Not surprisingly, this is being discussed the most. Also, there is a realization—and quite rightly so—that the fear about AI cannot be eliminated overnight, and some

implementation can be done that are less disruptive but create significant value, there is no alternative to getting data ready for doing anything worthwhile in AI.

Challenges for Pharma

Like opportunities, challenges to AI implementation in pharma companies is across the value chain. In an R&D intensive business like Pharma, a big hindrance is culture. We have seen that while outsourcing of specialized services like engineering design. Take manufacturing. Predicting the batch quality based on past data is a fairly low hanging fruit that in no way disturbs data integrity, product quality and patient safety. But when asked about the accepted levels of accuracy, the stakeholders often look for 100%, never mind what the current levels are. This is less about expectation and more about low confidence and unwillingness to change. But any AI tool will work on data. It will become better and better with data. So, 100% first time is almost a theoretical impossibility.

Many of the challenges that AI faces in traditional manufacturing industries are also valid concerns for pharma manufacturing. Integration of IT and Operational Technology (OT) is as big a challenge in pharma industry as it is in any other discreet manufacturing industries, if not to the same extent as process manufacturing industries.

Data availability in strategic areas is a problem. While pharma companies may be as good as any other global companies when it comes to corporate data, when it comes to data from manufacturing MES or even clinical trials – that can make transformative changes – data availability and quality is a problem.

Challenges for Healthcare

Healthcare's challenges for rolling out AI are far more.

Being a fragmented and localized industry, there are not too many large players. Level of IT maturity is fairly low. While many large hospitals have good levels of IT maturity for their non-clinical operations, the core processes, despite dependence on hi-tech medical equipment are relatively isolated from enterprise IT, as in manufacturing.

Like pharma, there is a culture/mindshare issue in healthcare. If anything, it is more. Doctors often see AI as a threat and are not comfortable using automated tools. While the low-hanging applications like converting manual writings to codes through OCR are being done, they are, at max, efficiency enhancers. One of the challenge there too is lack of available skills among technicians and even doctors when it comes to IT.

There is a huge mindset issue. While most doctors explicitly expect 100% accuracy in diagnosis, the current concurrence among multiple diagnosis is not more than 75%. In a study by the US National Center for Biotechnology Information, in April 2020, it was found that an AI system detected 17 out of 25 COVID-19 positive patients based on normal CT images, whereas professionals diagnosed all patients as COVID-19 negative.

Size of data is one of the most important prerequisites for AI. None of the healthcare providers have the kind of data to build a robust AI system by themselves. Since there is no data flow among the players, it is very difficult to build robust models. Data interoperability is still an idea. There is no national health information system that connects the hospitals. While there are efforts to do that at the government level of late, the technology is too primitive in those hospitals, with few exceptions, to try something like AI.

On the regulation front, ownership of data is a big challenge. Personal health data has been categorized as sensitive personal data by the draft Personal Data Protection bill and their usage would be highly regulated.

But beyond quantity and ownership of data, data quality itself is a challenge, thanks to high share of manual processes. In fact, that is probably the single biggest challenge healthcare businesses have to overcome before they do anything meaningful on AI front.

Critical Success Factors

Looking at the huge transformative ability of AI in both pharma and healthcare business and the numerous challenges that organizations face with walking on the AI path, the companies should keep in mind certain critical success factors.

Clear objectives/outcomes: While any project should have clear objectives and outcomes, in case of AI, the possibilities are so much and the disruptive ability too is significant. So, all plans should be well thought out. The beginning of that is setting clear objectives and clear outcomes for each of the objectives. Without clear objectives, AI could go haywire.

Clear data strategy: Good data is the prerequisite for any AI journey. So, even before setting objectives, organizations should consider a clear data strategy. That is especially true in these two industries where there is some way to go for getting data in place. The gap in data quality is far more acute in healthcare, as many

of the critical clinical data is still written manually. There are three components of a clear data strategy: data readiness, data management and clearly defined governance with easy and right access to data, while ensuring data privacy.

Cultural change/readiness/ownership: An AI project, unlike say, a cloud migration project, is clearly in the business domain. The ownership should clearly be of the people who will benefit from people and whose data would be considered, and whose process would be impacted because of AI projects.

While it is important for the stakeholders to take ownership, some of the cultural/mindset change has to happen with a lot more people. Right sponsorship at the CXO level is a must for success of AI in any organization.

Resisting the tendency to blindly replicate: To each his own. There is no short cut to AI projects. The tendency to blindly replicate from other geographical markets, other industries and even other companies in your industry may not work. While certain best practices in managing AI projects can be emulated, when it comes to building models, it has to be organization specific.

Transparency: The flow of logic should be traceable, both for regulatory and future diagnosis purpose.

Time Has Come

Businesses compete on data today. Beyond the competition, we saw the need for AI in pharma and healthcare in ensuring wellness and even survival of human beings. We have seen huge challenges each in pharma and healthcare industries recently during the COVID outbreak. Pharma supply chain gaps were exposed severely. Similarly, our healthcare system was at the verge of collapsing. While we could not build a robust world-class healthcare system overnight, we could manage it much better—with the help of AI. Just two use cases – early diagnosis of patients at home and using data to predict the timing of outbreak could have gone a long way in avoiding a situation like what we faced in Delhi, Gujarat, Haryana, Karnataka and UP.

AI is like the mythical Brahmastra. It can do wonders at the hand of the right people. Don't forget, with all its greatness, AI is not our master. Human beings are still the master. AI is still a tool. Nevertheless, a tool like we have seen never before. ■

APPLICATION MODERNIZATION

Application modernization must be accompanied by a comprehensive data strategy wherein data is collected in a central repository and accessible to all users

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APPLICATION MODERNIZATION

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Applications represent the Digital efforts of an organization and hence we are seeing modern applications leveraging cloud technologies getting bolted up to the critical application stacks. A large portion of applications that are critical are not cloud ready.

Today, having agile processes around application development and deployment is crucial for business success. Enterprises are increasingly looking to containers and microservices architectures to enable their developers to build and deploy applications that support new business opportunities while expanding existing business rapidly and easily. While it is relatively straightforward to deploy cloud-native applications in containers, most enterprise applications are still non-cloud-native, with monolithic architecture and persistent data storage.

The typical challenges that we saw during our interactions and discussions largely fall under these categories:

- People and Culture – Change is led by people
- Multiplatform – Integration and Consolidation
- Don't fix what is not Broken – a Pragmatic and grounded approach to modernization
- Tech Skills – Getting the right skills for the transformation
- ROI and Cost effectiveness of the project
- Governance, Risk and Compliance

Today's technology and businesses should provide for these challenges to ensure a successful transformation. So how does this road to success look like?

Applications that are moving to the Hybrid world often require modernization to fully leverage what the cloud offers in agility, scale, and performance. New software development paradigms, frameworks, and architectures need to be considered, such as higher performance, improved efficiency of resources, increased cost savings, auto scaling and load balancing for greater scalability. Today we have technologies that help you to provide a unified platform for various application types and additionally addressing underlying storage complexities for this new world. Leveraging the cloud technologies and providing the same experience these technologies help in providing enterprise grade security and control, scalability, and management across the new world IT needs.

The best way to implement such project would be use frameworks that ensure success. The minimum viable product approach was suggested by HPE during the discussions which helps transform your application for optimal cloud/ cloudlike operation using an agile build of MVP features.

In conclusion, all organization need to thread thru' this modernization journey and following the right application architecture based on current business needs, deploying the right tools and skills to transform to the new operating business model, building the right automation to be agile and resilient along with the right hybrid technology. ■

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A pplication modernization is an imperative to adapt and thrive in a dynamic business environment. Built on a foundation of digital transformation, organizations in the new economy are agile and equipped with responsive systems that enable to create new services and manage customer touch points on a continuous basis. Spurred by these capabilities, businesses can experiment frequently to create opportunities, tap new market segments and launch disruptive business models.

In contrast, businesses shackled with ageing technology are slow, inefficient and do not scale easily. These systems were built to harness a different set of objectives and worked well for that time and enabled organizations to enhance efficiency, productivity and cost-efficiency. As businesses expanded and new technologies arrived, more applications were added to achieve specific objectives. But the organizations ended up having sprawling deployments with outdated technology.

These systems operate in a heterogenous environment that do not communicate with each other with the result that often business units operate in isolation. Over time, the returns on investment began to diminish as monolithic systems are rigid and hinders agility. There is no single view of data and decision-making was unreliable; innovation was sporadic in the absence of comprehensive data management system; and the cost of managing these monolith systems spiralled up.

It is not that IT investments waned, but an increasing proportion of the IT budget went into improving operations and managing legacy systems than in value creation. One IDC estimate puts the figure of maintaining legacy systems at more than 78% of the IT budget with increasing difficulty in finding replacement hardware, software and people with skill sets to keep the old systems running.

Characterized by high degree of automation, modern applications have superior codes and embedded security with automated testing and release processes. These applications embody cloud characteristics of speed and scale; they are decomposed and built on a foundation of micro-services architecture; APIs are exposed for easy integration with other systems.

Modernization did take place with different semantics—it included initiatives such as moving an application from mainframe to another system; upgrading a system that had reached end-of-life; replacing an application that was no longer supported. Ironically these modernization efforts were very expensive and time consuming and sometimes projects took so long that deployment became outdated by the time it was in production.

These initiatives were primarily aimed at keeping the lights on, and reducing the cost of maintaining old systems and did not result in significant business impact. More importantly, migration took place within similar target environments and did not deliver new business capabilities. That was then.

A New Reality

Things began to change with the maturity of cloud-based infrastructure and services which delivered disruptive capabilities. Adding insult to injury, digital-natives and digitally transformed organizations began to unleash innovation at speed and scale, exposing the limitations of monolithic applications which were not architecturally designed to deliver scale.

Usually written in outdated languages, maintaining legacy applications were expensive and organizations could no longer rely on legacy applications with occasional modernization efforts to tweak existing capabilities. Left with no choice, businesses must truly embrace the agility and scalability of cloud-native applications to deliver continuous value.

Characterized by high degree of automation, modern applications have superior codes and embedded security with automated testing and release processes. These applications embody cloud characteristics of speed and scale; they are decomposed and built on a foundation of micro-services architecture; APIs are exposed for easy integration with other systems.

Modern applications leverage DevOps principles, serverless and containers. They can integrate with open-sourced tools and applications and amplify capabilities. Organizations, technologically equipped, are accelerating idea to innovation and are flooding the market with new applications. So much so that IDC predicts by 2023, 500 million new digital apps and services will be developed and deployed —equivalent to the number of apps and services created over the past 40 years.

These changes are accompanied by the advent of Big Data and Analytics ushering in a shift from product and service differentiation to application of knowledge and information. Digital and the ability to capture customer journey; together with easy access to compute and storage resources have enabled businesses to mine infinite amount of data for insight-based decision-making. As a result, organizations need agile systems and responsive IT department to harness data as a competitive advantage.

New Paradigm in Financial Services

As early adopters of technology, financial services have been at the forefront of disruptive innovation delivering online facilities and enabling secure financial transactions and digital wealth management services way before other sectors had leveraged the Internet

for customer engagement. At the same time, the sector leveraged technology for efficient loan disbursal, increase operational transparency and accelerate financial inclusion to underserved segments.

Yet the sector struggled with modernization efforts. Bogged down with layers of systems and processes underpinned with legacy infrastructure, IT systems of large banks comprised hundreds of applications and any modernization initiative would need to take into consideration a complicated network of dependencies— package implementations including core banking solutions, point solutions, custom applications and software-as-a-service solutions.

Disparate IT systems come with many baggage including inefficient operations, collaboration challenges and lack of visibility into customer engagement opportunities. This weakness has become more evident with the onslaught from fintech exploiting data-based insights to launch new services such as digital payments, stock brokering services and online platforms that facilitate loans and credit facilities. With increasing consumerization of technology and fast pace of change, banks and financial services companies must undertake application modernization to remain competitive.

Finally, market dynamics within the sector resulting in frequent mergers and acquisitions have necessitated app modernization to seamlessly integrate disparate systems.

Compliance and Regulatory Drivers for Application Modernization

If data is the currency of the new economy, it is also the most coveted business asset and therefore most vulnerable. There are more security breaches now than ever before—the first quarter of 2020 saw a 273% increase in exposed data compared to the same quarter in the previous year, according to a report by Cyber Risk Analytics and Risk Based Security. These breaches were due to hacking, indicating the dangers of external aggression.

Data privacy laws have become stringent and meeting security and compliance have become a key driver for application modernization. As digital becomes pervasive and more businesses get connected, vulnerabilities have increased exposing the organization to greater risks. Strengthening the security posture with modernization is deemed necessary to mitigate risk, meet with customer's privacy expectations and achieve regulatory compliance.

More businesses understand that security has strategic long-term implications and are reassessing the risks associated with legacy applications such as the rigidity which do not allow to make changes easily; and lack of visibility across disparate systems, making businesses vulnerable to attacks.

Given the financial implications, these imperatives are more critical for banks. According to a report by Lexis-Nexis Risk Solutions, 41% of 171 senior financial crime professionals in the UK have expressed concerns that legacy systems create technological obstacles to fight financial crimes with 43% expressing frustration in facing difficulty in exchanging data between disconnected systems.

