State of IT Infrastructure 2020

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Foreword

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Delivering trusted IT infrastructure in the form of any device, any time, any place, will be an imminent need

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I have met several senior leaders in the industry who have started using the term, "invisible infrastructure," and believe it is the future of IT infrastructure. Equally, there are many who staunchly believe this doesn't depict reality. Opinions are clearly divided—and they depend on where in the supply chain you are!

Business users who consume IT services, developers and CFOs (who write the checks) are happier avoiding a technology refresh. They would rather tap into a wire, consume the needed infrastructure and pay for what they use. Public cloud providers have proven this is possible, even though the scope is restricted to data centers and related services.

I have heard convincing arguments on the other side of the divide as well. This section believes we are not yet ready to let go of the hardware in data centers, user devices, appliances, and network equipment. They don't envision a near-term future where all of these will completely disappear or run without oversight.

While points of view differ, there is undoubted consensus that business must innovate, stay relevant for the industry 4.0 future, and have the ability to adopt to situations like the current COVID-19 pandemic we are facing. As evident from this research, while IT set us up to move in the right direction, the pressure to deliver outcomes will be greater from here.

Regardless of how you view IT infrastructure, enterprise still wants it delivered in a trusted manner. Taking on this challenge requires leveraging multi-cloud, Software-Defined Infrastructure, Artificial Intelligence, automation, and intent-aware operations to abstract infrastructure services, elevate KPIs to business levels, and present a truly "invisible infrastructure". I don't think this could have been possible without the advancement we see in technology as well as delivery and business models.

For decision makers, this presents a growing dilemma: Should they bet on running current infrastructure or on making a change?

From my recent conversations, it is evident that the balancing act has become even more complex. Resources are limited while the wide canvas of infrastructure elements around cloud, Internet of Things, Augmented Reality, Virtual Reality, blockchain and cybersecurity make navigating the maze a stressful exercise.

I believe the report "State of IT Infrastructure 2020" will serve as a compass for those mandated to provide IT infrastructure. The report does this by investigating peer strategies and extracting insights using unbiased analysis and distilling trends. I know its pages will accelerate your journey to Industry 4.0. And on behalf of my team and everyone at Wipro, I wish you a safe, happy and fruitful journey!

Editor's note

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New technologies and approaches are infusing inordinate power into organizations, turning the spotlight back on IT infrastructure

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A recent headline grabbed my attention. It asked, "Are deep tech and infrastructure sexy again?" New technologies and approaches— like automation, Artificial Intelligence, Machine Learning, IoT, edge and ambient computing, DevOps and boundaryless networks—are infusing inordinate power into organizations, turning the spotlight back on IT infrastructure.

Infrastructure strategies are about to witness a sea of change as organizations jockey for a place in the digital future. A recent IDC report suggests that public cloud spending alone is set to double from US$229 billion in 2019 to about US$500 billion by 2023[i]. Clearly, the change will be swift, challenging organizations to commit the right skills and seek out experienced technology partners.

That is why the "State of IT Infrastructure 2020" report will prove to be an invaluable guide, providing objective insights and ways to validate your thinking. This report, a first-of-its-kind, is the result of experience shared by global businesses and therefore, you can expect an accurate view of ground reality.

The executive summary of this report provides the big picture: The major challenges faced by organizations and the set of capabilities that must be delivered to business stakeholders at the right price point. The real challenge is to make the changes while keeping the lights on—more or less the equivalent of renovating an aircraft mid-flight! The report goes on to examine the reasons why organizations are taking this risk, the future state of IT infrastructure they hope to achieve, and where most organizations are today in that journey.

With digital being a major factor in delivering new customer experience, handling new channels,

and reimagining processes, we take a look at how this is resetting priorities and then peel the layers to gain deeper insights into the areas of storage, End-User Computing, network and tools.

No report would be complete without examining the growing trend of crowdsourcing, the evolution of the gospel of governance, and the need for newer security measures. We conclude by looking at the barriers that could delay infrastructure transformation and provide an industry-wide perspective.

While this report was being written, we began witnessing the devastating effect of COVID-19 and the lockdowns that came with it across the world. The pandemic put to test the resiliency for our systems and practices. The experience has given us insights into IT infrastructure that will also prove useful to you. I would also like to thank some of our leaders who volunteered to write special sections to share their personal insights through handling the pandemic situation.

Executive summary

Preparing for the brave new world of IT infrastructure

IT infrastructure in 2020 has the potential for seminal transformation. Emerging digital technologies and processes such as automation, Artificial Intelligence (AI), 5G, IoT, edge and ambient computing, DevOps, AIOps, and crowdsourcing are firing a new wave of innovation. This report shows that the IT infrastructure practice is coming to the party but not universally as it should. The COVID-19 lockdown and the ability of their IT to respond to the emerging situation was a reality check for many organizations; similar organizations operating in the same industry were faced with vastly different grades of challenges. It is not clear if some of them will ever recover from this.

IT infrastructure, which largely existed to support business, now has the opportunity to play a critical role. It can improve user experience, accelerate development, help meet regulatory requirements with greater confidence, extract more value from investments and directly add to the bottom line of businesses. For the bold and brave practitioner of IT infrastructure management, there is an entire world of tempting possibilities to consider.

Evidence suggests that businesses want to take a leap of faith and transform their infrastructure but they're restrained by the uncertainty (and conflicting views) around shiny new technology and the cost of modernizing legacy systems. There is also the uphill task of integrating data and the daunting mission of building the advanced skills and knowledge required to flawlessly push the transformation toward cloud and invisible infrastructure.

The findings in this report highlight the unique challenges before IT infrastructure specialists and how they are addressing these challenges. The report shows there are organizations that are experimenting and pioneering the way forward.

The top findings in the report turn the spotlight on the challenges and the way forward for designing viable solutions. The key takeaways include these topics:

- Aligning IT infrastructure to business outcomes is the top challenge faced by organizations suggesting that IT infrastructure must extend beyond enabling business and become an effective lever for success.

- 75% of businesses find that the need to upgrade outdated infrastructure is driving investments (the current average age of hardware in IT estates is slightly over 5 years). This implies that current infrastructure is unable to leverage new technologies such as AI, AR/VR/MR, ML, IoT, 5G, automation, voice-based HMI and blockchain.

- Nearly 81% of organizations are re-skilling their existing workforce in a bid to increase digital penetration.

- 24% of organizations do not have a single cloud partner. In other words, the multi-cloud is a reality, the pervasive digital push will ensure we address this state of cloud.

- 16% of organizations are operating live IoT-based solutions and the infrastructure teams own this (compared to 14% being owned by the business teams). IT infrastructure teams could find themselves in a situation where they play a diminishing role in this area.

- Over 6% of organizations have AIOps centric to their operations. 94% have either not implemented AIOps or only have a few pilots in some areas or have implemented AIOps only in select production areas. This is largely because organizations have not yet accepted the idea that AI-enabled automation would be the basis of all operations in the future.

- 39% have explored crowdsourcing and do not find it relevant for IT operations. Could creating breakthroughs by leveraging crowdsourcing for IT Ops be the new area for smart IT infrastructure team?

The post COVID-19 era is going to rekindle discussions for practical down-to-earth approaches to solving many of the challenges, with several revealed in the ideas and concepts discussed in each section of the report. For the keen observer and analyst, the survey results also point to the trends to follow, the investments to bet on and the expertise to tap into.

IT infrastructure post COVID-19 – A practitioner's view

There is no parallel to the uncertainty triggered by the COVID-19 pandemic. It is possible that we will slowly begin to get back to normalcy in a few months, but there is no doubt that we will remember 2020 for the pain, acute change, and the massive challenges COVID-19 presented to mankind. We will have our own special war stories to narrate!

While it is foolhardy to accurately predict when recovery will begin, we know this for certain: We were not prepared for a disaster of this scale and we cannot be as unprepared the next time.

Let's begin by thinking of the worst case scenario. Let's assume that the new normal will include frequent threats from the periodic re-emergence of the virus (or something equally disruptive). The challenge for planners is to make reasonable assumptions, take a cue from events that have been unfolding since the start of this year and create blueprints for the future.
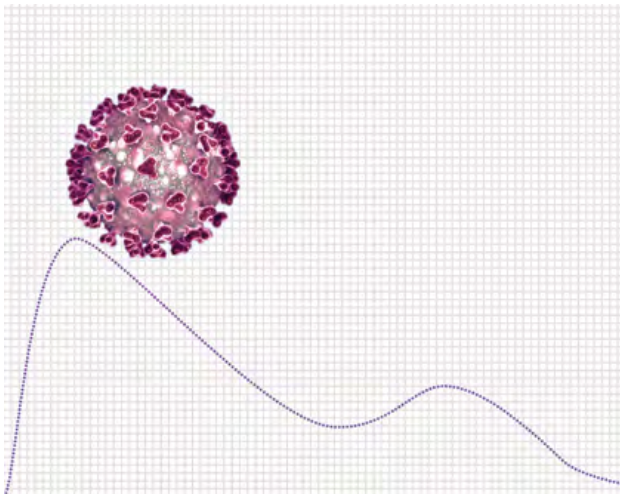
The recovery will be staggered; the recovery timeline will not be uniform across the world; the impact on the economy will not be uniform across nations; and government reactions will differ across the world. As we navigate through this, planners will have to consider how to **sustain** business through this phase, **rebound** back to normal and, importantly, not fail to **capitalize** on

emerging opportunities (see Figure I: Recovery from the pandemic). As Yuval Noah Harari, the best-selling author of *Sapiens* and *Homo Deus* said, "The decisions people and governments take in the next few weeks will probably shape the world for years to come."[ii]

Impact on the business

A health crisis has very quickly turned into a financial catastrophe. Unemployment, stress on financial systems and shrinking GDP is going to result in a big shake out. The severity of the impact will alter many aspects of the world as we know today. However, business is bound to anticipate the following scenarios influencing their future operations and prepare to handle them appropriately:

Uncertain state of demand

The state of the local economy has a critical influence on the spending appetite of customers. Discretionary spends will be put on hold based on the circumstances of the customer. Customers will realign their priorities, changing their buying preferences and patterns.

In a bid to revive and protect local economies, governments will resort to interest cuts, loan deferments, tariffs, quotas, import control, selective subsidies and preferential subsidies, impose technical barriers, etc. This is going to alter known global demand patterns.