A large number of legacy applications are custom written and people who developed and maintained these applications have left the organization. Also, legacy applications are written in old programming languages and it is huge challenge to find people with required skill sets for ongoing maintenance. Finally, legacy applications require downtime for maintenance, updates and new releases and is becoming a burden in some sectors such as financial services and airlines industry, which require high availability and uptime.

Implementation Challenges

Even the best prepared organization can face road blocks during an application modernization initiative. Below are a few common challenges and can be addressed easily with due consideration:

■ Resistance from end users who are comfortable using old applications. Despite limitations, users tend to figure out shortcuts and procedures to make the system work for them and may find the prospect of moving onto new applications daunting. Getting users onboard is critical and one way to win this battle is to gather inputs for what works and what does not and incorporate those into the new system.

■ Selecting the right partner is critical, and partnering with an expert with the right skill sets means putting the best foot forward. This entails due diligence by a team of in-house experts aligning the organization's requirement and mapping it with the partner's experience, credentials, technical expertise and team composition. Partner's approach to modernization, expertise with tools, technologies, best practices, and understanding of legacy environment require due consideration.

■ Leveraging the right technology and platform is important in achieving modernization's objectives. There are many vendors with a host of offerings and a thorough analysis aligned with business objectives and long-term requirements is necessary. Where to host the application—on-premises, public cloud, private cloud, co-location; what language to use, which cloud platform to host. Decision-making must consider vendor lock-in, what kind of support is available and whether the technology supports a good eco-system of tools and developers.

■ Managing adequate funding and budgetary support for modernization efforts is a key challenge and building a water tight business case is important which must consider optimizing ROI from existing IT assets, particularly with respect to application portfolios.

■ Modernization efforts will not be able to deliver value if cloud-native applications cannot integrate with legacy applications and have to operate as digital islands. The idea is to synchronize powerful new technologies to achieve speed, agility and scalability while capitalizing on the operational capabilities of existing assets to deliver maximum ROI within a short time.

■ Ensuring continuous and automated security is a challenge and modernization enables to embed security in processes with good design practices such as automating software release pipeline using DevOps principles and making testing an integral part of development and release process with DevSecOps.

■ The beauty of cloud-native applications is that they can be highly available with built-in redundancy and self-healing capabilities. But redundancy entails additional expenditure and is sometimes is avoided which results in application failure, and so this is an important consideration during budget discussions.

■ Often application modernization is taken up as a technical project without considering business implications. A data-driven strategy provides insights into performance metrics, operations, security, cost, usage and availability which blends well with business objectives.

Critical Success Factors

Modernizing applications helps achieve specific objectives, chief amongst which is to enable IT to be agile, responsive, enable secure operations, provide

data, insights and simplify IT management. Business benefits are reflected in terms of rapid expansion, faster innovation, accurate decision-making and increased collaboration amongst stakeholders. Thus empowered, the organization is able to re-invent itself with frequent experimentation and failing fast while being able to roll out new products, services and embark on customer engagement strategies. So, what are the critical success factors and how to use these to measure the outcome of modernization efforts?

■ Any organizational initiative must have the endorsement of stakeholders with strong backing of senior management. This is essential to overcome implementation issues which requires budgetary support, process changes and user participation for inputs and adoption.

■ Application modernization must result in clearly enhancing customer experience—be it internal or external customer—demonstrating value in terms of increased convenience to consume services, access to information, enhanced collaboration, or greater insights into operations. Other clear outcomes include easy integration capabilities, scalability and

Often application modernization is taken up as a technical project without considering business implications.
A data-driven strategy provides insights into performance metrics, operations, security, cost, usage and availability which blends well with business objectives.

reliability to support new initiatives and business expansion initiatives.

■ These outcomes must come at speed and at scale, after all these are inherent capabilities of modern applications. Applications must be able to fulfill short-term needs which can vary depending on business objectives such as flexibility to incorporate frequent changes, agility to respond to external environment, scalability to support expansion plans while ensuring that the application can be easily ported to a different environment or hybrid environment.

■ While delivering quick business outcomes, the underlying technology and standards must be robust, reliable and futuristic. There is limited value in designing applications on a proprietary platform or using a language that is on the wane, and its value restricted to achieving specific outcomes. At the same time selecting a technology that is open-standards based and offers enterprise-grade performance will determine the success of the application.

■ Application modernization must be accompanied by a comprehensive data strategy wherein data is collected in

a central repository and accessible to all users. It is the glue that ties the success of application modernization to business outcomes by providing insights into operational performance such as bottlenecks in application delivery; evaluating redundancies, proactively managing performance and security issues; or initiating roll back. Data informs and enables to monitor application performance and introduce continuous improvements.

Getting Started

Organizations which undertake modernization journey are propelled by a need to leverage technology for innovation at speed and scale. Gone are the days when IT only supported operations and enablement. As digital unleashes disruption, businesses are forced to adopt digital capabilities at the core or get eliminated from the market. .

With increasing pressure to modernize, it is important to make the right moves and start well. A false start not only erodes the confidence of internal stakeholders, it also causes delays and minimizes the speed-to-market advantage.

Modernizing for speed and innovation must start by identifying the most critical business objectives followed by detailed assessment and evaluation of the IT estate. The analysis must answer questions such as which applications can be modernized easily; what dependencies can create challenges; what framework of tools, technologies and processes will enable a smooth and seamless transition. At this stage, organizations must identify specific use cases, and select the most appropriate one after assessing the difficulty metrics.

Planning and implementation must incorporate best practices in application lifecycle management such as DevOps and DevSecOps practices. Continuous testing must be an integral process to the development cycle so coding errors and security flaws are quickly identified and remediated without building technical debt. Application must be architecturally designed to work with open-source tools and technologies for a futuristic roadmap.

At the same time, automating configuration and monitoring the runtime environment with intelligent tools is necessary to win customer trust and confidence. Tools can be configured with performance benchmarks to take auto-remedial measures which prevent degraded performance. At the time, intelligent tools can monitor the environment to identify unusual behavior patterns, raise alerts and take corrective measures by preventing unauthorized or suspicious access. ■

CLOUD AS A SERVICE

Businesses should prioritize their long-term organizational goals based on their recent learnings to develop an impregnable cloud agenda for the future

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CLOUD AS A SERVICE

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Get a true cloud experience. Achieve a seamless user experience with access through HPE GreenLake Central to the self-service provisioning dashboard. The pre integrated solution is delivered on a pay-per-use basis, operated for you in your colocations, or data center and can be easily scaled up or down with business demand.

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Cost Savings
Pay-per-use consumption model avoids costly overprovisioning, resulting in a savings of 30–40%. When combined with management services from HPE GreenLake, admin and IT overhead costs can also be reduced by up to 40%. ■

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W hen Professor John McCarthy, an American computer scientist and one of the founders of artificial intelligence, envisaged the concept of network-based shared computing in 1961, not many realized that it would become the key for a successful business future decades later.

In 2006, tech behemoth, Amazon (through its cloud arm Amazon Web Services), started offering web IT infrastructure solutions to enterprises. Nevertheless, the concept of a shared IT platform (what is now known as the cloud) largely remained a buzzword for many years in the C-Suite dictionary. It was deployed mainly by large tech corporations and early tech enthusiasts. Most companies found it difficult to comprehend cloud usage - its core advantages - compared to the conventional data centers.

Fast forward to today, cloud technology has now become a core part of several industries. While cloud adoption had been witnessing significant momentum before the pandemic, its usage reached new levels of growth in 2020 due to the pandemic-sparked digital transformation accelerations.

What Is Cloud As A Service?

Cloud as a service is an umbrella term that refers to on-demand user access to various internet-based infrastructure, platforms, or services hosted by a third party on its server. The "as a service" cloud approach enables enterprises to focus on their core competencies without worrying about fluctuating business environments.

Amidst the pandemic, organizations that were erstwhile undecided about their cloud investments in no time accelerated its adoption to keep their operations afloat and deliver a personalized, uninterrupted, and on-demand experience. With cloud-based data processing capabilities, businesses could reimagine their supply chains and customer-connect channels.

By moving their applications, data, and workloads to the cloud, enterprises can develop new applications swiftly, deliver new services faster, and efficiently manage the demand-supply gap in a cost-efficient way. From ERPs to email solutions, cybersecurity, HR, and collaboration software, the list of cloud-based business applications is growing bigger and bigger.

According to Infosys' Cloud Radar 2021 report, by 2022, over 40% of surveyed enterprises are expected to move their systems into the cloud, up from 17% currently. The IT major added that growth had been driven by the cloud's capabilities to speed up how enterprises develop and launch new solutions, add new functions to software in use and expand processing capacity. Along with that, enterprises rely heavily on cloud-based ecosystems to foster collaboration, unlock value from data via AI, and discover new revenue streams.

The fascinating aspect of the cloud as a service model is its unique delivery mechanism, enabling enterprises to eliminate or scale storage space, applications, and other cloud resources as per their requirements.

Cloud enables employees to access relevant data and information from any device to collaborate in real-time, track customer feedback instantly, and improve overall brand value.

By moving their applications, data, and workloads to the cloud, enterprises can develop new applications swiftly, deliver new services faster, and efficiently manage the demand-supply gap in a cost-efficient way. From ERPs to email solutions, cybersecurity, HR, and collaboration software, the list of cloud-based business applications is growing bigger and bigger.

Gartner defines the cloud as a style of computing in which scalable and elastic IT-enabled capabilities get delivered as a service, using internet technologies. The research major estimates that global end-user spending on public cloud services will likely achieve 18.4% growth in 2021 to reach USD 304.9 billion, up from USD 257.5 billion in 2020.

Different Service Models Of Cloud As A Service

There are three key cloud computing service models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

■ IaaS refers to the cloud-hosted infrastructure provided by third-party technology partners on rent or lease. Under IaaS, enterprises can use servers, storage, networking, and virtualization capabilities in a pay-per-use model.

■ PaaS includes hardware and software tools provided by a third-party technology partner that enables businesses to develop applications and products (such as web servers, middleware, database management, analytics) virtually without spending an exorbitant amount of money on-premise data servers and storage.

■ SaaS-based solutions are the most common form of the cloud as a service model. They are user-ready, highly scalable offerings such as file hosting services, emails, and collaboration tools. They can be run directly through an internet browser and used by several users across devices to connect, collaborate and share.

How To Unlock The True Potential Of Cloud?

There is often a dilemma around cloud strategy, mainly due to the price-points and different deployment models. Once you embark on the journey of the cloud, managing it becomes critical. For example, companies

with years of experience managing on-premises workloads may feel overwhelmed with several cloud ecosystems, setting new policies, governance models, and driving cultural shifts within an organization.

In the past, it has been observed that young enterprises were making the mistakes of implementing the IT success stories of other organizations without understanding their own transformation needs.

There are no fixed rules for a winning cloud strategy. It is paramount for cloud users to think about the desired outcome and develop a detailed plan based on those results. Because of how business is changing, it will be vital for them to have at least a three or four-year horizon to make a cloud strategy.

Map Your Existing IT Environment: In the wake of COVID-19, customers have redefined their requirements. There is a solid need to re-access the right balance between on-prem infrastructure and cloud as a service. Before moving to the cloud, enterprises should analyze their current IT environments, define the purpose, evaluate the regulatory and security guidelines and get buy-in from all stakeholders.

It is critical to find out how they [organizations] can make their cloud journey seamless for their employees and customers.

Managing Cost Aspect: In IT, cost pressures have always been there, and they have become even more in the current situation that we are in because businesses are demanding more from IT. There is increasing pressure on IT to do more with less. The cost pressure continues to be one of the key drivers. And probably that was one of the first drivers for organizations to experiment with a public cloud offering based on looking at a better way or a cheaper way to do things.

Today, cloud providers offer various kinds of cloud pricing models such as flat-rate pricing, pay-as-you-go pricing, tiered pricing, per-user pricing, and more. However, any cloud deployment decision should not just be based on pricing. Businesses must create value for themselves and customers by adopting new technology solutions that fit their unique needs.

Enterprises should weigh the cost and impact-related analysis on a long-term basis. While some of the cloud deployments may look costlier initially, they can deliver exceptional return on investment in the longer term.

Compliance: When choosing your cloud partner, it is critical to look at a kind of legal compliance that businesses need to follow and whether the cloud

partner has those capabilities to meet. Because if not appropriately chosen, at a later stage, data transfer costs can be burdensome to bear. So it's a decision gone wrong.

An enterprise often made this mistake with their cloud journey when they are in the early stages of their growth model. They had limited insights into the bigger picture as they were unsure whether their business would grow. Hence, instead of analyzing compliance and other critical factors, they only evaluate pricing and basic features they get from a cloud plan.

The compliance initiatives should be adopted carefully by businesses as per the industry specifications and market demand. To ensure robust compliance, enterprises should have strong capabilities to monitor and track their cloud operations.

Security: An enterprise cannot deploy a robust cloud operating model without concentrating on the security aspects of the cloud ecosystem early in its deployment journey. Mainly for enterprises with a multi-cloud strategy, it is critical to assess their risk management capabilities and deploy dependable security policies and governance.

While one may say that the cloud provider is accountable for security, in essence, it's the organization that is held responsible for security. While agility is essential and simplification is critical for customers, cloud deployment cost needs to be low. However, that should not come at the price of losing sight of necessary data and managing things.

What Could Go Wrong During The Cloud Journey?

- Cloud transformation strategy is unclear and addressed as a pure IT topic. They are often missing top management buy-in.

- Organizations fail to manage people risks

- Cloud operation responsibilities are not clearly defined – consider the shared responsibility model.

- Organizations have insufficiently assessed the readiness of in-scope applications leading to the risk that a cloud migration (lift & shift) is executed instead of true cloud transformation.

- Organizations fail to define a cloud security target operating model (TOM).

Source: Why your cloud security operating model is key to create trust while transforming your business, EY Switzerland

Service Level Agreements (SLAs): SLA's are the most critical module of any cloud deployment plan as it provides a detailed outline of the level of service expected by a cloud user organization from the technology partner.

Whether the ecosystem is a public cloud, private cloud, or multi-cloud, the contract negotiations can be challenging once the agreement is signed, of course, unless it is a massive contract of long-term engagement and colossal billing. In that case, probably the service provider can make slight changes to the contractual points. Otherwise, they are not negotiable, especially in the public cloud ecosystem.

Enterprise decision-makers should be cognizant that most service providers have standard SLAs, describing the scope of services at various price points. These contracts are usually written in favor of the service providers by their legal teams. Hence they [SLAs] need to be assessed and negotiated well by an enterprise cloud user, especially in risk and governance. Suppose an organization is dealing with multiple cloud providers. In that case, it should get all partners to sign the operational level agreement (OLA) that provides detailed guidance on all technology partners' roles, responsibilities, and collaboration processes to execute their SLAs efficiently.

Key Questions That CIOs Must Ask Before Deciding On Any Cloud Model

- What are my unique business needs?

- What will be the current and future technology needs of my business?

- What is the financial capacity of the shortlisted service provider?

- Do we have data that should remain on-premises for regulatory compliance?

- Do I have the in-house capabilities to manage the cloud-based environment?

- How are the business models likely to evolve in the future?

- How will the different deployment models impact our finances?

- Are we ready to determine the level of authority that can be given to selected people for accessing data?

- Do we have a contingency plan in place?

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can pick and select the services that they want to avail and pay as per their usage. Some prominent public cloud service providers are Amazon Web Service, Microsoft Azure, Alibaba Cloud, Google, and IBM.

According to a research report by IDC, the Indian Public Cloud Services market revenue reached USD 3.6 billion in 2020 and is likely to touch USD 9.5 billion by 2025, achieving a CAGR of 21.5%. SaaS has a significant share in the overall public cloud services market, followed by IaaS and PaaS.

The public cloud, however, is not considered a perfect option for highly secure data. Since the network information is stored on a third-party external server, there are always chances of a data breach where users have no or little control.

Another most significant challenge in adopting the public cloud is the different standards being followed by cloud service providers. The lack of a uniform approach makes it challenging for organizations to shift between the providers and transport their data seamlessly. It is critical to have an industry defined common standard, from an association, say, Cloud Computing Foundation, so that switching cloud providers and porting data from one host environment to another with minimal disruption.

Which Cloud Deployment Model Is Suitable For You?

The success of any cloud transformation is hugely dependent on a careful cloud strategy exclusive to the business needs of an organization. The right ingredients of this strategy include cost analysis, risk management, and governance framework.

There are four key deployment models allied with cloud services: Public cloud, private cloud, hybrid cloud, and community cloud. Each cloud environment serves different organizational purposes, comes at a different price-point, and offers a diverse set of advantages.

∎ **Public cloud:** Public cloud refers to an internet infrastructure (SaaS, PaaS, and IaaS) of a third-party provider being accessed by multiple users. It's the fastest way of availing cloud services by enterprises and enables them to add more IT functionalities and pay per resource use.

The public cloud model is ideal for those enterprises who want to quickly access a broad spectrum of services without incurring exorbitant infrastructure and maintenance costs. Compared to the private cloud, this model is more cost-efficient and helps businesses seamlessly access ready-to-use resources. Enterprises

∎ **Private cloud:** Private cloud is an exclusive single-user setting where the user organization does not share the cloud resources with other firms. The dedicated private cloud environment is either provided through an on-premises data center or an offsite data center hosted by a third-party vendor. This kind of cloud environment is mainly appropriate for companies who deal with critical data and concerned about its security. Private cloud-enabled firms have a complete overview of where the servers are located and what security practices are being followed. Essentially, it means enhanced security, low latency, and greater control over data governance.

Organizations can customize the environment and fully exploit their hardware as per their unique business needs. This cloud deployment model needs robust talent support who can manage conventional data centers and ensure maintenance.

Interestingly, according to a Deloitte report titled 'Getting cloud right: How can banks stay ahead of the curve?', many large corporations, especially those for which security is essential, such as banks, have tended to prefer private cloud, or a public/private hybrid, because of the additional security, perceived or actual, it provides. It adds that this hesitancy on the part of large companies is disappearing.

■ **Hybrid cloud:** Driven by the growing digital transformation priorities of all scales, hybrid cloud environment, a combination of on-premises infrastructure, private cloud services, and public cloud, has become the most preferred deployment model by enterprises. A hybrid cloud environment enables enterprises to run their computing workloads on various efficient cloud models using end-to-end orchestration to meet the different customer needs. This model helps businesses address critical business challenges and discover innovative avenues to deliver IT resources at a reasonable cost.

It is complex and expensive to adopt a single cloud deployment model for global organizations in the age of digital transformation. While some of the IT workloads may benefit most from the public cloud, others may need better security and fit for the private cloud. There is always a combination of infrastructure and the service of platform service and software as a service. So multi-cloud is the scenario.

Infosys' Cloud Radar 2021 report highlights that 41% of the surveyed enterprises turned most frequently to private cloud. However, it also indicates a growing preference for hybrid multi-cloud arrangements amongst top enterprises to have greater flexibility by moving workloads between clouds.

A hybrid model enables businesses to seamlessly move their data applications across private and public clouds by leveraging the same infrastructure and operating ecosystem. With so much transformation and technologies, such as 5G, edge, and artificial intelligence becoming mainstream, the demand for industry-specific hybrid cloud solutions is picking up momentum.

Nevertheless, a multi-cloud hybrid strategy needs robust risk control analysis, consistent security policies, in-house talent to support processes, and a phase-wise implementation roadmap. In the current milieu of increasing cybersecurity attacks, businesses are wary of the credentials of different cloud partners. Hence, in the future, besides industry-optimized clouds, security will play a pivotal role in accelerating the hybrid multi-cloud environments. Enterprises are increasingly getting conscious of the approach adopted by their cloud partners to manage and store their critical data.

Conclusion

To summarize, the global health crisis has become a turning point for digital transformation acceleration and has validated the value proposition of cloud-based services in achieving the same. During the disruption, the conventional workplace models were abruptly thrown out of the gear. Cloud computing enabled private and public sector enterprises to leverage transformative technologies to increase their speed to market, adding new capabilities and take up the challenge of accommodating seismic shifts in consumer behaviors.

Cloud as a service model has enabled businesses to maintain business continuity and improve agility by ensuring better responsiveness in real-time, which could not be possible by using traditional infrastructure in today's digital-first ecosystem.

However, to get the most of the cloud as a service environment, businesses should start with an organizational vision and set business goals. A one-size-fits-all approach can have serious ramifications. Those new in the cloud journey should transform their processes by conducting necessary pilots to see how things turn out.

As we advance, organizations concerned about control, privacy, and governance will continue to adopt private cloud. In contrast, organizations that plan to move to a hybrid will create an intelligent operative ecosystem, incorporating AI-driven analytics and automation tools. ■

Six Essential Considerations For Cloud Service Level Agreement

Roles And Responsibilities: This is the most critical aspect of any service level agreement. All roles and responsibilities of different individuals and stakeholders associated with SLAs should be covered distinctively.

Data Ownership: A robust SLA should clearly define the data ownership policies and specify that it belongs to the user and holds all rights on it.

Performance Benchmarks: A robust cloud SLA should entail performance benchmarks parameters (such as uptime guarantee) and advance notice around planned maintenance so that businesses can scrutinize the different aspects of cloud performance.

Security And Risk: The specifics of the security standards and procedures that the cloud service provider will maintain and govern should be explicitly defined in the cloud SLA. The agreement should cover the penalties and actions should there be an information breach or data loss of cloud users.

Compliance And Audit Rights: Organizations should ensure to cover the right to monitor and audit the compliance in their SLAs. This parameter will ensure that the enterprise data is stored and administered as per the pre-defined service level agreement.

Conditions Of Terminating The Contract: Ensure that the SLA covers the detailed terms and conditions to continue or terminate the service by the user. It may include payments and forfeits clauses, activation, and renewable conditions, among other elements.

"Ultimately, the cloud is the latest example of Schumpeterian creative destruction: creating wealth for those who exploit it; and leading to the demise of those that don't."

– Joe Weinman, author of Cloudonomics: The Business Value of Cloud Computing

CLOUD MODERNIZATION

Cloud modernization is a journey. And there is no one exact path that works for everyone

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CLOUD MODERNIZATION

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With businesses demanding more from IT every year, modernizing existing data center infrastructures is an imperative. A modern data center architecture is based on the fundamentals of software-defined infrastructure thereby lending itself to automation at scale and a cloud-operating model. This also leads to creation of new roles like the SRE (Site Reliability Engineer) in the IT organization. Going back to business demand, the driver behind all this is developer velocity and productivity. Getting infrastructure delivered on-demand with the ability to scale it up/out when required completely through software (and not relying on archaic manual processes) is the need of the hour.

The Cloud Foundation architecture provides a blueprint for a modern data center with software-defined compute, networking & storage and fully automated lifecycle management from rack-stack to retiral. This foundational software can run on any commodity x86 server as well as specially engineered systems that ease out operations for IT teams. The Cloud Foundation can run in your data center, at the edge or even in the public cloud thereby delivering a consistent infrastructure regardless of underlying hardware; this means that applications can be rapidly migrated from and to the data center with no disruption to business. Software-defined approach helps customers to be more agile, and enables them to deliver IT services faster, more securely, and more efficiently than ever before.

TCL works closely with VMware to deliver customer-centric cloud solutions. For example, its software-defined networking, data centers, and infrastructure offerings use many VMware's technologies, including VMware Cloud Foundation, NSX, vCloud Director, and the vMotion technologies that make it possible to rapidly move workloads between public and private cloud instances. The architecture also delivers a robust layer of infrastructure capabilities including the ability to run modern container-based applications governed by Kubernetes, distributed firewalls, policy-based storage management, support for both hyperconverged and traditional storage and a wide variety of infrastructure hardware to choose from. Being VMware cloud verified means a mark of distinction because of the quality technology behind it, Customers can be assured that a VMware Cloud Verified service provides Compatibility, Choice and Control. TCL delivers a service that is compatible and interoperable with VMware's environment, enabling a more seamless transition to the cloud, saving the customer time and money ■

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To say that cloud adoption is on the rise is stating the obvious. Look at the way business and IT forums are dominated by discussions how public cloud is enabling collaboration, remote working, and business innovation. This trend is backed by strong evidence from the ground with analyst reports that have surveyed hundreds of organizations.

The 2020 Gartner Cloud End-User Buying Behavior Survey found that almost all respondents indicated their organization plans to maintain or increase IT spending on Cloud Computing in the next 12 months. Organizations want to leverage the rapid pace of innovation that cloud-based infrastructure and platform services facilitate to launch new digital services and customer experiences. Respondents indicated that by 2023, 40% of all enterprise workloads will be deployed on the cloud and platform-based services, up from only 20% in 2020.

Needless to say, the COVID pandemic has accelerated modernization efforts forcing organizations to adopt cloud and take advantage of scalable resources to enable seamless collaboration, facilitate business continuity with cloud-enabled virtual desktops. However, the momentum to adopt cloud-based modernization was evident long before the COVID pandemic. According to an IDC report in 2016, The Salesforce Economy, Cloud Computing spending had been growing at six times the rate of IT spending between 2015 and 2020.

The Burden Of Legacy - Impetus To Modernize

Businesses have started realizing diminishing returns from legacy IT systems and embarked on modernization initiatives. Trapped with legacy systems, organizations are unable to scale, experiment or launch new initiatives and were losing competitive advantage even as the digital economy burgeoned with new and agile players disrupting the market with a slew of innovative products and services.

The challenge of managing legacy systems combined with the imperative to respond to external environment is leading organizations to embark on IT modernization initiatives. However, the key thing to remember is that just migrating to the cloud does not deliver value and the real measure of cloud is what you do when you reach there by taking advantage of cloud capabilities.

The cost of operating and maintaining legacy systems far outstripped IT spend on innovation as much of the spending was going into keeping the lights on. Any change or update made in any part of the system must be reflected across all dependencies making it extremely difficult, time-consuming and a costly affair to effect changes.

Built over a period of time, legacy systems are an amalgamation of systems, platforms and applications coded in outdated languages. Worse, these systems were built to achieve specific objectives and worked in isolation and it was extremely difficult to access data and get insights across departments for effective decision making. This led to operational inefficiencies, cost-overruns, inability to launch customer initiatives and business innovation.

Sometimes vendors stop supporting old systems and organizations are left to fend for themselves. Employees who knew these systems and people who wrote the applications may have retired or left the organizations and therefore the burden of maintaining the systems shift completely to the user organization which become unsustainable in the long run.