Shift in channels

There will be short-term and long-term constraints on travel, reducing face-to-face interactions, restricting exhibitions, conferences, events, meetings, footfalls in stores, stadia, and other public spaces. There will be a marked shift towards digital channels for interactions, decision-making, and purchases. This will render high street formats unviable for many businesses (example: retail and banks). Margins will be under strain.
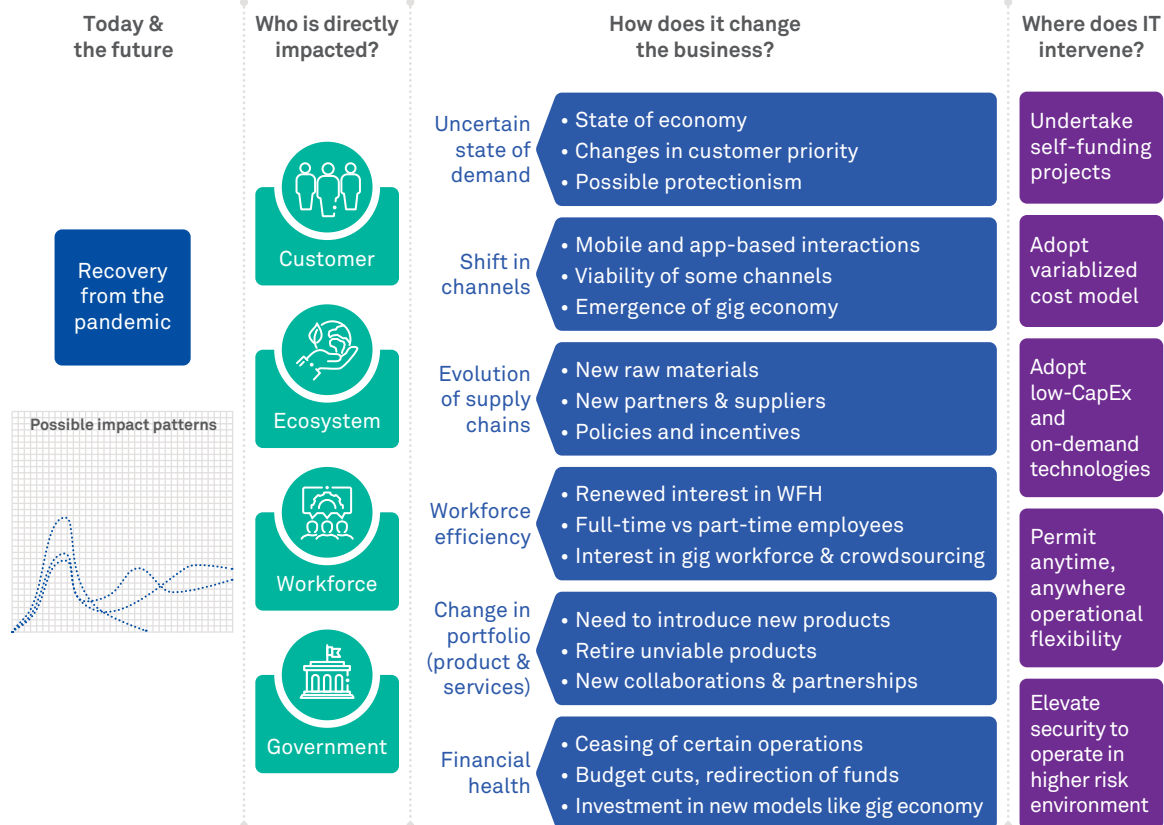
Figure I: Recovery from the pandemic

The gig economy will become a preferred model for product and service design and delivery. Crowdsourcing will see a major shot in the arm. This will be an outcome of the fact that the pandemic will render millions jobless. According to the International Labor Organization (ILO), more than four out of five people (81%) in the global workforce of 3.3 billion are currently affected by full or partial workplace closures.[iii] Projections suggest that the US alone will see the loss of 47 million jobs, sending the unemployment rate to a shattering 32.1%.[iv] As the economy recovers, rehiring and retraining will take time, money and resources. Instead of waiting to recover, organizations will explore crowdsourcing.

Evolution of supply chains

Modern supply chains are incredibly complex. The disruption caused by COVID-19 will bring supply chain risk management into sharp focus. Manufacturing hubs will change. Businesses will design new capabilities that allow their second and third line of suppliers to access real-time data and ensure they can turn to a demand-centric model. The volume of data being handled along with the analytical and predictive models will change dramatically and so will the infrastructure to back it.

Additive manufacturing/3D printing will see renewed interest. This will spawn expertise in sourcing and handling new materials, distribution of designs and Digital Rights Management (DRM), and will change the way spare parts and components are manufactured and distributed. A major showcase of 3D printing prowess came when the 3D printing community stepped forward to print oxygen valves, hands free door handles and components for test kits.[v] The rise of 3D printing will also result in new policies and incentives that can tilt the balance of relationships and practices established by traditional businesses.

Workforce efficiency

Having tested the viability of Work from Home (WFH) for almost two decades, businesses are going to make deep investments in the practice. The employee-institution relationship will undergo a severe evolution. HR practices will change and employees will want work from anywhere, providing services to multiple

organizations (and distributing their earnings risk) instead of opting for full time employment with a single employer. New tools to monitor and measure workforce efficiency will be in demand. Complying with regulatory norms around data, its location, storage and access will come in for scrutiny. It will take time to overcome these operational challenges, but the concept of WFH has arrived. The scenario will, however, vary from industry to industry.

Among the biggest changes COVID-19 will trigger is the urgency to induct bots into the workforce. While bots will work collaboratively with employees in areas such as finance and insurance, mining, utilities, telecom, health care, retail, construction, logistics and warehousing, they will be able to go independent when necessary. It is a good guess that many organizations will measure their ability to withstand uncertainty by the ratio of bots to employees in the organization. This trend will also give rise to a greater acceptance of—and investment in—automation, Artificial Intelligence and cognitive process automation in business processes.

Change in portfolio

This situation also presents an opportunity to adapt existing products and services to new demands or creating new offerings and venturing into new areas. Businesses will also have to take rapid decisions to retire unviable products and exit existing businesses. The churn will result in new relationships, new collaboration ecosystems, new networks and new competitors. Organizations must be prepared to reset and reboot their operations.

Financial health

The financial strain on businesses will be unprecedented and the ability to absorb this strain will vary across industries. Budget cuts, redirection of funds, the hunt for new suppliers, etc., will intensify. Amidst the uncertainty, projects will morph to meet new requirements. But the dominant thrust of businesses will be to invest in digital. Businesses that do not digitalize will become irrelevant. An interesting image has been making the rounds of LinkedIn and Twitter. It asks, "Who led the digital transformation of your company? A) CEO B) CTO C) COVID-19.[vi] Five years from now, many organizations that survive the financial stress induced by COVID-19 will be responding with "C".

Implication for IT infrastructure

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Based on some of the business changes, we can explore the best possible alignment the IT infrastructure team can plan for and how they can address new requirements in a changed business environment. IT infrastructure teams would do well to bring attention to:

- **Adopting variablized cost model:** Without clear business projections from business, the appetite to absorb fixed cost will significantly reduce. The preference will be to switch spend towards variable cost and semi variable costs.

- **Undertake self-funding projects:** There will be an urgency to execute projects that build new capabilities or to take up urgent cost takeout activities. The infrastructure teams will have to figure out innovative ways of accomplishing and funding these.

- **Adopt low CapEx and on-demand technologies:** Without a clear forecast of what, when, where of the requirements from business, IT planners will find it challenging to arrive at demand and capacity projections. Fortunately, a range of cloud options is available that can substitute CapEx-heavy investments to a utility-based model, and allow easy exit and realignment. This means planners can go wrong with decisions but still manage to change their actions.

- **Permit anytime anywhere operational flexibility:** Without the ability to clearly pin down the operational requirement to a location, the need will be to adopt IT technology suppliers that provide flexibility and realignment options across the globe.

- **Elevate security to operate in higher risk environments:** Budget constraints may curtail some scheduled technology refresh or defer crucial upgrades. This will necessitate implementation of new operational practices, redesign of some networks, and augmentation of tools to ensure risk reduction. This will ensure no guards are let down, opening opportunities for malicious actors.

In the following analysis, we provide recommendations on how projects around the required IT initiatives can be prioritized. Projects are placed in four quadrants based on the priority level and the required investments to realize outcomes (see Figure II: Project investments and priorities post COVID-19).

- **High priority - High investment:** While the business sees a need to invest in these projects to increase its digital powers, the investment requirements can limit the vigor with which these projects are pursued. IT departments should explore innovative ways of engaging the partner ecosystem or other gain share models to fund these projects.

- **High priority - Low investment:** IT should invest and continue projects around these since they will eventually deliver the capability required that will align the business to optimally operate in the post COVID-19 era.

- **Low priority - High investment:** New transformation projects around these areas have to be carefully evaluated on a case-to-case basis before investments are made. The rewards may be high for certain industries and they may see reason to invest even if the ROI may be a few years away.

- **Low priority - Low investment:** While enterprises may not see compelling need to take up these projects, some businesses can see rationale to take up these projects in standalone mode or in combination with other projects.
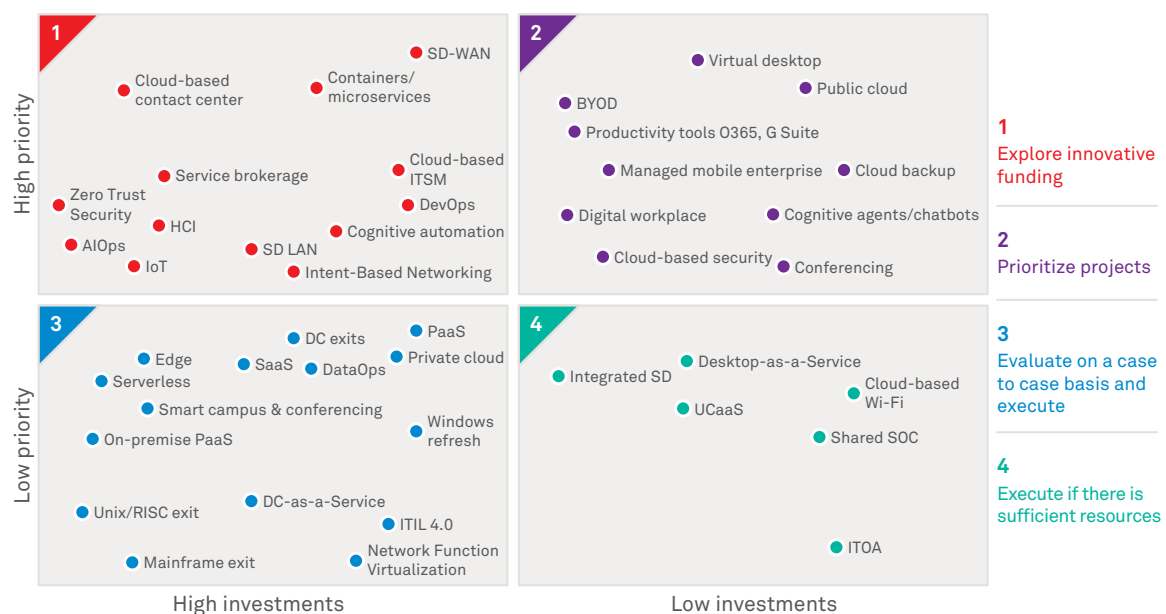
Figure II: Project investments and priorities post COVID-19

Conclusion

We have historical precedence that goes back a century for similar pandemics. Unfortunately, we can't draw parallels and apply learnings from the past to today's digital era. But we can use reasonable assumptions, trace patterns, and make informed choices. We hope the ideas and scenarios presented here serve to ignite fresh thinking. We are certain new ways will emerge to **sustain** businesses during the lockdown phase; but what we must aim for is the timely **rebound** and the ability to **capitalize** on emerging opportunities.

The need for change

The dynamic world of IT infrastructure

IT infrastructure has been a silent sentinel overseeing the success of organizations. In the last few years, digital transformation, data technologies, neural networks, Internet of Things (IoT) distributed applications, Artificial Intelligence, cloud and the growth in device types have swiftly re-written the rules of IT infrastructure.

IT infrastructure has become more important than ever before; today's storage devices must also be able to compute, networks must become intelligent, latency must reduce, computational capacity must be elastic, infrastructure should support DevOps, and security must be dynamic. The scale of disruption in the IT infrastructure landscape is unprecedented.