Business Value Of Cloud Modernization

The challenge of managing legacy systems combined with the imperative to respond to external environment is leading organizations to embark on IT modernization initiatives. However, the key thing to remember is that just migrating to the cloud does not deliver value and the real measure of cloud is what you do when you reach there by taking advantage of cloud capabilities.

Organizations want to transform customer experience, power innovation, increase agility and flexibility, reduce operating costs and drive data-based decision-making. While cloud is not a prerequisite for any of these objectives, it becomes a force multiplier as cloud accords tremendous flexibility, agility and scalability which is not possible in traditional IT environments.

Therefore, much of these modernization efforts are being tied to cloud adoption. According to IDC, by 2024, nearly 50% of Cloud Computing spend will be tied to digital transformation and account for nearly half of all software sales. Worldwide spending on Cloud Computing between 2019 and 2024 will grow 19% annually, from USD 179 billion in 2019 to USD 418 billion in 2024.

At the same time, the agility and scalability of cloud has spawned a new generation of entrepreneurs that are disrupting the market with new customer experiences by leveraging big data and analytics. In contrast, organizations relying on traditional IT systems take time to ramp up systems before they can launch new initiatives.

Cloud's pay-as-you-go model enables businesses to start virtual servers almost immediately and scale up as the demand grows. This kind of agility facilitates frequent experimentation and fosters innovation. What's more, the quick and easy access to resources and simplicity in deploying and managing the environment frees IT from day-to-day management and enables to focus on value creation, which in itself is a huge business benefit.

Meanwhile, the shift in consumption from a capex

to an opex model becomes a big draw for cloud-based modernization, allowing organizations to access the latest and latest resources without having to make any upfront investment. Cloud has lowered the entry barrier democratizing access to resources to boost big data-based digital initiatives which have required huge investments in a traditional set up.

As digital generates more data, organizations are overwhelmed with data and are challenged to acquire and provision massive storage on an ongoing basis. Cloud's scalable and cost-effective storage facilities address one of the main drawbacks in traditional IT environments.

Organizations are finding cloud modernization attractive due to the standardization via automation wherein users can launch infrastructure using scripted codes, use sophisticated tools to manage traffic, monitor performance, leverage cloud elasticity, and achieve continuous security and compliance.

Cloud features such as autoscaling redeem IT managers of the nightmare of managing workloads and enhances predictability. Disaster recovery is easily achieved by leveraging multiple data centers and designing self-healing architectures with automated failovers.

In terms of business value, one of the best leverages of cloud deployments is the flexibility it accords to optimize workloads for cost and performance whereby workloads can be deployed on the most appropriate compute resources to maximize cost and performance.

Organizations are learning that the cloud is inherently more secure as cloud providers invest in the latest security technologies and best practices and are way more experienced in securing the physical data center compared with individual organizations. There is more awareness that cloud security is a shared responsibility in which the provider secures the infrastructure layer while customers must secure access to the data, OS and application. This is in contrast to traditional data center security approach which focuses on securing the perimeter.

Finally, organizations can access the latest technologies as infrastructure providers are continuously innovating to equip organizations with building blocks. Cloud-based services, such as managed database, containerization, serverless, and tools to facilitate continuous development facilitate innovation at speed and scale.

Use Cases Across Verticals

The common use cases across verticals are workloads that are highly unpredictable, such as

corporate websites, e-commerce, and marketing applications. Dev and test environments are also commonly used as environments and can be easily built and destroyed.

Users must remember that migrating a stand-alone application or a piecemeal approach will deliver limited value and not yield benefits unless it is accompanied by changes in business processes. A complete modernization effort entails adopting appropriate approaches such as re-architecting to facilitate application scalability and re-platforming on appropriate cloud offering. Some common uses cases in different verticals are discussed below.

Manufacturing: Supply chain, logistics, sales and marketing enablement. Product development is another common application to enable seamless collaboration between teams across locations and to facilitate central access proprietary resources.

Banking and Financial Services: Customer services and customer engagements via digital channels. Despite the sensitivity of customer data, the sector has effectively leveraged cloud to track customer journey, using big data and analytics to launch innovative products and solutions spawning a new generation of fintech providers.

Retail and Commerce: The sector gained prominence riding the power of cloud to deploy e-commerce applications and take advantage of its inherent elasticity and launch payment solutions. Other applications include customer care, supply chain and logistics and big data and analytics solutions for operational insights.

Media and Entertainment: Publish content and take advantage of the inherent elasticity which allowed media and gaming platforms to scale up and down according to the traffic. Cloud enables to deliver content in a variety of format in real-time and curate customized content.

IT and ITES: Use cloud-based infrastructure resources for capacity building and offset fluctuating demand. Tap cloud resources for big data and analytics to manage tickets, analyze performance, seat utilization of employees, SLA management, granular insights into operations to enhance productivity and profitability.

Implementation Challenges

Cloud adoption is fraught with challenges and organizations must be well prepared before taking the plunge. Below are most common challenges.

Mindset: Cloud adoption requires an evolving mindset as the journey progress. Beginning with an understanding that cloud adoption is a journey, the organization must shift focus once the initial phase is over to cloud enablement, building team capabilities and identifying tools, strategies, and best practices to facilitate continuous benefits from cloud.

Migration: Selecting the correct migration strategy aligned with organizational goals and aspirations. From lift and shift to refactoring and re-platforming, the challenge is to balance the immediate benefits with long-term goals. Sometimes a simple lift and shift may achieve the immediate need for high availability, but it may not deliver the desired scalability, so the application will need to be re-designed with a micro-services architecture and DevOps enablement.

Application and Workload Management: Managing and optimizing workload is a continuous process and requires deep knowledge of the cloud vendor's environment and best practices. Often organizations select a specific service to start with, but understanding pricing mechanisms and how to combine different approaches yield better benefits. Knowledge of monitoring solutions and designing self-healing capabilities are some best practices.

Investment: Continuous investment in skill upgradation and expertise is critical to effectively exploit DevOps, big data analytics, serverless and micro-services. The cloud ecosystem led by open-source technologies is exploding with new tools and capabilities and cloud adopters must be aware of the landscape. If the required skill sets are not available internally, it is better to partner with an external vendor.

Governance and Compliance: Setting up a governance framework and ensuring compliance is business-critical but challenging as it must comprehensively address all regulatory issues. Given that cloud is all encompassing cutting across sectors, stakeholders, and geographies, designing a governance framework is an arduous task. Governance framework must be designed to achieve compliance via automation using appropriate tools. This includes code-based configuration, security hardening processes, role-based access, alerts and auto-remediation processes.

Critical Success Factors

Defining metrics help to identify activities for course

correction. The good thing in cloud is that it allows continuous tweaks and optimizations and since there is no upfront investment, there is little to lose when you want to make changes. Some essential metrics include the following.

Business Continuity: Depending on business imperatives, define the desired uptime and how can it be achieved. Aside from best practices and design principles, high availability also has cost implications. For instance, to achieve high availability, application will need to be deployed in two availability zones and must be running simultaneously to achieve automatic failover in case one data center goes down.

Cloud-Native Benefits: Legacy and archaic systems will not deliver cloud benefits, such as inherent scalability and agility. Only a modern application with micro-services architecture, DevOps enablement and containerization will give the speed and scale in a cloud environment. So, success measures should consider these aspects while gauging application agility and maneuverability.

Governance, Compliance and Security: Security is a shared responsibility in the cloud, wherein access is

Continuous investment in skill upgradation and expertise is critical to effectively exploit DevOps, big data analytics, serverless and micro-services. The cloud ecosystem led by open-source technologies is exploding with new tools and capabilities and cloud adopters must be aware of the landscape.

denied by default, unless user specifically allows access. Therefore, measure of success is monitoring adherence of policy-based access, what kind of remedial measures are in place and most importantly, how well the governance framework has been designed. Regular audits via log tracking and analysis enables to keep track of security and compliance.

Benefits Of Adoption

Benefits of adoption will become evident over a period of time as organizational responsiveness increases dramatically with agility, higher productivity, availability and lower cost of ownership and savings.

Automation: Managed services, such as database, auto-scaling, load-balancers, serverless, eliminate routine management tasks, such as provisioning, updating, patching, scaling, freeing IT to focus on value creation. Automation significantly reduces the margin of human error. Self-healing and automated failover capabilities make deployments highly available and performant and deliver consistent and predictable IT infrastructure and systems.

Savings: Autoscaling ensures resources are

automatically turned on or switched off depending on utilization, in contrast to the traditional environment where the organization has to provision resources based on the estimated peak load, regardless of utilization. There is flexibility in deploying workloads to improve performance by re-aligning the optimal resource for performance and cost benefits.

Performance: Applications can be designed for high performance with built-in redundancy across separate locations using auto-scaling and load balancing. Close and continuous monitoring of resources and analysis of incoming traffic enables to detect anomalies and take pro-active measures to ensure consistent application performance.

Ease of Use: Resources are easily accessible and can be provisioned immediately without wasting time in procurement. Automated environments can be launched with scripts with tools to monitor, raise alerts and take remedial actions. As opposed to traditional environments which have long procurement cycles and tightly integrated applications where maintenance is tedious and time consuming.

How To Get The SLAs Right

It is important to draft initial set of ground rules to overcome unanticipated challenges, such as network outages, downtime, security breaches, minimum processing power, and legislative and regulatory changes. This becomes critical given that cloud providers operate across geographies, political boundaries and physical networks and agreeing upon a minimal level of service delivery helps prepare for contingencies.

Some aspects to consider when designing SLAs include the following:

■ The parameters and minimum levels of service availability required for each element of the service and what remedies are needed in case of failure.

■ Establish metrics for performance of services and guarantees for service reliability.

■ Work out the latency and speed of access to data. There may be different slabs of service delivery depending on your level of subscription.

■ Make sure ownership of your data is stored on the service provider's system, and your rights to get it back.

A clear SLA and service deliverables demonstrate the technical capabilities and internal processes. SLA should specify how issues will be identified and resolved, by whom and in what time period.

■ Establish security standards for systems and infrastructure to be maintained by the service provider and the right to audit compliance.

■ Guarantees for data protection in case of a disaster. Service provider must showcase detailed and robust systems for data back up and disaster recovery.

■ The agreement should clearly mention customer responsibility and explain what you are liable for. This will help to protect your data and manage workloads in an optimal manner.

A Partnership Approach
The cost of a failed migration is high and therefore organizations must tread the path carefully. It is a good idea to work with an experienced cloud services partner who understand the cloud ecosystem, has technical accreditations, certified experts, and good reference of customers.

Some things to help identify a good partner include the following.

Business Understanding: Each customer's objective is unique, and the partner must be able to align the technical capabilities with deep understanding of business, industry, geography, and ethos. At the same time, the partner should be able to help identify priorities and goals to help you design a migration framework.

Clear SLAs: A clear SLA and service deliverables

demonstrate the technical capabilities and internal processes. SLA should specify how issues will be identified and resolved, by whom and in what time period. Working relationship with the cloud platform should also be clearly stated.

Expertise and Experience: A reasonably good indication of the partner's expertise is reflected in the maturity of the frameworks, internal processes, data management, kind of resource or knowledge management systems, and service visibility dashboards. Inquire into the skill sets of employees, training schedules, attrition rates and resources planning and practices.

Security Capabilities: Assess the partner's knowledge and understanding about security and technical capabilities to enable you to meet with your legal and regulatory obligations. The cloud partner plays a crucial role in helping meet the security scenarios from preventive, control, and recovery standpoint.

Multi-Vendor Partnerships: Multi-cloud is not just a de-risking strategy but also enables to access the best offering from different cloud providers. Check out the delivery capabilities of your partner and whether it can deploy and manage in multiple public cloud environments. An integrated platform to manage multiple cloud environments simplifies management, providing clarity and visibility into operations. ■

"The cloud is about how you do computing, not where you do computing."

–Paul Maritz, former CEO of VMware and Pivotal

DIGITAL TRANSFORMATION IN POST DISRUPTION ERA

The crisis has turbocharged digitalization efforts by enterprises who need to sync their efforts to accomplish long-term digital transformation value

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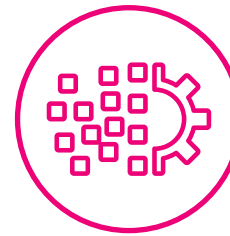
The COVID-19 pandemic is indisputably the crisis of the worst order in recent times and has drastically changed the way organizations function. The outbreak has made every enterprise realize the importance of championing digital ways to mitigate such unforeseen scenarios.

Amidst rising uncertainty and alarming levels of virus spread, organizations that were solely dependent on traditional business practices struggled to operate due to a sharp decline in revenues, interrupted supply chains, and consistently changing consumer behavior. Those companies who were slower to incorporate digital technologies in their processes failed to compete with those who already had started their digital transformation journeys.

Whether it was setting up a fully remote workplace for thousands of employees or building new apps to manage erratic customer expectations, the role of technology in enterprise ecosystems soon become more prominent than ever.

Most of 2020 saw organizations adopting digital technologies primarily for a speedy workforce transitioning from a conventional office environment to a remote work ecosystem and deliver consistent customer experience.

IT teams worked like COVID warriors to ensure that their employees have access to the required resources, software licenses, and necessary hardware equipment (such as laptops) to operate and connect with customers remotely.

Initially, the spotlight was on setting up interim online processes and deploying short-term tactical measures to empower employees to manage frequent changes in demand and supply while keeping business operations afloat.

However, as the COVID situation went from bad to worse and prolonged lockdowns were announced, it became evident that the new normal would continue for

an unspecified time even after COVID-19 subsides. And to tackle the newfound challenges, businesses would have to incorporate digital technologies in every process they run.

What Is Digital Transformation?

The term digital transformation has often been confused with digitization, digitalization, or IT modernization. Many people use the above terms interchangeably as synonyms – sometimes out of ignorance and repeatedly to achieve specific business outcomes. But in reality, the notion that all these terms are interchangeable is far from the truth.

The pandemic has demonstrated that nothing can be taken for granted.

Let's first understand what does digitization and digitalization mean.

Digitization: Digitization is defined mainly as a technique to transform analog data into digital files. Digitization or digital representation of documents helps organizations and governments store, access, and share vital records and information with employees or people at large through emails, websites, mobile apps, or other online channels. For example, converting paper-based employee record data into PDF files using document scanners or converting analog video to digital formats can be examples of digitization.

However, digitization alone cannot augment any process or deliver additional value to an organization.

Digitalization: Digitalization enables businesses to improve their operations, workflows, and processes by leveraging digital technologies, such as cloud, analytics, and machine learning. In simple terms, digitalization helps organizations automate their business systems quickly and makes it easier for their customers or employees to get the requisite information.

Gartner defines digitalization as the use of digital technologies to change a business model and provide new revenue and value-producing opportunities; it is the process of moving to a digital business.

Digitalizing is essentially taking data out of digitization environments and enabling businesses to generate data, collect it, make sense of it, and convert it to decisions related to operational efficiencies or help create more channels to drive new revenue streams.

From automating processes to delivery, digitalization enables businesses to collect data, analyze trends and make informed decisions. For example, by deploying an AI-based expense management tool, an organization

Digitalizing is essentially taking data out of digitization environments and enabling businesses to generate data, collect it, make sense of it, and convert it to decisions related to operational efficiencies or help create more channels to drive new revenue streams.

can track hard copy receipts, prepare expense reports, verify the claims with organizational policy and analyze expense data. By automating the process, enterprises can keep track of employee spending, save the time of their human resources, recognize revenue leakage, improve policy compliance, detect fraud, reimburse faster, and improve the overall employee experience.

There could be multiple such initiatives that may be part of an organization's digitalization projects.

Digital Transformation: In contrast, digital transformation is a very diverse and broader subject. It cannot be defined as a standalone project. It's a continuous and strategic transformation exercise undertaken to develop innovative business models by leveraging deep-tech to improve employee and customer experience. It's an approach where digital technologies or cloud-based solutions are adopted for a complete overhaul of the business to build a trustworthy enterprise. The real-time actionable insights bring a new level of understanding between clients and companies, driving unparalleled prospects in the longer run.

While there is a common consensus among businesses that the concept of digital transformation revolves around leveraging various technologies to achieve definite business objectives, there are no standalone industry-defined parameters to outline its key ingredients.

The road to digital transformation includes a cultural, organizational, and operational change in how a company works. It is the process of a fundamental shift in roadmap driven by a sequence of digital capabilities transforming people, processes, and technology across the business to accomplish measurable outcomes in efficiency and user gratification.

Who Owns Digital Transformation (DX)?

In the pre-COVID era, there was a consensus that enterprises should assign the responsibility of leading digital transformation to a C-level executive who understands the business dynamics, its unique technology requirements and can build a digital culture across functions.

Going by the above, CIOs and Chief Transformation Officers become an automatic choice to act as a sponsor for company-wide digital transformation initiatives. In recent years, many companies have been onboarding Chief Digital Officers to assign the leadership responsibilities of organizational transformation.

However, DX's success requires several rounds of

In the post-pandemic era, digital transformation is essentially owned by everyone. Every individual irrespective of his function, role, and responsibility, comes up and looks for opportunities, saying how to minimize contact? How do I make it self-sufficient to work it on its own, and I try to reduce the interventions from my side?

deliberations by all the top leadership, technology heads, function heads, and, of course, buy-in from employees. DX is a cultural and philosophical change, and its actual activation depends on effective engagement with employees.

In the post-COVID world, as businesses' focus shifts from survival strategies to growth tactics, digital technologies will play a more prominent role in driving a customer-centric approach. However, the digital transformation approach may not give desired results without a well-connected, coordinated, and integrated ecosystem.

Before implementing any change, it is pivotal to conduct focused group discussions (FGDs) with all employees to generate their feedback and address their concerns. As users of the proposed technology, employees need to be aware and comfortable with the technological changes. They might have questions, need more training requirements, and have concerns about their job role.

Most importantly, the different groups of an organization – such as HR, IT, operations, finance, or other service functions – may have already invested in digitalizing some part of its operations to modernize its processes in silos. In that case, it becomes critical to align and integrate those processes.

In the post-pandemic era, digital transformation is essentially owned by everyone. Every individual irrespective of his function, role, and responsibility, comes up and looks for opportunities, saying how to minimize contact? How do I make it self-sufficient to work it on its own, and I try to reduce the interventions from my side? And that's where businesses are going further, where the digital transformation will enable more and more intervention, which will support a long-term journey.

An effective change management strategy is another critical element of a successful digital transformation roadmap. It lists the step-by-step process of change and classifies the business problem, phase-wise implementations, and the outcome.

The Route Towards Successful Digital Transformation

In the current volatile times, a holistic approach to adopting and acclimatizing to digital has become a strategic necessity for enterprises. Today, more and more people are getting accustomed to digital-only behaviors for work, healthcare, entertainment, virtual socialization, education, banking, and daily shopping requirements.

Need For A More Strategic Approach: As a result of the pandemic, many companies accelerated their digital transformation strategies. There has been a growing understanding that succeeding in this unique setting requires enterprises to adopt a more strategic transformation approach rather than disintegrating and piecemeal working methodologies.

In 2021 and beyond, the role of digital technologies is going to expand further. To accomplish tangible business outcomes, ensure business continuity, and build long-term resilience, the focus on data collection methodologies and high-end engineering solutions is increasing. Organizations would focus on streamlining workflows, automating back-end applications, and using artificial intelligence and machine learning solutions to classify customer behavior, analyze demand and supply engines, detect anomalies, and make well-informed decisions.

The scale and speed at which this transition is happening is unprecedented and pushing businesses to accelerate their digital transformation agenda and make continuous efforts to modernize their legacy systems, transform their talent and integrate their processes.

A KPMG-Forrester consulting report, 'Going Digital, Faster' notes that without a coordinated, connected approach, the new digital organization may suffer many shortcomings of traditional models: siloed functions, unresponsive operations/supply chains, and a constant clash to access the right talent.

No Defined Path: There is no single path of successful digital transformation. Even if the core tenet of digital transformation remains the same, its implementation roadmap and overall approach may be unique to each organization. It is hugely dependent on company size, industry, past experimentations, budgets, customer requirements, and, most notably, how digitally mature an organization is? Every organization needs to identify its purpose to take the digital transformation route and the key outcomes it wants to achieve. Whether it is only customer experience or improving the digital supply chain, IT modernization, or drive more innovation or all of them. Unless the purpose is defined, it would be challenging to take an exact transformation route.

For example, the connotation of digital transformation would be very different for a conventional organization with years of investment in legacy technology than new, digital organizations such as Flipkart and Netflix. They will have objectives different from each other to further their digital transformation initiatives.

So, the key questions to ask for any company looking to derive the most from the digital initiatives are: What is my business strategy? What are my business goals? What do I want to achieve? What customer is expecting? And then decide, what will be the benefits? What would be the cost and the risk associated? And what is the time in order?

Key Checkpoints: Three critical areas need strong attention as checkpoints to accomplish any digital transformation goals.

First and foremost, to fully realize the benefits of digital transformation in an accelerated, truly customer-centric environment, the infrastructure being used at home must be at par with what employees have in their offices. That's the primary thing that businesses have learned while developing an effective work-from-home strategy. If employees don't have good connectivity at home, they won't match their office productivity. During the pandemic, many companies have invested significantly to upgrade the remote workspace infrastructure of their employees. However, still, the network experience in several employee locations was far from being satisfactory. Here, service providers, such as Airtel, Vodafone Idea, and Jio have an essential role to play.

Secondly, it becomes paramount for organizations to have a proper alignment of IT with business objectives. You cannot build a truly customer-centric culture into the DNA of your business until it's far knotted to the company's overall mission and vision. Missing alignment between IT and other service functions often results in fragmented goals and paralyzes the comprehensive transformation plans of an organization. CIOs and IT leaders need to deliberate with all service functions and business groups to establish a shared vision of transformation across the organization.

Today, customer experience has become highly crucial. Companies, such as Netflix, Facebook, and Amazon relentlessly invest in predictive analytics and machine learning algorithms to raise the bar for customer experience. Users are demanding similar experiences from other companies. So, businesses compete with their rivals, offering similar products and services and competing with these companies on the customer experience front. And if there is no collaborative approach to digital transformation, it's impossible for an organization to onboard the digital transformation journey and create unique experiences for their customers.

The third crucial factor that enables a company to drive a successful digital transformation strategy is enterprise agility. An organization that aims to kickstart a significant change needs to improve the agility of its IT infrastructure and culture. Whether it is a cross-functional collaboration or a strong focus on continuous improvement, employees should be aligned with the business goals, organizational vision, and changing customer preferences. The agile digital ecosystem should allow the organization and its people to embrace new technologies speedily, take continuous feedback from customers, and improve it rapidly.

If there are any cultural or talent gaps, those need to be addressed on priority through effective change management. There is a lot to learn from startup culture. Larger enterprises are very slow to learn. Engaging with the startup ecosystem enables businesses to understand key business trends, technology trends, and solution trends. Setting up digital enablement centers where key priority areas can be talked about, BCS train scouting and transcoding can be done for general technologies.

Governance: A Key Component Of Digital Transformation

While digital technologies improve efficiencies and enable enterprises to bring personalized customer experiences, their deployment also comes with a share of fears, especially around data integration, security, and regulatory compliance.

In this case, it becomes highly imperative to deploy a robust metrics mechanism to measure employee and customer engagements consistently. Let's comprehend why?

Over the last few years, there has been a massive upsurge of businesses developing cutting-edge solutions to increase their outreach through multiple web and mobile interfaces. The pandemic has accelerated that trend. All sectors – from banking, retail, education, health care, travel to manufacturing are deploying innovative digital technologies today. These technologies enable businesses to generate humongous amounts of data to create a wide-ranging impact on the customer service experience.

The significance of data to a digital company is the same as the importance of blood in a human body. It is only because of good quality data that a digital organization can transform its processes to function smoothly, collaborate extensively and deliver exceptional client experiences.

However, merely having access to more data does not serve any purpose unless and until it is not managed, secured, and governed. While gathering data, enterprises

If there is no centralized governance model, an organization may achieve robust results in one of its digitalization projects but never fully execute the transformation. Individual protocols, solutions, and initiatives lack consistency, and hence they need to be put under one centralized umbrella.

need to ensure that they have proper governance and monitoring mechanisms that help them decide data that needs to be collected, used for analysis and protected as per the different country's data compliance laws.

If there is no centralized governance model, an organization may achieve robust results in one of its digitalization projects but never fully execute the transformation. Individual protocols, solutions, and initiatives lack consistency, and hence they need to be put under one centralized umbrella. Effective governance also includes how an organization's employees behave and act on various social media channels. They are considered the brand ambassadors of their respective companies and need to be trained and advised on things they can share, promote, or refrain from. For instance, a personal post on social media channels on COVID treatment by an employee working with a pharma firm may be seen as professional advice of the Pharma company he works for by people.

Then, security threats increase by leaps and bounds, significantly when the network endpoints are multiplying and getting complicated to manage. In the post-pandemic era, no enterprise can claim that they are fully prepared to tackle any threat.

Key Challenges

It's A Journey, Not A Destination: As we've discussed above, leadership plays an essential role in driving the culture of change, strengthening the culture, and building new dynamics for the future. There has to be a delicate balance between an organization's immediate needs, which need to be evaluated after taking stock of existing processes, market forces, and future needs. Digital transformation is a long-term process, and any enterprise investing in it should understand that they are creating the complete digital framework to build the future of their organization.

Expecting Quick Gains: It is getting the cultural change, hiring the right digital talent in the team, taking strategic reskilling initiatives, making meaningful investments in technologies, testing the environment, aligning and realigning with business goals, and ensuring that it is responsive enough to tackle varied dimensions through real-time data and cognitive capabilities, that makes digital transformation successful. And all of these elements take a considerable amount of time.

Lack Of Proper Sync Between Business And IT: In the past, it has been observed that many companies, due to lack of internal skillsets or cultural readiness, unable to derive immediate benefits from their digital transformation initiatives. It is paramount to understand that just moving legacy apps to the

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cloud will not deliver a long-term edge to a business. Unless and until there is proper sync between IT and business, cultural readiness, and clear objectives to the organization, it would be challenging to get the transformation kicks in.

Managing Newer Risks – Is The Organization Ready?:
Organizations embarking on the digital transformation route should assess whether they are prepared to handle the unknown threats, requiring significant process recoding. Layers of security and trust are the core components of successful digital transformation. For instance, before deploying autonomous robots and supply chain automation capabilities, utmost care

should be taken to give the level of authority to people who can access a given set of data. The new innovative technologies also come with a greater risk of data breach and hack. As we've discussed earlier, data is highly crucial for any business and responsible for driving exceptional customer and employee experiences in the ever-connected digital transformation world.