The changes are exciting. The emerging IT infrastructure landscape offers new opportunities for innovation, supports new capabilities, and unlocks larger rewards.

IT infrastructure has also been central to the advancement of technology. We can trace the fascinating history of IT back to the key developments that shaped the course of its journey (see Figure 01: Key developments in IT). Some of these developments took years for the world to note and realize their true impact. Others showed immediate promise and grabbed attention

but eventually proved to be not-so-significant. From the history of developments in IT, it is evident that innovations in infrastructure and platform technologies have played a profound role. These innovations introduced new capabilities and shaped the development of the entire field.

Ease of adoption, affordability, and value to the user determine the success of an innovation. Unfortunately, many innovations in the IT infrastructure space fizzle out due to the lack of an apt software—in the form of large monolithic applications, a platform, or an embedded piece of firmware.

Successful technology does not necessarily make its presence felt in an enterprise. A gaming device makes a good example of this truth. Businesses do experiment with new technologies, they undertake proof of concepts, run pilot projects—but ultimately, there has to be clear and measurable ROI and business value to drive widespread adoption.

The emerging IT infrastructure landscape offers new opportunities for innovation, supports new capabilities, and unlocks larger rewards.

1850 – 1954
- First submarine cable
- Telex Machines
- ENIAC
- Modem
- Commercial Mainframe

1955 – 1967
- Transistors
- Hard Disk
- Digital Phones
- CDC 6600 Supercomputer
- Moore's Law

1968 – 1971
- Integrated Circuits
- Internet
- Fiber Optics
- Intel 4004 Microprocessor
- Unix

1972 – 1974
- Banking automation
- C Language
- Modern Mobile
- Ethernet, Barcode
- IBM SNA LAN

1975 – 1980
- Computer Games
- Email
- Apple ii
- Oracle
- GPS

1981 – 1983
- MS DOS, RISC Processor
- Novel Netware,
- Commoditized Networks,
- First Computer Virus
- TCP/IP

1984 – 1985
- Multimedia
- Macintosh
- Firewall
- First laptop
- Commercial Li-ion battery

1986 – 1992
- Multi-Protocol Router
- WWW, DTP
- GSM Cellular
- SSD
- Linux

1993 – 1995
- Intel Pentium
- Mosaic Browser
- Bluetooth
- Fiber Channel(FC)
- Java

1996 – 1997
- DVD
- Search Engines
- Netflix
- First IoT
- Wi-Fi

1998 – 2003
- VMWare
- Dot com burst
- Commercial 3G
- Blade Servers
- iTunes

2004 – 2009
- Social Media
- AWS Cloud
- DJI Drones, iPhone
- Mobile Internet
- Bitcoin

2010 – 2012
- Hi Res Smartphones, iPad
- The supercomputer revolution
- Converged Infrastructure
- Conversational Interface SIRI
- Raspberry Pi
- NVMe

2013 – 2015
- Playstation, Xbox
- Apple Pay
- SD-WAN Terminology
- Wearables Apple Watch
- Kubernetes
- Tensorflow, Windows 10

2016 – 2018
- AR/VR
- AI Revolution
- WannaCry Largescale Randsomeware
- Persistent Memory (Intel Optane)
- Hyperscale DCs cross 400

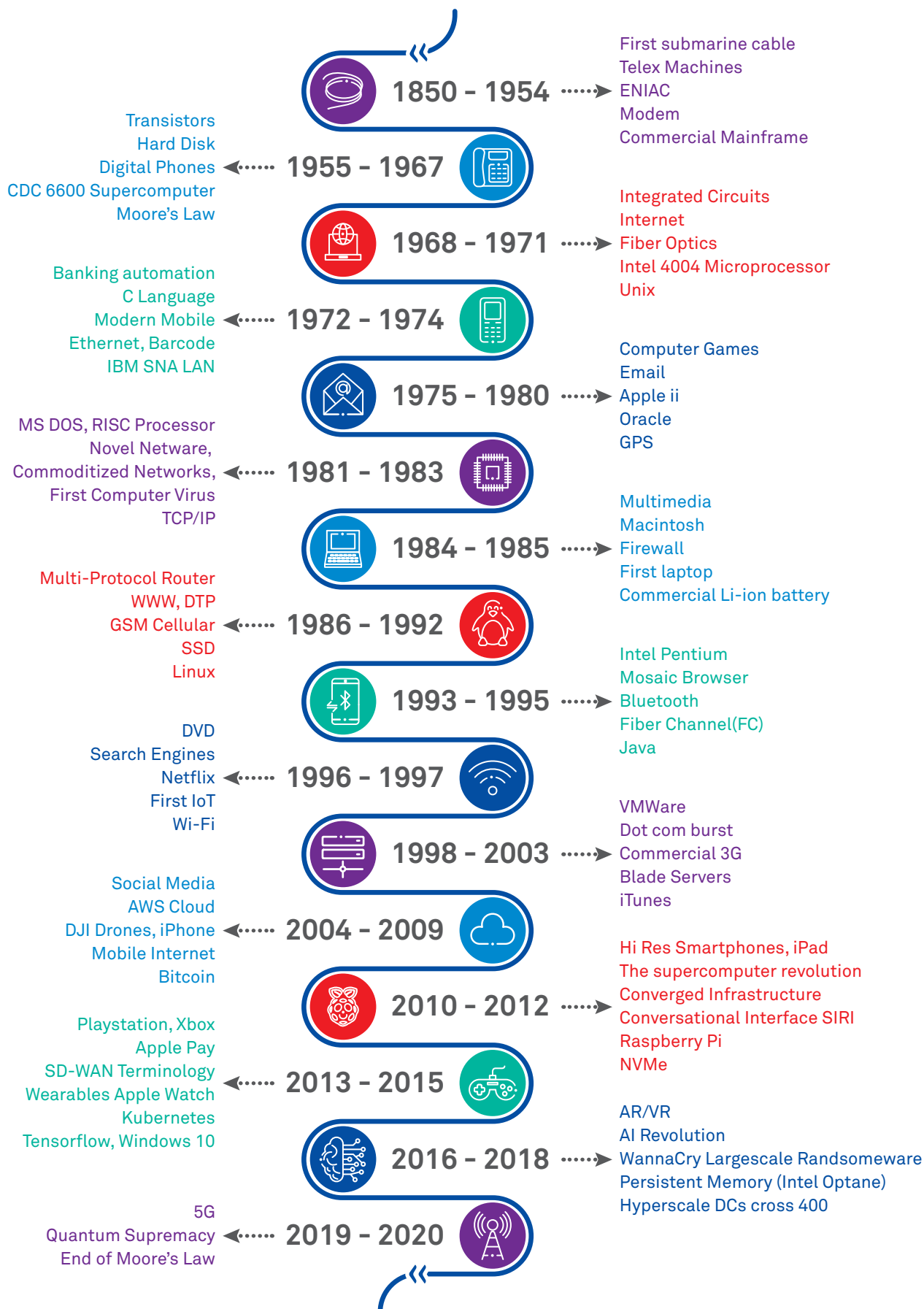**2019 – 2020**
- 5G
- Quantum Supremacy
- End of Moore's Law

Figure 01: Key developments in IT

IT infrastructure and the enterprise

The enterprise scenario is more challenging than it appears because technology often doesn't exist in isolation. It has to interoperate with existing systems and address the changing operational requirements of business. Therefore, interoperability, security and compliance become added criterion for success within the context of an enterprise. It is this complex mix of criterions that results in the failure of many promising technologies.

How an enterprise looks at their IT building blocks and how they are aligned with their value systems has also evolved (see Figure 02: The new enterprise viewpoint of IT infrastructure). Additionally, with constant change in business models, enterprises have experimented with different operating models.

During the days of the mainframe, one single team planned, built and ran IT completely.

This model was difficult to scale as the skills and nature of work broadened. Breaking the ownership between IT infrastructure and applications is a tried and tested model today. It is easy to segregate work into different teams based on their skills. As outsourcing became a common practice, this model changed; retaining control while engaging parties from outside became important.

A common practice today is to segregate and associate compute, storage, network, user devices and platforms (that abstract them for applications) with IT infrastructure teams whereas application lifecycle is handled by a different team. This model is now being challenged. With the advent of cloud, digital adoption, the practice of DevOps and full stack platforms, some of the distinct segregation in technologies and processes is getting blurred. We are at a cusp that is putting to question many existing beliefs and practices.
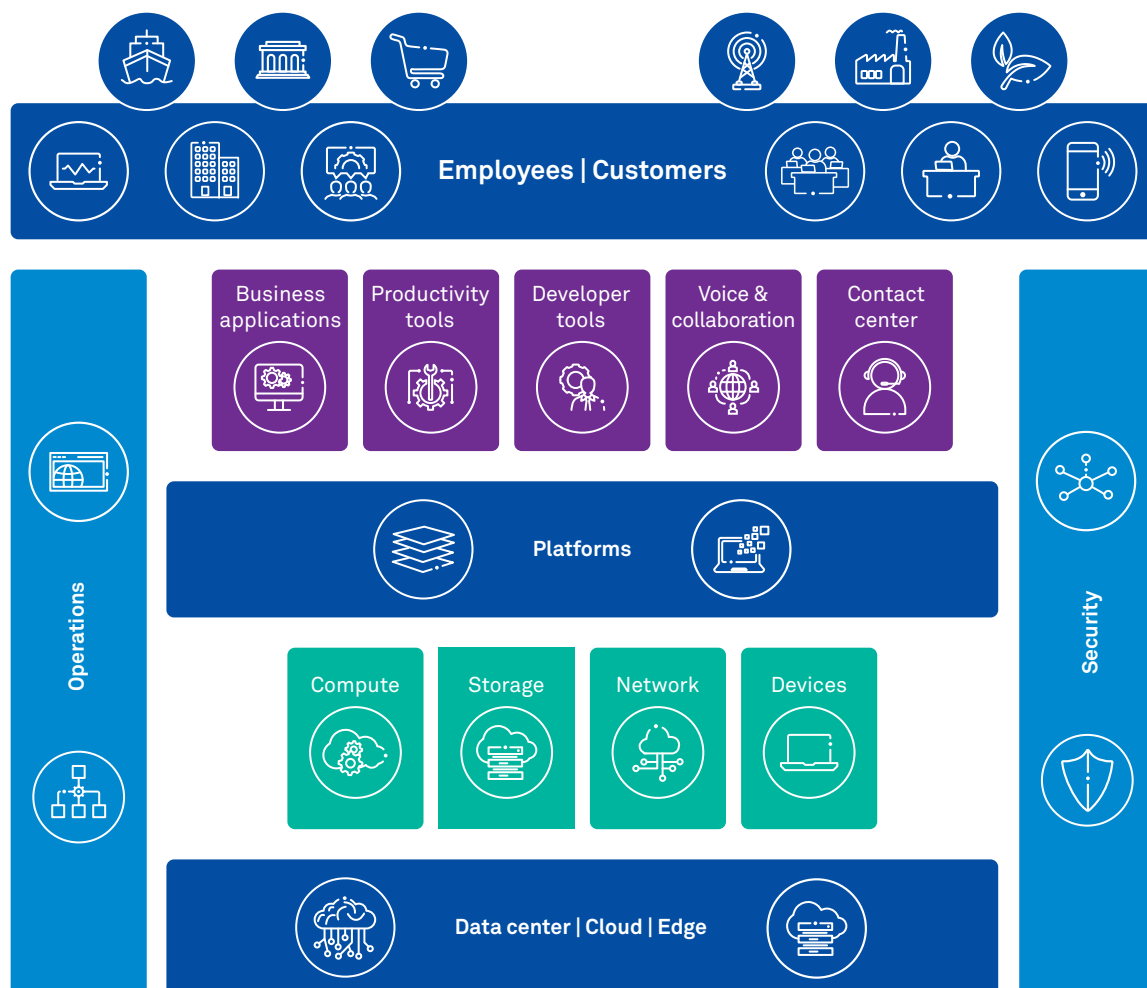
Figure 02: The new enterprise viewpoint of IT infrastructure

The changing profile of IT

IT is an enabler of modern business. It has become more than just a tool to make back office processes efficient. Social media, mobile, cloud and IoT have blurred the lines between the physical and the virtual world. Digital is now about delivering new Customer Experiences, handling new channels, building scalable and sustainable practices and developing the capability to sense, analyze and control an outcome in the real world.

The Fourth Industrial Revolution (Industry 4.0) has also become an important phrase in the vocabulary of IT infrastructure practitioners. The Fourth Industrial Revolution combines hardware,

software, and biological entities in cyber-physical systems. This brings into sharp focus the need for seamless interfaces, communication and connectivity.

IT infrastructure has a key role to play here. Professor Klaus Schwab, Founder and Executive Chairman of the World Economic Forum, and author of *The Fourth Industrial Revolution*, expects this era to be marked by breakthroughs in emerging technologies in fields such as robotics, AI, nanotechnology, quantum computing, biotechnology, IoT, the Industrial Internet of Things (IIoT), decentralized consensus, 5G, 3D printing and fully autonomous vehicles.

Mouse over/click the icons in the picture for details

Products

Value stream

CapEx →

OpEx →

Development

Always ON

Boundaryless compute

Digital world

Digital concierges

Help desk

Cognitive operations

git

Smart campus

Field support

Crowdsourcing

Mobile workforce
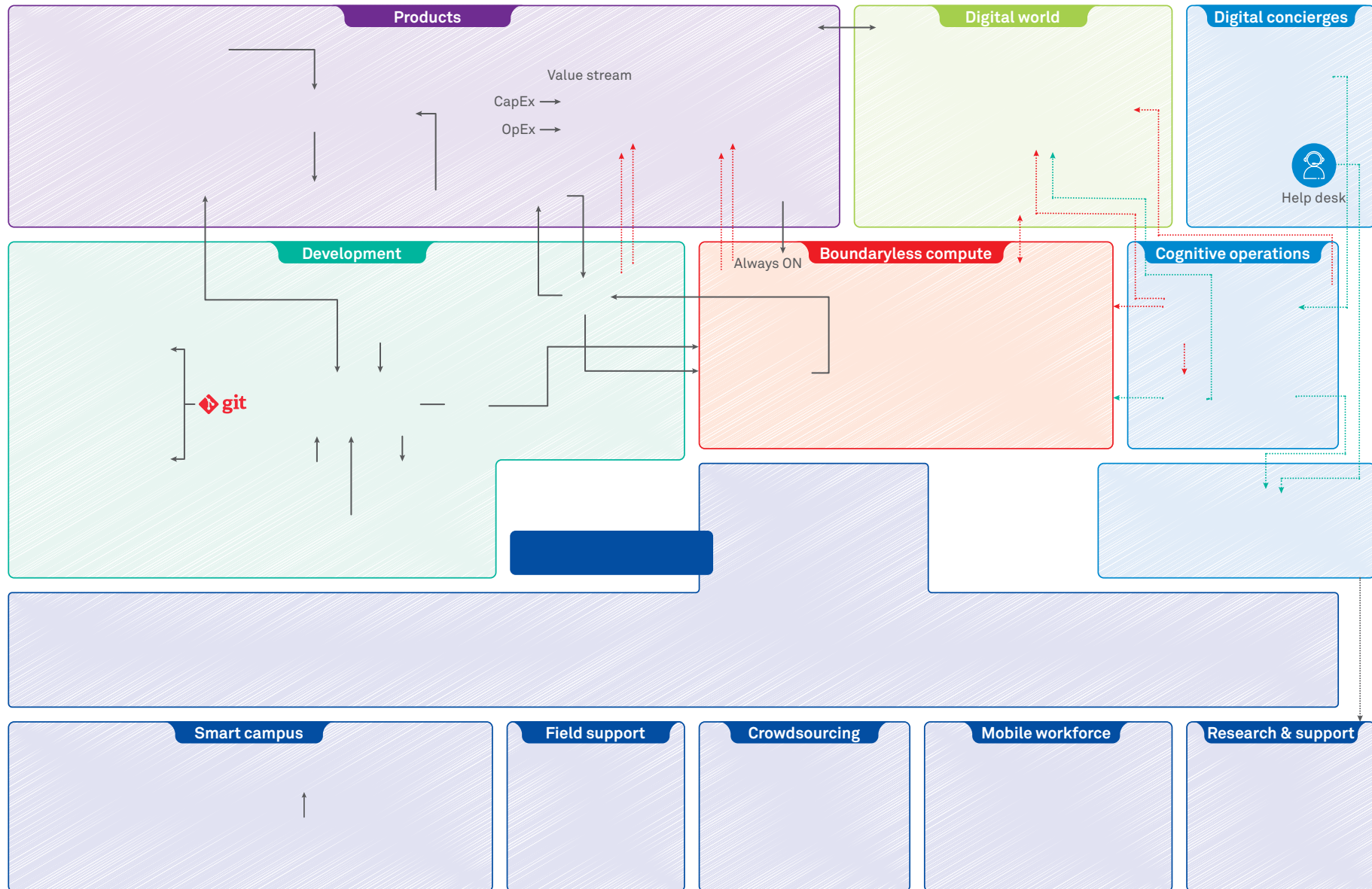
Research & support

Figure 03: New technologies: Forcing an amalgamation of stakeholders

These technologies force various stakeholders such as business planners, architects, developers, operations teams and innovators, to one table. They need to amalgamate their thinking around one unified ontology (see Figure 03: New technologies: Forcing an amalgamation of stakeholders).

ITIL 4.0, IT4IT, and SAFe provide dependable guidance to break some of the IT silos, align to business needs and evolve the enterprise architecture. As enterprises invest into and evolve their infrastructure for the future, the digital infrastructure must provide a suitable overlay to align with the best practices prescribed by these models, reference architectures and frameworks.

Changing business dynamics, new drivers of change

The pressure to change and evolve to a digital-ready infrastructure can vary across organizations. There are many factors that influence the change. The respondents of our State of IT Infrastructure survey 2020 felt that adoption of SaaS and cloud applications followed by modernizing and simplifying legacy applications were the leading factors driving the change in IT infrastructure (see Figure 04: What are the key technology drivers influencing your digital integration strategy?). This view is likely to see a subtle change as businesses become more aware of the need to provide their applications with access to data across digital channels in the coming months.

Q: What are the key technology drivers influencing your digital integration strategy?

High priority

Adoption of SaaS and cloud applications

Modernizing and simplifying legacy applications

Providing application and data access across digital channels such as web, mobile, etc.

Seamless integration with partners and suppliers

Using data from devices and sensors for decision making

Low priority
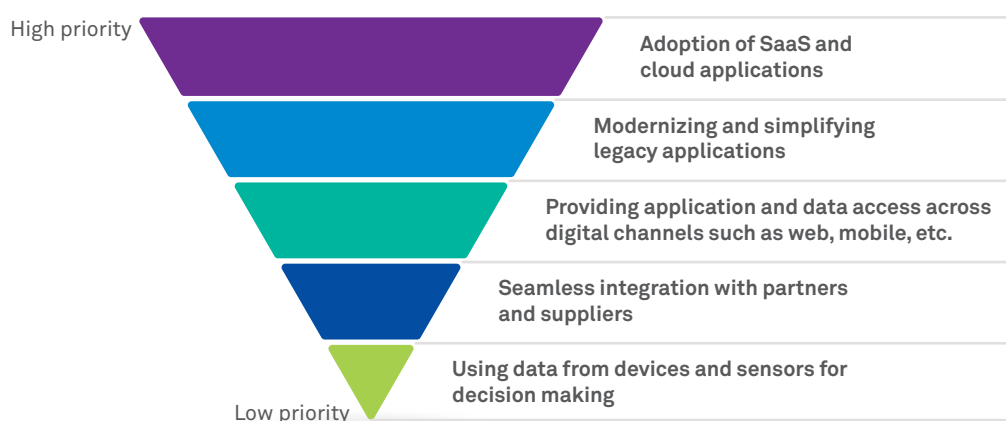
Figure 04

Anik Dubreuil,
CEO of Innovapost & Chief Digital Officer of Canada Post

Over the last ten years, a convergence of technology and business trends have dramatically changed the way IT is implemented and leveraged in the parcel industry. The speed of adoption for new technology has gone from decades to a few years, the introduction of connected devices has led to the generation of huge amounts of data, and the complexity of our application landscape has increased exponentially. At the same time, there has been enormous growth in e-commerce and a variety of new competitors have entered the market. We believe that we have a once-in-a-generation opportunity to address these IT and business challenges by leveraging market advancements in public cloud technology platforms. Cloud technologies will enable us to become more nimble, faster-moving, and cost-effective as an IT organization. While the roadmap ahead is not fully defined, the destination is clear.

New possibilities, new competition

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Innovation is everywhere: In the way new products are designed, sourced and manufactured; how business models address new users and customers; how governments are run; the way technology is applied to enable positive social change; how assets, talent and capital are used; pathways to meet regulation and conservation goals and how collaboration is intensified. Any or a combination of these can fire innovation. We asked respondents of our State of IT Infrastructure survey 2020 what prompted innovation in their organization (see Figure 05: What are the factors influencing the need for innovation in your organization?). An overwhelming 75% said it was the need for new solutions and new ways of doing things. This response reflects the urgent need to extract more value from technologies and processes around cloud, mobility, virtualization, networks, Disaster Recovery, business continuity, security, service management and IT helpdesk support. It tells us that organizations know they can get better value for money if they innovate around integration, provisioning/issue resolution, monitoring and automation. The question is "how?" In the complex array of technologies available today, an error in decisions can set back a business by years if not months.

Q: What are the factors influencing the need for innovation in your organization?