For businesses to drive successful digital transformation strategies, it would be critical to prioritize which processes and essential functions of business and sub-functions need immediate transformation than the rest. An organization should map its high-priority, middle priority, and lower priority functions to maximize its returns/value from transformation initiatives. After identifying these priorities, every function should be weighed based on their digital maturity and the technology investments needed to achieve the desired state. This entire process can help an organization to identify a business case and define its digital transformation roadmap.

Beyond Technology Planning
The pandemic has proved to be a catalyst for digital transformation as it pushed enterprises to realign their priorities and invest aggressively in remote working solutions and cloud IT environments. While during the pandemic, organizations did not have enough time to measure every aspect of their digitalization goals more thoroughly, this can not be a winning strategy in the post-COVID era.

The phenomenon of robust enterprise-wide connectedness needs an excellent design framework that depends on measuring scope, business priorities, employee readiness, risks, cost, time, and value.

Any digital transformation's primary goal is to improve the customer experience. Enterprises must revisit their business priorities and processes and find technological solutions to make them more impactful to drive exceptional customer experience. The erstwhile silo-based approach should be discarded.

There is no doubt that companies with a high digital quotient will be far more comfortable addressing changing customer needs and new business models in the years to come. However, enterprises should refrain from deploying a random technology just for the heck of it. What works for others may not works well for you!

Most importantly, businesses must keep a mindful approach to test their technology deployments on user experience, integration, governance models, scalability to achieve more outstanding results from digital transformation. ■

"When digital transformation is done right, it's like a caterpillar turning into a butterfly, but when done wrong, all you have is a really fast caterpillar."

–George Westerman,
author and academician

INDUSTRY 4.0

Industry 4.0 has provided manufacturing companies an opportunity to leapfrog. They have to seize the opportunity, while ensuring that the objectives are right and the challenges that may disrupt the journey are tackled effectively

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ndustry 4.0 or the Fourth Industrial Revolution, often described as the coming together of physical, digital and (to a limited extent) biological planes, is, in practice, the large-scale automation of the manufacturing industries, which till a few years back, lagged in the use of Information Technology in their core processes. Though automation itself is not a new phenomenon, in the recent years, the manufacturing systems and enterprise IT systems have increasingly started talking to each other seamlessly, resulting in the data being captured being used to take decisions—both long-term business and immediate operational decisions. While many have pointed out to 'self-monitoring' being a defining factor of Industry 4.0, it may be just taken as one of the visible benefits of the phenomenon.

The term, Industry 4.0, originated in Germany in 2011, with Prof Wolfgang Wahlster sometimes being credited as the coiner of the term. In 2012, Germany—one of the leaders in manufacturing industry globally—created a working group, which presented a set of recommendations to the German federal government.

However, the phenomenon got large-scale attention when the World Economic Forum chose it, albeit under the name Fourth Industrial Revolution, as the theme for its annual meeting at Davos. WEF Chairman and Founder, Klaus Schwab, evangelized it and has also written a book, explaining the concept.

Today, all manufacturing, mining and similar industries have taken to it seriously, putting it centrally in their future strategy. Many even describe it as digital transformation of the manufacturing industry. According to globally renowned technology engineering research firm, TWI Global, Industry 4.0 is a growing trend towards automation and data exchange in technology and processes.

It is not that manufacturing companies haven't been using Information Technology. They have been doing

that for a long time, from ERP (enterprise resource planning), SCM (supply chain management) as well as in many ways in terms of enterprise functions like CRM, HCM and financial management.

What Industry 4.0 has done is that it has brought technology to the 'core' of the manufacturing business—that is the shopfloor.

The genesis of the industrial revolution can put the importance of Industry 4.0 in context. The first and the second Industrial Revolution were all about the physical aspect, namely huge machines powered by steam and electricity manufacturing goods. The third revolution saw the emergence of digital processes, namely the advent of computing in industrial systems. With the Fourth Industrial Revolution, we see the confluence of the physical and digital. By integrating enabling technologies like the Industrial Internet of Things (IIoT), cloud computing, analytics, artificial intelligence (AI), and machine learning (ML) into the production facilities and throughout their operations, companies are increasing efficiency, productivity, and safety, not just in manufacturing but also helping the management take decisions based on actual data—and increasingly based on forecasts, based on that data.

According to a study by Markets & Markets, the Industry 4.0 market was estimated to be around USD71.7 billion in 2019 and is expected to reach USD156.6 billion by 2024, at a CAGR of 16.9% from 2019 to 2024. The primary push for growth comes from the adoption of IIoT because of the increasing emphasis on operational efficiency and agility. The COVID-19 pandemic has only increased the demand for Industry 4.0 technologies as businesses look to build resilience through automation.

Indian manufacturing companies also seem to have woken up to the benefits offered by Industry 4.0, even though there aren't many case studies as of now. Increasingly, companies are looking at conducting pilots to newer ways to do things efficiently.

The government too seems to be rooting for Industry 4.0, as can be evidenced by the launch of Smart Advanced Manufacturing and Rapid Transformation Hub (SAMARTH) Udyog Bharat 4.0 initiative by the Department of Heavy Industry (DHI) under the aegis of the Ministry of Heavy Industries and Public Enterprises, Government of India. This initiative aims to raise awareness about Industry 4.0 among the Indian manufacturing industry, to reach 25% of the total GDP by 2025 with the help of demonstration centers.

Business Imperatives

Over the past few years, the demand for Industry 4.0
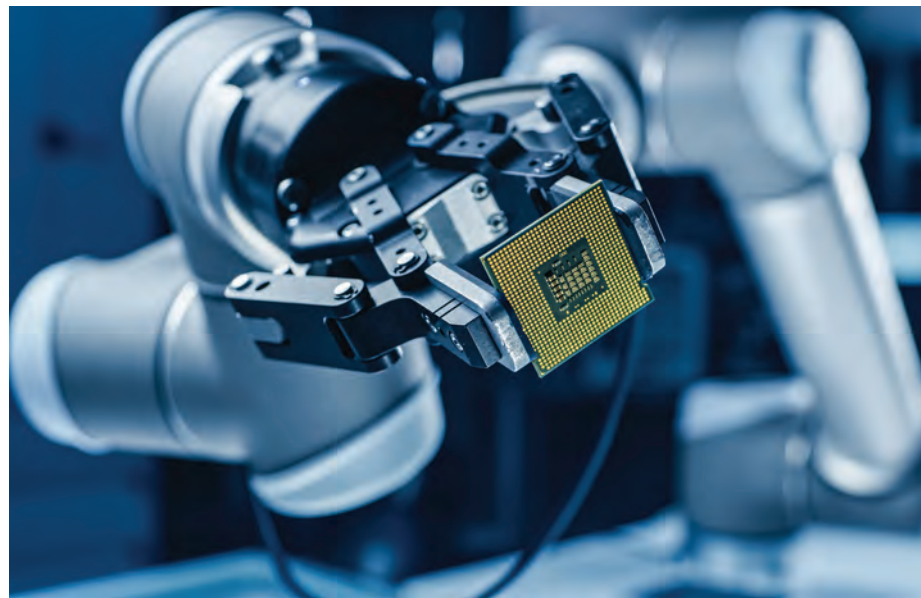
With the Fourth Industrial Revolution, we see the confluence of the physical and digital. By integrating and enabling technologies like the Industrial Internet of Things (IIoT), cloud computing, analytics, Artificial Intelligence (AI), and Machine Learning (ML) into the production facilities and throughout their operations, companies are increasing efficiency, productivity, and safety, not just in manufacturing but also helping the management take decisions based on actual data—and increasingly based on forecasts, based on that data.

solutions has seen a significant uptick. This reflects the increased availability of solutions and the rising demand in the corporate sector for such solutions, especially in the manufacturing space.

The primary driving reasons for Industry 4.0 happen to be productivity gains, better flexibility, and agility or faster time-to-market. By managing the production and the supply chain better, there is also a significant improvement in customer experience. Resource

efficiency and sustainability are also touted as reasons for the gaining popularity of digital solutions.

Industry 4.0 is a conglomeration of different digital technologies and processes that evolved or existed in silos in many ways. For instance, Radio-Frequency Identification or RFID technology has been around for decades, even going back to World War II when the Soviets gifted a ceremonial seal to the US ambassador. It contained a passive microphone and antenna that radio waves could activate. But it was only at the turn of the millennium when RFID became mainstream as organizations started to leverage them for managing inventory, track assets, or even quality control. Today RFID tags are an integral part of the modern factory, where companies and supply chain and production management also use them for innovative things like creating customized products.

Technologies like Virtualization, Real-time Monitoring, Business Analytics, Modularity, AI, and ML are part and parcel of the Industry 4.0 solutions. Weaving all these myriad technologies in a mesh and providing a solution that helps better manage operations and aids in working with suppliers, partners, or even customers, is the crux of Industry 4.0. Many experts describe Industry 4.0 as the marriage between OT (operational technology) and IT (information technology), combining traditional production processes with innovative technologies such as IoT and AI.

The primary driving factors behind the adoption of Industry 4.0 solutions are:

Enhanced Productivity: Simply speaking, by integrating business processes, companies can produce goods more efficiently and faster while allocating resources cost-effectively. Using technology, the downtime on production lines can be significantly reduced as processes and functions are automated. One of the best instances of how manufacturing companies have enhanced productivity is through the use of robotics on the shop floor. Today, robots can be found in the core space doing bulk work in any mid-size and large-size manufacturing unit. Right from handling raw materials to wrapping the finished product, robots bring efficiencies and speed. Another factor that works in favor of automation is that robots can be pre-programmed to operate 24/7, even when the lights are out— these aids in continuous production. In addition, robotic equipment can be customized for complex business functions.

Improved Efficiency: Industry 4.0 improves overall efficiency and productivity through seamless collection

Smart Factories

In many ways, smart factories are an ideal representation of what Industry 4.0 truly stands for. The term usually refers to manufacturing facilities with fully integrated and automated solutions, which aids in streamlining production and dispatch. Smart manufacturing is the manner in which production machines, computers, and analytics interact with each other, primarily on the shop floor. Robots play an important role in smart manufacturing. Smart technology can also reduce the requirement of human workers, especially in dangerous and hazardous environments like steel and aluminum factories.

Smart factories are also renowned for being highly productive; they can work 24/7*365 without a break. This makes them cost-effective as well. With optimal use of resources and waste reduction, these factories are also sustainable from an ecological point of view. Little wonder, many companies are looking at setting up smart factories, especially as a greenfield project. Little wonder, then the market size is ever-increasing. According to Mordor Intelligence, the Global Smart Factory Market was valued at USD270.74 Billion in 2020, and it is expected to reach USD461.82 Billion by 2026, registering a CAGR of 9.33% during the forecast period, 2021-2026. Even in India, smart factories are being set up, especially with the push on the Atmanirbhar Bharat program. According to Prime Minister, Narendra Modi, India will be a manufacturing hub in the days to come. The government's production incentive schemes will increase India's manufacturing output by USD520 billion.

and analysis of data in real-time. By analyzing data from multiple sources like shop floor, supply chain to distributors, production functions like batch changeovers, NPIs (New Product Introductions) are improved through instant feedback. A good instance of how Industry 4.0 is helping faster product innovations can be found in implementing 3D printing technologies in the manufacturing space. By using additive manufacturing, companies can quickly produce prototypes and test the feasibility of a product, thereby reducing the timelines and failure rates significantly.

Another space where immense cost and efficiency

gains are witnessed is in maintenance and repairs. Companies incur high costs in terms of maintenance of equipment, especially when there is an unscheduled downtime. But today, through the use of analytics and sensors, maintenance can be turned predictive. For instance, aviation companies use predictive maintenance for their aircraft engines by using sensor technology and business analytics. A single jet engine contains some 12,000+ individual components, generating 10 GB of data per second. By using this data, airline companies know the health of the engines in real-time, thereby allowing them to schedule maintenance based on actual wear and tear rather than time or distance-based schedules. This results in immense cost savings as the downtime is reduced, and the maintenance and repair are quicker when you know which part is faulty and needs to be fixed.

Flexibility and Agility: Another way in which companies benefit from implementing Industry 4.0 solutions is in terms of flexibility and agility. The integrated business allows the companies to scale production up or down depending upon the need, requirement, and market dynamics. Companies are also better able to respond to customer demands and can customize products accordingly.

Increased Collaboration: Traditionally, manufacturing plants operate in a silo. Even when a single company operates multiple manufacturing units, there is seldom any connection at the ground level. But this drastically changes when Industry 4.0 comes into play. As business processes get enhanced and production lines are connected centrally, it improves collaboration and learning. Much of it is done automatically, through machine-to-machine and system-to-system interaction, without any human intervention. For instance, a tweak in one factory that leads to better production outcomes can be quickly rolled out to other factories without much of a hassle.

Typical Approaches

While the theoretical advantages are plenty, it is not one-size-fits-all. Each organization, based on its nature of business, size, level of automation, IT maturity, and business objective, may have to follow a different path.

For example, what is the motivation for an Industry 4.0 initiative? Typically, there are three approaches of initiating.