New solutions, new way of doing things **75%**

Business Intelligence (BI) and data monetization **52%**

Mergers and Acquisitions **11%**

B2C E-commerce **18%**

New business models **68%**
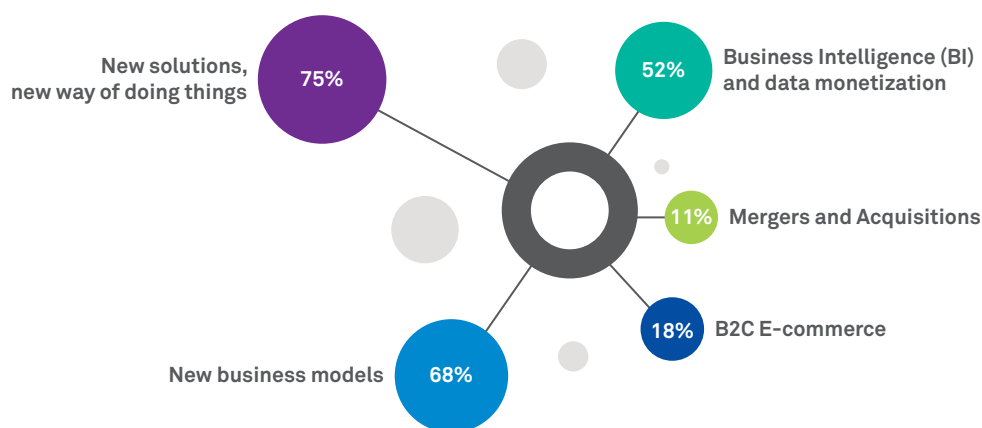
Respondents were asked to choose multiple response options

Figure 05

Technology analysis and trends

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For decades, Wipro, as a technology provider and partner to global organizations, has witnessed changes in how businesses approach the evaluation, purchase, implementation and integration of core technology. Our survey shows that 80% of organizations determine which technologies to opt for based on internal analysis; 58%, depended on third party consultants and expertise; while 53% relied on outsourcing vendors/partners (see Figure 06: What is your methodology to evaluate new technologies for the IT infrastructure landscape in your organization?). In the next few years, this balance will change. Everything is moving extremely fast—cloud, serverless computing, the death of data centers (DC), edge devices and computing, IoT, dynamic security and the arrival of highly dependable connectivity with 5G! Businesses will depend more heavily on the technological expertise of consultants to push them quickly and unerringly in the right direction.

Q: What is your methodology to evaluate new technologies for the IT infrastructure landscape in your organization?

- 🟪 Internal analysis
- 🟦 Engage third party consultants
- 🟩 Rely on outsourcing vendor/partner
- 🔷 Rely on published reports from leading analysts

80%

36%

53%

58%
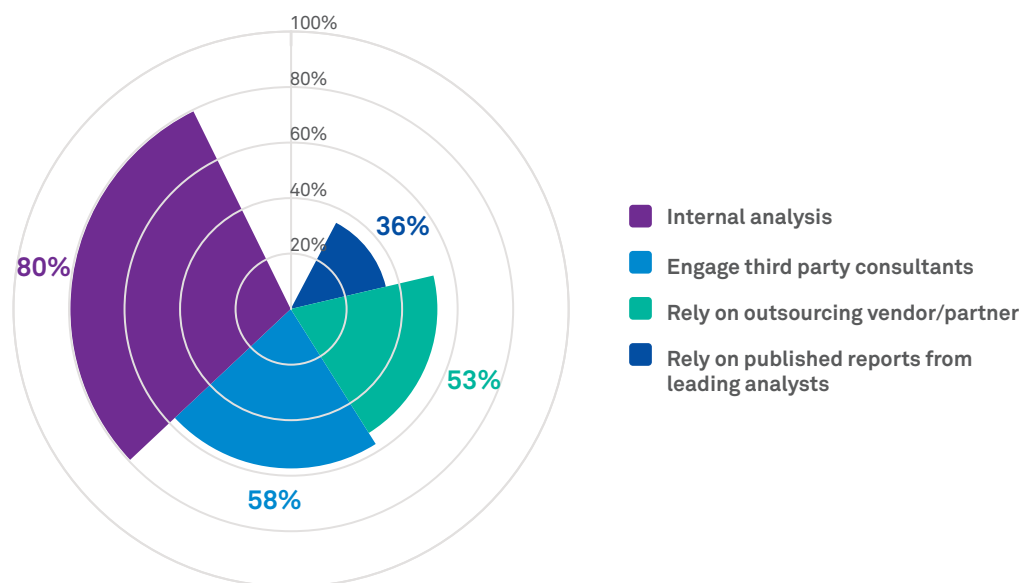
There could be multiple technologies adopted by the organizations

Figure 06

Evolving applications and platforms

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This hyper-connected world, which is only going to improve with technologies such as 5G, is a key aspect of the digital world. The ability to sense, analyze and control the interaction "amongst and between" artificial things, natural things and humans is opening up a world of value generation (see Figure 07: New paths to value generation). As business invests in acquiring these new capabilities, the application and platforms landscape is expected to see radical changes to acquire new business agility as well as the ability to rapidly innovate and deliver exceptional Customer Experiences (CX).

The implication for infrastructure operation will be to support hosting, networking and security for any application, a COTS, bespoke application, cloud-native applications or various SaaS or PaaS. Creating a foundation for operations that integrates clouds on a multi-cloud model, provides reach to edges, transforms the network and creates a workspace that embraces digital holistically will become a priority. Public cloud is the key enabler here supported by Software-Defined Infrastructure (SDI) which helps automate IT and run modern infra and apps. Finally, delivering DC modernization for agility, cost efficiency, faster time-to-market for new apps will occupy the minds of IT infrastructure specialists.
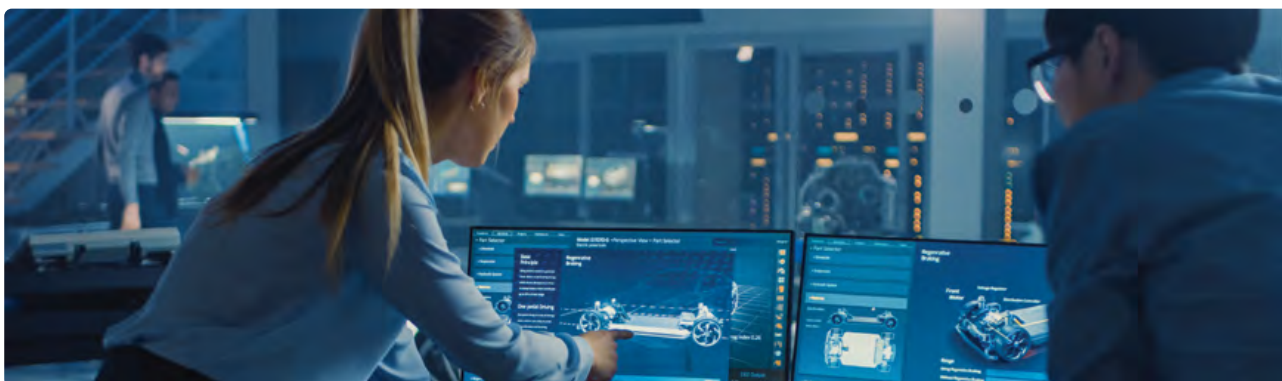
Ability to **sense, analyze** and **control** the interaction "amongst and between" artificial things, natural things and humans is opening up a world of **value generation opportunities.**

Humans interacting with natural things

Natural things interacting with other natural things

Humans interacting with other humans

Humans

Natural things

Artificial things

Natural things interacting with artificial things

Humans interacting with artificial things

Artificial things interacting with other artificial things
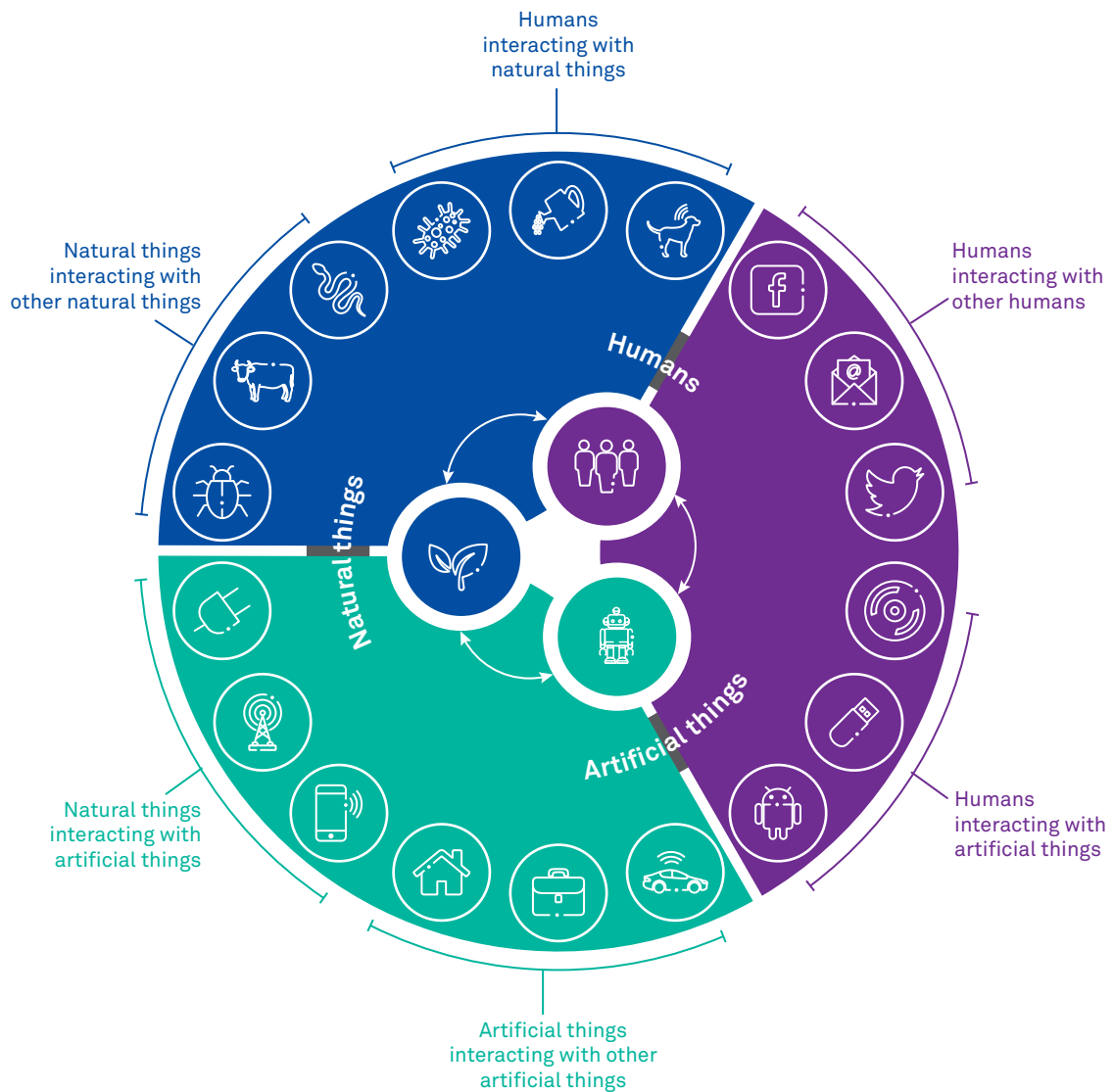
Any application & platform

Traditional apps

Cloud-native apps

SaaS apps/PaaS

SAP

amazon web services

Google Cloud Platform

Microsoft Azure

Microsoft Dynamics

ORACLE APPLICATIONS

Office 365

workday
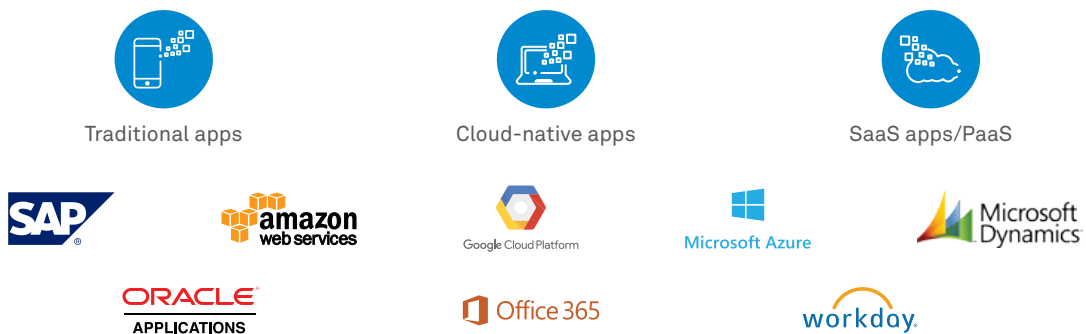
◀ **Edge <> Network <> Cloud & data center** ▶

Figure 07: New paths to value generation

Delivery models

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To understand how businesses approach IT delivery, we asked our respondents to identify the categories under which their IT delivery model fell (see Figure 08: How do you categorize your current IT delivery model?). A significant 62% said that many services were outsourced in a managed services model. It is not difficult to identify why this is popular: It improves efficiency, especially if services are consolidated with a partner; pricing can be made predictable; and capital costs become operating costs. But we believe that among the most important reasons today to opt for an outsourced managed services model is the quick access to new technologies that partners provide and the proactive approach they bring to continuous modernization.

Q: How do you categorize your current IT delivery model?

- **Many services are outsourced in a managed services model**
- **All services are owned in-house but with resources hired on T&M basis**
- **All services handled by in-house teams**
- **Many services are outsourced as an outcome-based model**
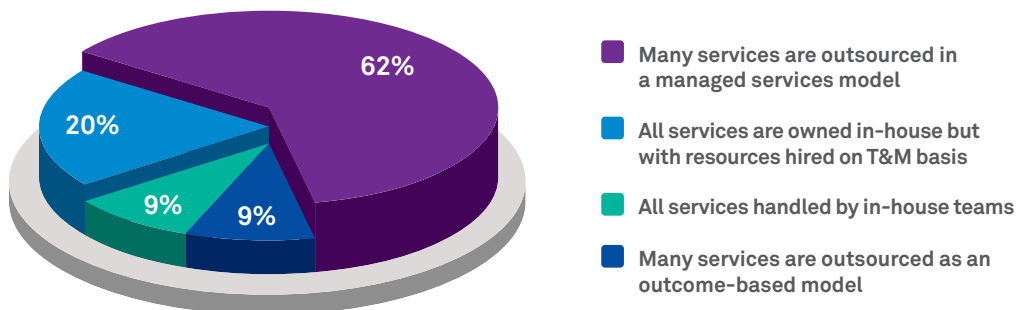
Figure 08

Asset aging

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Our survey showed that IT assets, on average, were 5 years old (see Figure 09: What is the average age of hardware in your IT estate?). In real terms, these have served beyond their call of duty. In several instances, these assets will be responsible for failures and risks, unable to leverage new software features, slow in using a greater number of resources and unable to sling data around the network as quickly as is expected. Businesses should examine these assets and identify those ready for a quick refresh.

Q: What is the average age of hardware in your IT estate?

5

1 2 3 4 5 6 7 8 9 10

Years

Figure 09

Technical debt

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Organizations often stop enhancement on certain systems or are forced to freeze further development due to many technical and commercial reasons. With business pressure to move on, many hasty projects result in patches of IT systems that require more resources to change in order to let them run their life till sunse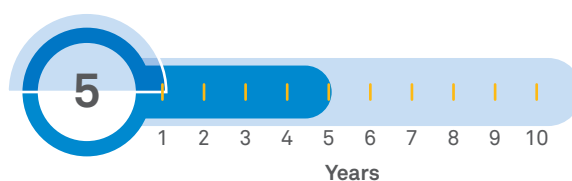t. This is often justified even though these create large risk exposures. Unaddressed technical debt can be dangerous. It increases the strain on budgets as well as on the staff responsible for these assets. However, technical debt is not always seen as a negative factor—after all, it allows the business to move ahead on projects. While this is borrowed from software parlance, the concept fits the world of IT infrastructure extremely well. Our survey showed that technical debt has become a major issue. The response we got was 47% (see Figure 10: How much of technical debt is carried in your estate that is end-of-life?)—enough to wake up and take corrective action.

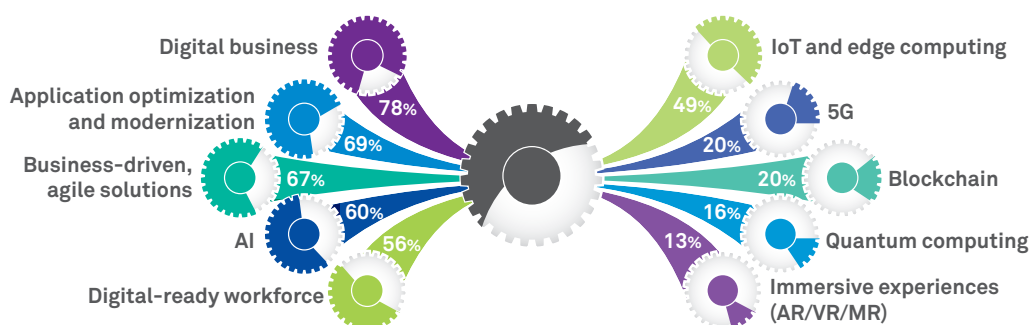**Q: How much of technical debt is carried in your estate that is end-of-life?**

47%

Figure 10

Factors influencing future of IT infrastructure

●●●●●

A range of advanced technologies is reshaping business. Some apply to specific industries. Examples of this are autonomous vehicles or robotics. But there are a set of broader technologies that apply to businesses across industries with a deep bearing on the scope of infrastructure. Our survey highlighted the technologies/factors that were already under the scanner (see Figure 11: Which technologies/ factors are likely to be embraced by business and will impact your technology investments?). The push to create digital businesses stood out (78%) followed by application optimization and modernization (69%). This is not surprising as the two go hand-in-hand. The next three factors—business-driven agile solutions (67%), AI (60%) and digital-ready workforce (56%)—are the ones to watch out for in the immediate future. How your business approaches them could make the difference between leaders and laggards.

Q: Which technologies/factors are likely to be embraced by business and will impact your technology investments?

Digital business 78%
Application optimization and modernization 69%
Business-driven, agile solutions 67%
AI 60%
Digital-ready workforce 56%

IoT and edge computing 49%
5G 20%
Blockchain 20%
Quantum computing 16%
Immersive experiences (AR/VR/MR) 13%

In an organization, multiple factors can influence business and investment

Figure 11

Threats and vulnerabilities

●●●●○

Cybersecurity threats are becoming extremely sophisticated. Many insider and persistent threats have the potential to bring an organization to its knees. These require IT to remain vigilant, and keep its data, applications and networks under continuous and intelligent surveillance with automated response systems. Some of the threats that demand maximum priority are insider threats, DDoS, botnets, phishing, ransomware, exploit, viruses and worms and Advanced Persistent Threats (APT).

Our survey showed that a majority of businesses—57%—had experienced some type of security breach in the last 3 years (see Figure 12: Have you had incidents of security breaches in the last 3 years?). Chances are that of the remaining 43%, several businesses, perhaps as many as 15%, have still to discover that their data, applications or networks have been breached. The truth is that because there have been no incidents is not reason enough to be lax about cybersecurity or not have a fully modernized detection and response mechanism in place.

Q: Have you had incidents of security breaches in the last 3 years?

5%
Less than 10

7%
More than 10
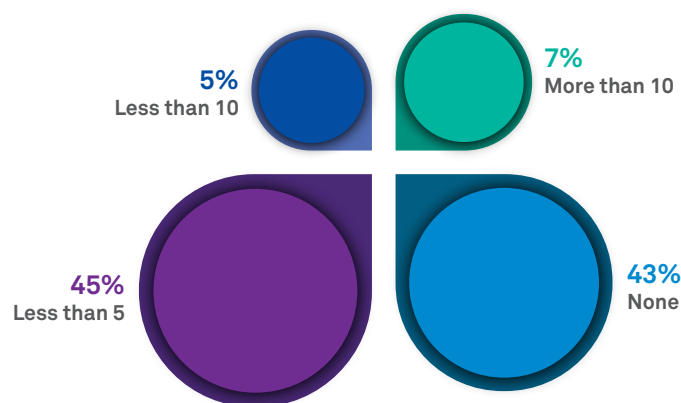
45%
Less than 5

43%
None

Figure 12

Swamy Kocherlakota,
EVP, Chief Information Officer, S&P Global

Early on in our transformation journey, S&P Global made a commitment to prioritizing a cloud-first approach to our technology strategy. Our journey began with a bold move to migrate to the public cloud and reduce our dependence on physical data center space. This step forward was made possible by leveraging the innovative IaaS, PaaS and SaaS solutions available in the marketplace, coupled with a significant internal education campaign to build our employees' knowledge around cloud-first thinking. As part of this enterprise effort, all employees were provided an introductory cloud course (with more than 5,000 completions to date), while 7 persona-specific learning paths were also established to enable deeper cloud learning. Today, 65% of our infrastructure is in the cloud, including the majority of our employee productivity applications, contributing to the significant savings we committed to in our 2017 Investor Day. As the global COVID-19 pandemic took shape and altered our ways of working, this cloud-first foundation also enabled S&P Global to scale effectively and transition >99% of our 23,000 employees seamlessly to remote work while maintaining consistent service to our customers.

State of IT spend

What the next 12 months look like

CXOs of the digital era have to make a complete mind shift. They have to move away from the warmth and familiarity of the decades-old practice that built infrastructure that was meant to last. Instead they must move towards building infrastructure that is fueled by innovation, measured against its ability to stay adaptive and user-centric, evolves in real-time and remains sustainable. It is alarming to think that the risk-averse approach of standardization and homogeneity is no longer a weapon to control predictability and permanence. If anything, they are fast becoming liabilities in the world of real-time data and analytics, Artificial Intelligence, cognitive automation and the Internet of Things. As an IT infrastructure leader, you face a fundamental choice: remain a builder and manager of data center functions and risk obsolescence or become an agile and responsive partner in the journey of digital businesses.

Businesses of all shapes, sizes and ambitions are facing some IT challenges that are similar: what infrastructure to bet on? How to optimize existing spend? How much to invest? How to predict budgets? To find the answers and dig deep into the radical changes in the IT infrastructure space, Wipro surveyed IT professionals who live and breathe the reality of change. Here, we look at how IT decision-makers

feel their organizations are performing. This exercise has led us to what we can call the "State of IT spend", a guide, companion and benchmark to your own decisions in the next 12 months.

Top IT infrastructure challenges

Wipro's State of IT Infrastructure 2020 survey suggests that over the next 12 months, aligning IT infrastructure to business outcomes will remain the top challenge faced by enterprises (see Figure 13: What are the IT infrastructure challenges faced by your organization?). However, as most enterprises aim to digitalize their business, some challenges will be more pressing. For example, businesses expect to face bigger challenges when it comes to modernizing their legacy infrastructure, meeting security and compliance objectives and creating enterprise infrastructure for the digital business.

IT challenges vary by company size. Compared to large enterprises, small/medium businesses need more guidance when it comes to adhering to security and supporting their business 24x7.

They also face geopolitical challenges. For example, some may operate in regions where compliance and data privacy is more demanding than other regions. Small/medium businesses

Q: What are the IT infrastructure challenges faced by your organization?

Most challenging

1 Aligning IT infrastructure to business outcomes

2 Legacy modernization

3 Security and compliance

4 Creating enterprise infrastructure for the digital business

5 Finding and retaining digital-ready workforce

6 Optimizing IT infrastructure

7 Supporting the business 24/7

Least challenging

Figure 13

are hungry for new technology, they don't have legacy to bother with, and are more agile. They need more assistance with assessment, implementation and support.