Objective-based or KPI-based. This is the traditional

Of late, many of the decision-making cycles are moving top-down. The top managers get convinced about the value that some of the new technologies like IoT and 3D printing can bring to their business and expect the production and technology managers to fill in the details and make it happen. While this may, at first glance, look non-serious, in reality, sometimes it works wonders, especially in old-fashioned manufacturing organizations with so much resistance to change. A new CEO driving it means there is least resistance from the senior managers.

business approach, where the motivation to go for Industry 4.0 is derived from specific business objectives. These objectives could be operational or strategic. The initial KPIs are decided accordingly.

In a typical initiative driven by operational-specific objective, things like efficiency, productivity of the shopfloor to downtime may be used to derive the initial KPIs. In strategic-specific objective, the KPIs could be the overall cost, worker safety, accuracy of forecasting, to even capacity planning and supply chain planning.

It is not uncommon to start with one set—or even a mixed set of KPIs—and to go into others later, after building confidence through execution. This is why in many organizations, while many of these objectives are discussed early on, the low hanging fruits are taken first to build confidence among the larger set of stakeholders.

Try New Technologies (Use Case-Led). Of late, many of the decision-making cycles are moving top-down. The top managers get convinced about the value that some of the new technologies like IoT and 3D printing can bring to their business and expect the production and technology managers to fill in the details and make it happen. While this may, at first glance, look non-serious (see the third approach), in reality, sometimes it works wonders, especially in old-fashioned manufacturing organizations with so much resistance to change. A new CEO (the new generation in family businesses, for example) driving it means there is least resistance from the senior managers. However, this can just be a good starting point. Ultimately, the organization has to come down to specific KPIs.

Eagerness To Show Off Digitization (Me Too Factor). In short, this is a non-serious approach that is bound to fail. Many just want to score PR brownie points or enter the race with herd mentality without understanding the nuances of Industry 4.0. However, if the production, sales and IT heads are in sync with each other, they can together turn this to successful initiatives. But that is more an exception than the rule.

So, with what perspectives should an organization start.

There are three perspectives that organizations seem to approach it – the customer perspective, the shopfloor perspective, or the supply chain perspective. In some digital transformation exercises, companies may simultaneously take up all three.

Challenges Galore

Industry 4.0 is reasonably subjective and means different things for different businesses. While some may wish to leverage the whole bouquet of available technology offerings, others might take a more structured piecemeal approach. Because of this, challenges differ not only from sector to sector but even from company to company. While everyone aims for productivity gains and business resilience, there are still a set of common concerns that can be listed as:

Investment and Legacy Systems. A large number of companies in the manufacturing space, even today, are riddled with legacy systems and archaic technology. Making a complete transition to a connected Industry 4.0 system can be costly, tedious, and time-consuming. Due to constraints in interoperability, many businesses are hesitant to make the shift, as it could result in a breakdown in the system. To ensure that things work correctly, it is essential to synergize IT and OT, namely the machines on the ground and the software in the data center, to "speak" to each other.

Vendor Support & Expertise. One of the things most companies that are implementing Industry 4.0 solutions are worried about is vendor support. Considering that the technology is constantly evolving, companies are wary of vendor lock-ins. What if there is a newer, better, and cheaper way to do the same thing? What happens to the current investment? These are the sorts of questions that many companies are grappling with. In addition, since the field is relatively new, finding the right talent for managing such solutions can be difficult for any company.

Process Ownership. Digital transformation is an all-encompassing journey that entails everyone in the company, right from the very top to the very bottom. Also, a transformation of this magnitude takes a long time. Given the far-reaching implications, defining the objectives and laying down the roadmap is an essential step. The digital transformation process should be owned and driven by a dedicated set of renowned executives for their business and IT skills. Everything must be clearly outlined at the very onset of the project. This becomes all the more crucial, as there are many regulatory compliance issues that need to be addressed, especially in data privacy and storage.

Managing Expectations. Implementing and investing in Industry 4.0 requires a detailed analysis. But, what is also very much needed is to stay grounded and be real in terms of expectations. More often than not, there are

While creating significant efficiencies, an interconnected network also yields a much broader attack surface with the capacity to move from one provider to the next quickly. Therefore, grid-based industrial cyber threats have become core risks to safety, reliability, and business continuity.

unrealistic expectations of accuracy and productivity gains associated with digitization. While the benefits of technology implementation are apparent, they are not immediate and across the board. It takes time for things to settle and the gains to stack up. But, if there are unrealistic expectations at the onset, they can lead to much discontent and disappointment.

Greenfield vs. Brownfield. A deliberation often accompanies any deployment of Industry 4.0 solutions, whether it will be more effective in a greenfield or brownfield scenario. Basically, greenfield starting afresh with a clean slate, and brownfield implies implementing solutions in existing infrastructure. To be fair, a greenfield implementation will often be more desired, as you can choose the best solutions and focus on the business aspect. In a brownfield implementation, technology can sometimes become a challenge as any new infrastructure must co-exist with the incumbent equipment and system. As a result, sensors and other hardware that are being deployed need to be physically attached and aligned with existing machinery. Yet, as the technology keeps changing with question marks on the reliability and longevity of existing solutions, it is often more advisable to start with a brownfield deployment.

Physical Safety. While Industry 4.0 is all about automation and digitization, physical safety still remains an issue. With high-end systems in place, the workforce needs to be trained diligently to utilize them and interact with the systems. Thus, proper checks and balances must be ensured in terms of the physical safety of not only the costly machines but the ever-more costlier humans that operate them.

Cyber-security and Industry 4.0. The rapid adoption of IoT devices with Industry 4.0 helps ensure efficiency and cost savings. But while IoT devices allow measure and monitor operations, particularly in distributed operations, but they also add new attack vectors if the appropriate security controls are not ingrained. While creating significant efficiencies, an interconnected network also yields a much broader attack surface with the capacity to move from one provider to the next quickly. Therefore, grid-based industrial cyber threats have become core risks to safety, reliability, and business continuity.

In September 2019, the discovery of malware was made at India's Kudankulam nuclear power plant. Later, on October 30, the Nuclear Power Corporation of India Ltd (NPCIL) confirmed that a computer in the Kudankulam power plant's administrative network was infected on September 4. Imagine, if valuable and highly guarded assets like a nuclear plant can fall prey to intrusion, the threat to an automobile manufacturer or an FMCG company is much grave, especially ransomware threats.

Questions to Ask

- What is the objective?

- What kind of problems/opportunities exist?

- What kind of solutions should we look at?

- Where do we stand?

- What are the building blocks?

- What are the business cases?

- Do all use cases can be made into business cases?

Glossary of Important Terms

The Industrial Internet of Things (IIoT) is the backbone of Industry 4.0 ubiquitous and high bandwidth Internet is the means through which machines connect to each other.

Mobility: Mobile technologies are one of the fundamental forces driving the uptake of Industry 4.0 solutions. They aid in end-user communication and streamlining operations.

Analytics: On-the-go analytics is one of the defining features of Industry 4.0. As automation becomes pervasive, analytics will play a critical role in business processes.

3D Printing: From creating prototypes to creating spare parts, 3D printing is being used in various ways in the manufacturing space. As 3D technology evolves, there will be greater play for Additive Manufacturing in the future.

Augmented Reality: Envisioning a product or service before it takes shape can make production pretty easy. It can also greatly aid in maintenance and repairs. Overlay of digital over physical is what augmented reality is all about.

Edge Computing: Enables companies to process data on the site or local space, thereby reducing the data load on the central server. Edge computing thereby enables agility and productivity significantly.

Human Machine Interactions: While automation and digitization are at the core of Industry 4.0, the human touch cannot be completely ruled out. Human-machine interactions are still quite relevant, especially in the command center.

Automated Decision Making: Data is the fuel that drives the Industry 4.0 revolution. With advances in connectivity, data virtualization, decision-making has been highly automated.

Artificial Intelligence/Machine Learning: Through a combination of hardware and software, AI solutions can solve complex problems, predict failures, and adapt by learning new tasks.

Thankfully, technology provides the solution to the problem it creates. One of how cyber-security threats are being dealt with is through AI for Threat intelligence. The software solutions like firewalls have become more dynamic, picking up information about threat vectors in real-time as soon as they emerge. This helps in neutralizing the adverse impacts such malware could have had on an unsuspecting organization.

Starting Steps

In the end, the adoption of Industry 4.0 is no more a question; it is an eventuality. Yet, for the implementation to deliver on its goal of increased efficiency and reduced costs, certain pointers need to be borne in mind before implementing such solutions.

The TAC recommends some key factors that should be remembered while planning the Industry 4.0 journey.

Set a Goal. It is imperative to have a precise goal in mind before adopting any solution. The goal should be clear and well-defined, covering both the short-term and the long-term timeframe. This document will define the goalpost, the benchmarks by which the success and efficacy of the project can be examined.

Go Piecemeal if Required. Most of the companies still have huge legacy systems in place. Replacing them can be time-consuming and costly. It will then be an easier way to start small by implementing solutions and then assessing the gains. This can also be a great way to get the management's buy-in for investments.

Value over Cost. Unlike buying a product or a license, implementing Industry 4.0 is an investment. Hence, the implementation of technology should not be weighed through the prism of costs but that of value. To do so, it is important to work with the right partner who can deliver the solutions.

Change of Culture. Industry 4.0 is a sort of evolutionary step towards the future. It is not mere automation or digitization; it is a complete overhaul of the business. Unless the technology is ingrained deeply, it will not be effective. Hence, organizations need to prepare for change and embrace it.

Years back, Albert Einstein famously said, "I never think of the future - it comes soon enough." The future, a digital one, is being shaped right in front of us, even as we carry out our lives. This revolution is going to be no less disruptive than the original Industrial Revolution of the 19th century. ■

"The Fourth Industrial Revolution is characterized by a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres."

–Klaus Schwab, Founder and Executive Chairman, World Economic Forum

NEXTGEN DATA CENTER

Multitude of changes from modernized applications to distributed computing to increased levels of digitization have significant implications for the data centers of today. A modern data center design should take all that into account.

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Data is now everywhere, IoT edges and many distributed clouds, thanks to the data explosion at the edge driven by IoT. This is driving a digital foundation of edges, data centers, multi-clouds – distributed, in silos, often replicated several times and with sovereignty, compliance needs driving data gravity. We are seeing a shift from centralized and closed approaches in large data centers to many small centres of data everywhere, highly decentralized and distributed – "distributed clouds" not everything is going to the public cloud.

Organizations need help to design/architect a modern Data Center to enable a robust edge-to-cloud digital foundation and for them to :

Redefine experiences and operations at the intelligent edge: Help connect to new data sources and types, with the capability to act locally – and with a zero trust security approach.

Bring the cloud experience and operating model to your apps and data where they are: Bring the cloud's self-serve, pay-per-use (reserve may apply), scale up and down, managed for you as-a-service to the masses of apps and data still in co-locations, data centres and edges – with simplicity and speed, elastic, at scale – without the cost, risk and time to move data/refactor apps. Cloud is an experience and an operating model that has to reach apps and data everywhere – edges, colocations, data centers and clouds.

Unlock the value of all your apps and data – and legacy apps will no longer be the #1 barrier to digital transformation – they will be a source of innovation, enabling enterprises transform apps, transform data for insights and transform service delivery and create new experiences, efficiencies and innovation in the next wave of digital transformation – and beyond.

Entreprises need to look at the complète Data Center lifecycle while embarking on a DC modernization or Digital Transformation journey:

- **Advisory :** Translate IT strategy to a Data Center strategy to support HIT and Edge.
- **Design :** Design solutions and Fit out with mission-critical resilience, performance & efficiency.
- **Modular DC integration and professional services :** Services to support Modular Data center design, implementation and integration.
- **Management and Operations :** Improve ability to meet operational goals and service level objectives. End to end DC Management Services bridging HIT, Edge and DC.
- **Assessments :** DC Facility Condition and Capacity. Site Availability and Resiliency . Energy Efficiency. Operational Risk Assessment.

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T he name belies the trend and urgency as NextGen datacenters are anything but next generation. In fact, embracing it now means running just to keep pace with current trends and needs. As the benefits of digital transformation begin to shape market conditions, businesses are forced to embrace agility as a strategic capability.

Traditional datacenters are simply not equipped to cater to the demands of the new realities which require scalability at speed to support innovation, business expansion and compliance requirements. Businesses with hardware-defined data centers are severely handicapped in responsiveness and have often become an impediment rather than an enabler. Challenges related to long hardware buying cycles, integrating legacy systems, maintaining datacenter equipment distract the IT team from creating value as more than 80% time goes in fixing and maintaining things just to keep the 'lights on'.

When IT is unable to support the organization due to shortcomings in the data center, it loses out on flexibility, agility, responsiveness to achieve competitive edge. Reinventing the data center with new capabilities provides the potency to survive and thrive in dynamic business conditions.

The Business Value of NextGen Data Center

The business landscape has drastically changed as digital transformation has ushered in a data revolution spawned by social media and IoT. This has enabled organizations to capture data and use analytics to gain deep insights into user behavior, understand changing needs, identify new trends and spot opportunities. Artificial Intelligence and data-based insights are enabling businesses to predict demand accurately and design better products and services at high speed.