Budgets for technology

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Technology is now the backbone of every business. This is because of two reasons: technology is becoming more sophisticated and able to meet the needs of every business; and costs are not as daunting as they once were. Technology is becoming affordable and the value it provides offsets the costs by several magnitudes.

Even small organizations have technology budgets. But there is hesitancy in making investments. This is because every business has its own needs that are different from others. Therefore, determining exactly how much to spend on different expense heads (data center, storage, hardware, applications, operating systems, middleware, networks and telecommunication, bandwidth, integration, automation, security, backup, business continuity, monitoring, reporting/compliance, support, training, deployment, consulting, etc.) becomes tricky. With cloud becoming an integral part of IT infrastructure, there are additional considerations such as legacy modernization and application/data migration.

Q: What is your likely spend on these tech areas in the next 3 years?

End-User Computing: Decrease 22%, Remains the same 42%, Increase 36%
Data center and cloud (IaaS and PaaS): Decrease 8%, Remains the same 13%, Increase 79%
Service Desk: Decrease 36%, Remains the same 49%, Increase 15%
Network: Decrease 11%, Remains the same 39%, Increase 50%
Software and tools (used for operations): Decrease 11%, Remains the same 30%, Increase 59%
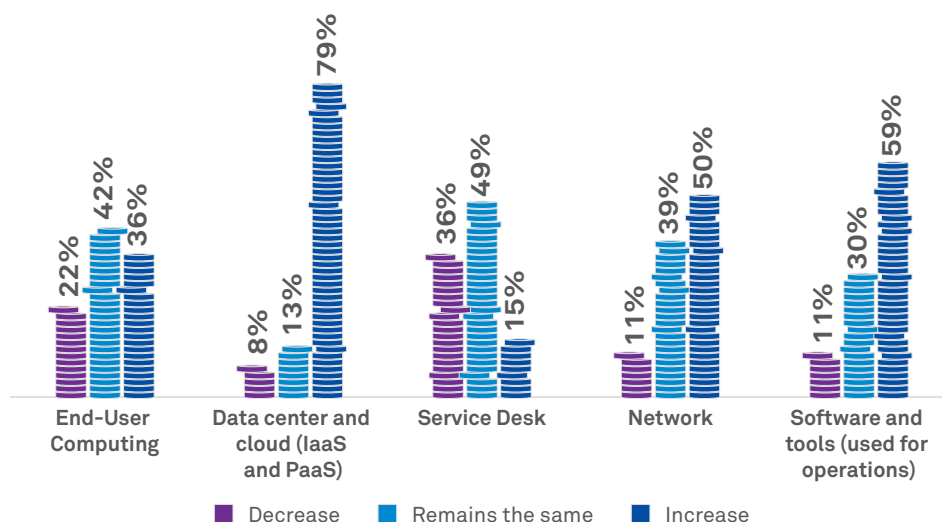
■ Decrease ■ Remains the same ■ Increase

Figure 14

What is the spend on different areas of IT?

The average business spends on IT are estimated to be around 3-6% of total revenue. Naturally, a startup will spend more as a percentage of revenue than a large and mature organization. IT spends tend to taper off as an organization grows in (employee) numbers and years. With well-thought out support and maintenance strategies, scaling can be achieved by large organizations while keeping costs under control.

Respondents in our survey pointed to the areas where they plan to increase, decrease or maintain spend at the same level as before (see Figure 14: What is your likely spend on these tech areas in the next 3 years?). The single-largest expense account appears to be for data center cloud (IaaS and PaaS). This is a good indication as it means IT infrastructure costs can be controlled and aligned with business needs in the future. What is striking is the fact that 85% of

respondents said they plan to either decrease or keep spends at the same level as before for Service Desk. Spends on Service Desk may plateau as automation and intelligence drive support, allowing organizations to scale support without adding to costs.

What is the IT spend approach – Run or Change?

Your business is unique. The industry you operate in, the scope/service you deliver to business, the geographies you operate, existing investments, etc., are important factors that determine how much you spend on IT. As per the survey on the IT infrastructure spend budget between Run and Change, the average spend on Change by an enterprise is 43% (see Figure 15: How have you planned the IT infrastructure spend budget between Run and Change?).

Based on our broader experience in the industry we are seeing enterprises adopting a smart spend

Q: How have you planned the IT infrastructure spend budget between Run and Change?
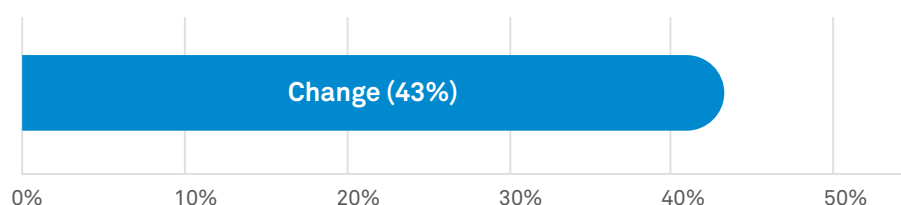

Change (43%)

0%   10%   20%   30%   40%   50%

Figure 15

approach, which is about using your budgets wisely by optimizing the current operating models and transforming it to drive IT-enabled business value

(see Figure 16: Smart spend – Transform and not just cost reduction). This smart spend approach also helps businesses transform and not just reduce cost.
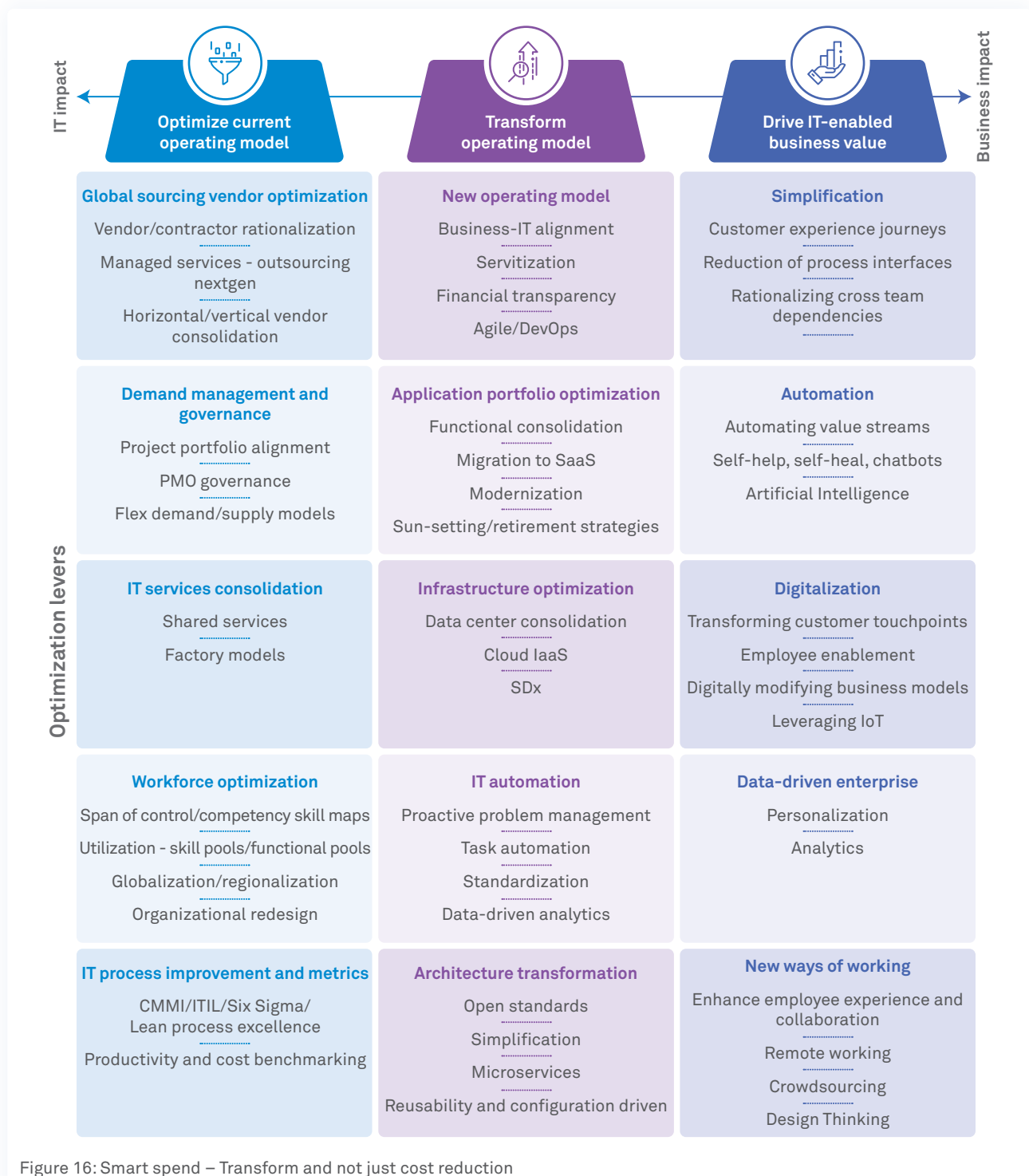

IT impact ← Optimize current operating model — Transform operating model — Drive IT-enabled business value → Business impact

Optimization levers

Optimize current operating model	Transform operating model	Drive IT-enabled business value
Global sourcing vendor optimization Vendor/contractor rationalization Managed services - outsourcing nextgen Horizontal/vertical vendor consolidation	**New operating model** Business-IT alignment Servitization Financial transparency Agile/DevOps	**Simplification** Customer experience journeys Reduction of process interfaces Rationalizing cross team dependencies
Demand management and governance Project portfolio alignment PMO governance Flex demand/supply models	**Application portfolio optimization** Functional consolidation Migration to SaaS Modernization Sun-setting/retirement strategies	**Automation** Automating value streams Self-help, self-heal, chatbots Artificial Intelligence
IT services consolidation Shared services Factory models	**Infrastructure optimization** Data center consolidation Cloud IaaS SDx	**Digitalization** Transforming customer touchpoints Employee enablement Digitally modifying business models Leveraging IoT
Workforce optimization Span of control/competency skill maps Utilization - skill pools/functional pools Globalization/regionalization Organizational redesign	**IT automation** Proactive problem management Task automation Standardization Data-driven analytics	**Data-driven enterprise** Personalization Analytics
IT process improvement and metrics CMMI/ITIL/Six Sigma/Lean process excellence Productivity and cost benchmarking	**Architecture transformation** Open standards Simplification Microservices Reusability and configuration driven	**New ways of working** Enhance employee experience and collaboration Remote working Crowdsourcing Design Thinking

Figure 16: Smart spend – Transform and not just cost reduction

Top factors leading to IT budget increase

It is hard to imagine any component of business, other than funding and cash flow, having as wide and deep an impact as IT. Today, IT determines how quickly you switch from savings to fueling growth; how easily you stay ahead of competition; how keen are customers to transact with you; and how inspired are employees to want to continue working for your organization. Therefore, an increase in IT infrastructure budgets should not always be viewed with suspicion. It may have its roots in a variety of compelling factors.