Thus empowered, organizations are confident

NextGen data center enables organizations to raise the game by delivering benefits that includes optimizing operational efficiencies of business applications, reducing time-to-market, facilitating product innovation, improving employee productivity, and enhancing responsiveness and customer experience by leveraging real-time insights.

in decision making and are able to move at a rapid pace. Agile businesses are bringing in game changing capabilities forcing competition to adopt modern technologies. More often than not, the modernization must begin by reinventing the data center to take advantage of modern applications, cloud services, big data analytics, machine learning and IoT.

Even though traditional data centers ramped up capacity and added new technologies, there are inherent limitations to what data centers can do with a finite set of resources. Catering to business requirements at different points in time, ad hoc ramping focused on solving specific business problems, such as increasing

storage, compute, or network capacity, but could not deliver transformational benefits.

The arrival of NextGen data center came as a shot in the arm to set up flexible, scalable and distributed systems enabling access to IT resources quickly and easily. It does not matter where the resource may reside—within the premises, in colocation centers and in the cloud as automated intelligent systems facilitate dynamic access to resources at a location where required in a seamless manner, adding, and subtracting infrastructure at speed, setting up environments for testing and experimentation, failing fast and innovating on an ongoing basis.

NextGen data centers leverage a software layer to abstract hardware resources bringing into play a dynamic policy-driven configuration environment that kicks in operational efficiency, cost optimization and tremendous agility. This shift from hardware-centric to a software-driven data center dramatically empowers the IT team to raise the game from being a service provider to a business partner. It enables to move beyond just keeping the lights on to delivering value by optimizing business-critical applications and delivering outcomes.

Orchestrated by intelligent software, these systems can dynamically scale at speed within a in a hyperconverged environment leveraging a consumption-based model. From an ownership model, organizations become empowered consumers by shrugging off the need to make huge capital expenditure. Operating in a highly regulated environment, software-defined data centers enhance the security posture by leveraging code-based access to networks and resources, continuous monitoring solutions with built-in auto-remediation that can block access and raise alerts in case of deviation.

NextGen Data Centers Deployment Trends

NextGen data center enables organizations to raise the game by delivering benefits that includes optimizing operational efficiencies of business applications, reducing time-to-market, facilitating product innovation, improving employee productivity, and enhancing responsiveness and customer experience by leveraging real-time insights.

No longer are organizations held back due to rigid, inflexible infrastructure that do not scale and cannot integrate with modern technologies. Software-defined data centers, built along the concept of dynamic scaling, high availability, auto-scaling, load balancing, and

unified management, delivers the technology edge sorely lacking in monolithic data centers.

Organizations can deploy workloads in the most suitable environment based on business imperatives quickly and easily. For example, workloads which require high security and scalability such as a proprietary software with commercial implications may reside at the customer location while data capture and analytics to enhance the product may be deployed in public cloud. New initiatives and workloads with a high degree of unpredictability are ideally suited for public cloud deployment on a consumption basis, lowering the capital investment and associated risks.

To leverage this kind of capability, organizations are ramping up investment in data centers modernization efforts. This is evident in global end-user data center infrastructure spending projected to reach USD 200 billion in 2021, an increase of 6% from 2020, according to Gartner. Despite a 10.3% decline in data center spending in 2020 due to restricted cash flow during the pandemic, the market is still expected to grow year-over-year through 2024. Trends are a little different in India as pandemic woes are affecting IT investments and a large chunk is being diverted to building remote working capabilities such as Virtual Private Networks, desktop-as-a-service, and security but the data center growth is slated to grow in 2021.

Much of the spending is being spurred by digital initiatives to provide new customer experiences such as combining existing physical delivery mechanisms with digital channels. This is much evident amongst retailers adding digital experiences for tighter integration of consumer engagement across channels when the pandemic caused a steep downfall in customer footfall.

Not just retailers, businesses across spectrum including the automobile industry embarked on digital initiatives to beat the pandemic set-back. For example, as car sales dipped, automobile majors launched new business models by partnering with rental companies to offer cars on a subscription basis.

Healthcare providers leveraged digital channels to care for non-COVID patients during the pandemic. While telemedicine is not new, adoption was relatively slow. But much of that resistance melted during the lockdown as care and supervision had to continue and healthcare systems had to adjust the way they triage, evaluate, and care for patients using methods that do not rely on in-person services. Thanks to the ongoing digitalization initiatives at large hospitals including Manipal Group, HCG Cancer Hospital, Medanta Medicity, and Apollo could bounce back with minimum disruption.

The entertainment industry is gradually moving bulk of its delivery over the OTT platform. Even as the trend gained momentum, the pandemic became an inflection point for streaming videos and poised to be a game changer in the history of the entertainment industry. Digital is evolving customer retention strategies with enhanced loyalty program with continuous monitoring to make the most appropriate offer at a specific touch point.

Implementation Challenges

Putting in place a data center strategy that leverages resources on a dynamic basis is complex and must take into account the total cost of ownership, privacy and security issues and integration challenges with legacy applications. It requires comprehensive planning, taking into consideration business priorities, technical capabilities and defining the right partnerships.

While flexibility and agility are business drivers, balancing the TCO is critical to achieve comprehensive benefits, otherwise costs can spiral out of control and diminish the gains. In the ownership model while calculating the TCO, meticulous and informed planning can significantly reduce capital expenditure while taking into account operational expenses associated with maintaining the infrastructure, power, networking and personnel and costs associated with downtime, cooling, energy inefficiency, non-optimized compute workloads and network connectivity.

While considering cloud assets, it is important to understand the provider's billing model, the robustness of the service partners and ecosystem of developers to have a rich choice of applications. The TCO calculation must consider the levels of service availability; guarantees for reliability; performance of services including latency and speed of access to data; slabs of service delivery, etc. Consider the guarantees for data protection in case of a disaster and what remedies must be taken in case of failure.

Legacy applications and processes are not inherently designed to scale and integrate with cloud-native tools and will not be equipped to take advantage of NextGen data centers. So, data center modernization must be accompanied with application modernization with cloud-native capabilities that can scale at speed, built on a foundation of micro-services architecture and exposed APIs.

Most organizations with traditional data centers are bogged down with legacy systems with hundreds of applications including package implementations, point solutions, custom applications and software-

as-a-service solutions. These systems will be highly challenged to work in converged infrastructure and modernization efforts must look into these aspects during planning.

Data center operations spanning different environments, service providers and geographies have complex security, governance and compliance challenges. Security in the cloud is a shared responsibility whereas traditional data centers deploy security on the perimeter. The governance framework must consider security and compliance requirements in different environments and use automation such as code-based configuration, best practices such as security hardening processes, role-based access, alerts and auto-remediation processes.

Data Availability

Built on a foundation of availability and reliability, data centers form the backbone of business operations, and any downtime can result in disastrous consequences. Failure of critical-business applications such as those that enable financial transactions, air-traffic control, monitoring applications not only result in compliance failure and financial loss but also result in death and destruction. These applications require high availability of five 9s, 99.9999 availability for safety and security of operations.

NextGen data centers deliver high uptime by deploying applications in a hyperconverged environments with real-time data replication and automatic switchover in case of failure. Most public cloud providers offer availability zones enabling customers to deploy applications simultaneously and software-defined data centers allow to advantage of capabilities that trigger automated disaster recovery in another location when an application goes down.

However, architecting highly available applications has cost implications as the deployment needs to be running simultaneously in multiple environments, therefore uptime and availability requires a calibration of cost and business requirement.

Cloud-native modern applications built using containers and serverless have high resilience and self-healing capabilities due to high degree of automation. Built on the principle of immutable resources, these systems can automatically detect a weak resource and replace it to always deliver consistent level of performance.

Data availability is critical as losing access to data can result in revenue loss directly and indirectly with many employees dependent on that data to do their work.

Analytics programs processing large amounts of data from devices in real-time basis provide inaccurate output in the absence of continuous and credible data inputs.

Critical Success Factors

Below are few indicators to measure the success of a modern data center initiative.

Capacity: Data center scalability is a basic measure of its deliverables. It does not matter whether the capacity is delivered from the in-house data center, outsourced provider or public cloud as long as the performance of the workload is not compromised. During peak loads, the application load balancer may route traffic to servers located in third-party data centers to deliver consistent user experience.

Control: Having a solid management system that cut across environments is crucial to the success of a modernization strategy, given a hyperconverged environment comprises multiple data centers in different locations. The control layer must be equipped with robust monitoring and management capabilities that enables resource provisioning; provides visibility into resource utilization and performance; and enforces

Putting in place an execution plan for NextGen data center must begin with a vision of transforming and simplifying the IT infrastructure via abstraction wherein automation is seen as simplifying management, enabling speed, and reducing the margin of human error.

security via a single window to cut down inefficiencies and cost-overruns and ensure compliance adherence. A metrics-based automated management platform to ensure scalability and application performance; code-based configuration; automation of administering routine tasks such as managing patches, updates; and with reports on security, utilization and performance metrics cuts down on management complexity while enabling operational efficiency.

Compliance: Operating across boundaries in hybrid environment, compliance and security can be hit with roadblocks but this can be overcome by deploying best practices in design principles and strengthening processes with continuous monitoring and remedial solutions. Security must be embedded with SecurityByDesign approaches that includes code-based configuration, log tracking, alert management, identity-based access to resources, and auto-remediation processes. Physical data center locations must adhere to global security standards and certifications, such as PCI-DSS and SOC compliance.

Cost: With multiple delivery models in play, cost can spiral out of control and service management is

essential to achieve business benefits at a controlled cost. Leveraging IT Infrastructure Library (ITIL) principles for metering and analysis to accurately predict consumption trends, capacity management and chargeback should become integral in the management of NextGen data center.

Security: Sophisticated software is needed to manage and orchestrate identity, intrusion detection and policy enforcement. Software release and management processes must be managed and deployed via automated pipeline using DevSecOps principles and continuous security and compliance achieved by automated tools with alert management. Use of analytics is essential to enhance monitoring and compliance to proactively identify and prevent security events.

Possible Approaches

Putting in place an execution plan for NextGen data center must begin with a vison of transforming and simplifying the IT infrastructure via abstraction wherein automation is seen as simplifying management, enabling speed and reducing the margin of human error.

The following are few things to bear in mind while charting the path to a software-defined data center with transformational capabilities.

Define Your Own Cloud Strategy: Each organization must chart its own path depending on the burden of legacy systems, competitive pressures and the imperative to innovate. While doing so, it is prudent to align solutions that allow to leverage the existing people, processes, and technologies. Although there is no playbook for a definitive path to transition, the plan must prioritize business objectives, align security and compliance requirements; map availability of skills sets. At the same time, the plan must be periodically reviewed and tweaked to suit dynamic business requirements.

Identify Business Objectives: Knowing exactly the business requirements in the short-term and long-term make it easier to design an effective transition plan. For example, if are you looking for business continuity solutions, then depending on the criticality of the workload, you must design your backup and disaster recovery. Again, if your core application requires scalability and has high security requirements, explore a private cloud option to supplement capabilities of the in-house data center.

Competitive Landscape: Understand the competitive

Understand the competitive scenario with regards to the kind of applications and use cases. If the sector is leaning heavily on analytics, then you need to define your digital strategy and take advantage of public cloud capabilities to capture and store data for real-time analytics.

scenario with regards to the kind of applications and use cases. If the sector is leaning heavily on analytics, then you need to define your digital strategy and take advantage of public cloud capabilities to capture and store data for real-time analytics.

Edge Computing: This is definitely a consideration as it will determine the location of your data centers. To avoid latency, data centers must be in close proximity to users, so you may need to leverage multiple small data centers and your strategy must design that input.

Hybrid Cloud: Leverage different data centers options for specific business objectives, using combination of different public cloud providers and using colocation with on-premises deployment. Public cloud gives unlimited scalability while private cloud may be more appropriate for a workload that requires heavy regulatory compliance. Again, if the need is to launch a new initiative which does not have dependencies, then you can just start using a public cloud infrastructure

provider. Often large organizations become multi-cloud adopters by accident as different departments may start using different solutions.

Operational Efficiency and Agility: Managing a software-defined NextGen data center requires new technical capabilities such as DevOps, design architectures built for scale and availability and deep knowledge of security issues. An assessment of in-house skill sets is important to build capability or identify the right partner with required skill and experience to help make the transition.

Most organizations are putting in place a Nextgen data center strategy to take advantage of flexibility and scalability and to keep pace with the changes brought by social media, cloud, and analytics. Hyperconverged data centers enable to bridge the gap faced by traditional data centers saddled with legacy systems to stich a solution that embraces digital technologies and leverage opportunities to experiment and innovate on a continuous basis. ■

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"For the past 50 years, everyone focused on the three Vs - volume, variety and velocity. The focus in the age of insight is the fourth V - value. In the age of insight, data is acted upon close to the moment of creation to drive action and understanding."

–Antonio Neri,
President and CEO, HPE

INDEX

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"The best way to predict your future…. is to invent it."

–Alan Kay, Computer Scientist

The Future of Enterprise

This book is for IT decision makers in large and medium Indian enterprises who are planning their future technology implementation plans in selected technology areas.

This book is produced by 9.9 Group under the aegis of its flagship B2B technology publication and community platform, CIO&Leader. The contents of the book have been prepared based on the deliberations of senior enterprise IT leaders and senior representatives from technology industry, through a program called Future of Enterprise, part of the 21st annual conference of CIO&Leader. All the meetings were conducted virtually in the months of February and March, 2021.

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