Q: What is driving an increase in your IT budget?
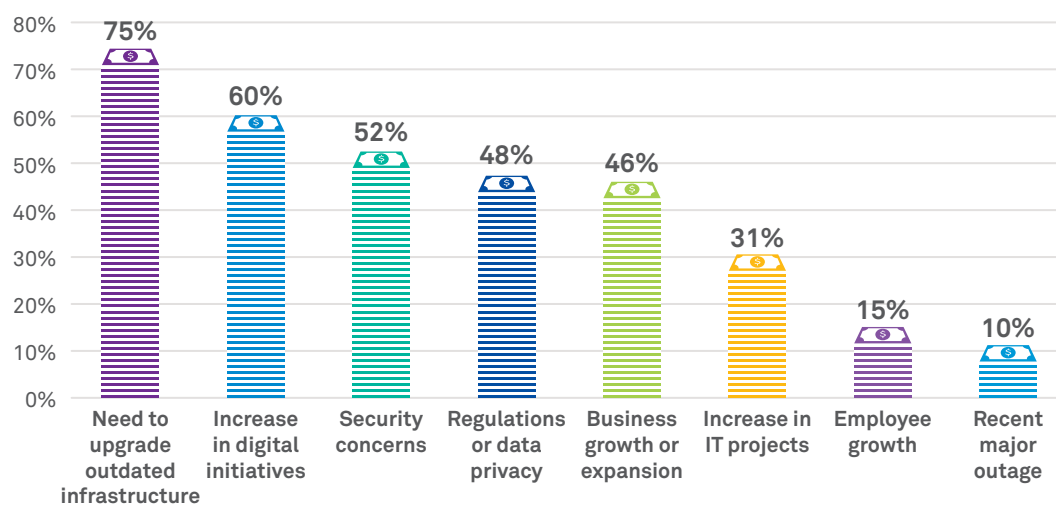
Respondents were asked to choose multiple response options

Figure 17

Our survey showed that the need to upgrade outdated infrastructure was the #1 reason (75%) for organizations to increase IT budgets (see Figure 17: What is driving an increase in your IT budget?). This is logical. As noted earlier in this report, the average age of IT assets in an organization is over 5 years which implies that the assets are ready for a refresh or an upgrade. The #2 reason for increasing IT budgets is the pressure from implementing digital initiatives (60%). This factor is only going to become more pressing as every industry moves towards digital. Finally, as IT infrastructure covers a larger estate, with more interfaces that include devices, networks and partner systems, security and compliance becomes a major issue. So we are not surprised to see that security concerns (52%) are driving an increase in IT budgets followed by regulations and data privacy (48%). The employee growth factor (15%) indicates that in the future employees will demand that their organizations explicitly publish investment details of IT aimed at employee skills enhancement and support. The

hidden signal in the survey results is in the IT budget increase due to recent major outages (10%). Now, this is a major cause of concern. Many enterprises do not factor outage into their IT budgets even though it directly impacts business and leads to loss. Has your organization faced this situation or have you set aside a contingency budget?

How is IT operational budget different from budgets for strategic IT innovation?

Technological innovation doesn't always have to be billed to the IT infrastructure team. Sometimes, the innovation is required as part of the business strategy. For example, a hotel chain may create a mobile application that allows guests to remotely check in and use their mobile phones as a digital key for their rooms. This saves the hotel the manpower required to manage a front desk and saves considerable time for the guest. The first is business efficiency, the second is customer delight. Both are part of business strategy. Developing these applications and upgrading them should not be part of the IT budget; managing them should be.

The simple truth is that spending an increasing amount on strategic business or operational IT is no guarantee for growth or leadership. What truly matters is how these costs are managed— through platforming, outsourcing, automation, cloud enablement, etc., without compromising on employee and customer satisfaction.

Need to upgrade outdated infrastructure was the #1 reason for organizations to increase IT budgets.

IT infrastructure and future

Interesting times ahead

The ability to absorb innovation depends on the risk appetite of an enterprise. Some believe in experimenting with bleeding-edge technology while others take a conservative approach and wait for the technology to mature. The interesting aspect is that the risk appetite can vary within an organization or a business from team to team.

Gartner's hype cycle[vii] is a good way to track technologies though their lifespan and determine when to adopt them based on needs. It is almost always the case that the IT infrastructure team will want a reasonable amount of maturity in a technology and a well-developed supplier ecosystem to ensure they can deliver services with committed SLAs. But IT infrastructure teams must move on and push the envelope.
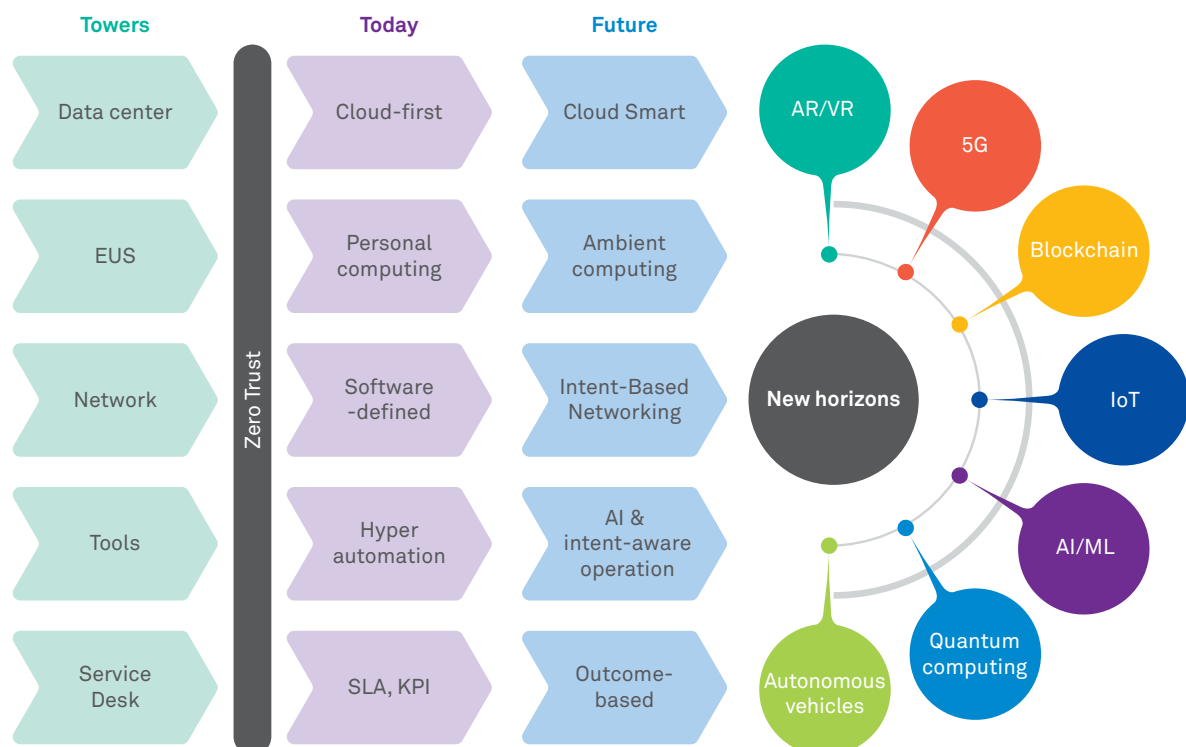
Figure 18: The evolution in IT infrastructure technology

It is almost always the case that the IT infrastructure team will want a reasonable amount of maturity in a technology and a well-developed supplier ecosystem to ensure they can deliver services with committed SLAs.

For each tower in the IT infrastructure space there is an evolution in technology (see Figure 18: The evolution in IT infrastructure technology) with some, just over the horizon, that have the potential to radically transform the business and the practice of IT infrastructure. Here, we examine some of them:

Data center: Many enterprises have adopted a cloud-first strategy – a practice where businesses always consider consuming a readily available application or service from a cloud rather than building something from the ground up. Many enterprises are enforcing a more disciplined cloud-only strategy where all applications are consumed from a cloud. Now, a decade into the cloud-first approach, we find enterprises evolving to a Cloud-Smart approach. This involves a more judicious decision-making process where the destination can be a cloud or a non-cloud landscape that is chosen based on technology fitment, benefits and application mission.

End-User Computing (EUC): Personal computing gave us laptops, desktops and mobiles. Now, practically everything around us is a computer of some sort. Devices like AR/VR headsets, wearables and AI-based virtual conversational assistants like Alexa can become part of everyday work. The future workspace could have us interacting with everything around us, from wall surfaces to embedded cameras.

Network: A software-driven network meant freedom from hardware lock-in and flexibility due to programmability. With this reasonably achieved, it is time to progress further to intent-aware networks which are able to ensure expected business outcomes and deliver

operational goals emerging from distributed cloud services, dynamic workforce placement and new age security threats.

Tools: IT infrastructure is becoming complex with Software-Defined Infrastructure and cloud delivering mission-critical digital services. Tradition tools combined with human-curated rules and automation scripts are becoming ineffective in delivering the exacting levels of service assurance demanded by business. By applying AI and mimicking human reasoning at scale, AIOps brings in a new set of tools that address the gaps.

Service Desk: Using automation, AI, conversational technologies, etc., the Service Desk is evolving beyond CSAT to deliver business value, customer experience and employee productivity. Its KPIs in the future will focus on business outcomes.

Security: With a growth in IT infrastructure surface, vulnerability from malicious actors and intrusions has escalated. Businesses must move to a "zero trust" paradigm that is rooted in the principle of "never trust, always verify." It leverages network segmentation, preventing lateral movement, providing Layer 7 threat prevention, and simplifying granular user-access control.

On the bleeding edge

There is a push for infrastructure operations to increase their risk appetite and adopt technologies faster. Some areas where broader interest is becoming visible include the following:

AR/VR/MR: Augmented Reality (AR)/Virtual Reality (VR)/Mixed Reality (MR) have begun to impact areas like training, data analytics and gamifications.

5G: The next evolution of cellular communication that promises ultra-low latency, assured bandwidth, high reliability and security offers the option for organizations to establish private networks for their local communication requirements. In addition to the network, features like mobile edge computing enabled by 5G can be of significant interest.

Blockchain: Leveraging the distributed ledger technology, a range of blockchain-based applications is finding interest in scenarios

involving multi-party environments like supply chains, IoT and asset tracking. Infrastructure teams will be required to provide connectivity and host blockchain mining nodes.

IoT: In a hyper connected world, IoT is becoming an integral part of a product or service. IT teams are expected to provide networking reach, edge computing and analytics to make a success out of IoT.

Quantum computing: With Moore's Law virtually dead, computing will leverage the power of fundamental particles to perform computations and reach the next level. While true business applications can be a few years away, quantum communication and quantum cryptography can be of immediate interest for some businesses.

AI and ML: AI and ML are being used in many areas of enterprise, including IT operations. While still at a relatively nascent stage, both technologies will have a large impact on managing large data sets and customizing hardware, etc. Infrastructure teams must be prepared to deal with them.

Autonomous vehicles: There are many practical use cases of customized autonomous vehicles to be used in large facilities, factories, warehouses, mines, healthcare, etc. The IT Infrastructure teams have to manage high bandwidth network, command and control when dealing with autonomous vehicles.

The future state

Software and platforms are turning out to be the heart of business. API-fication has become fundamental. The gig economy and digital technologies have challenged established businesses. Now the pressure is on organizations to reinvent themselves to stay relevant and competitive.

Many organizations have begun to think of themselves as software companies. They want to get IT best practices and IT culture incorporated into their organizations. Infrastructure teams are asked to be active contributors toward this goal. They are in the position to fulfill crucial Day 1 and Day 2 roles to help scale the digital ambitions of their organizations.

To maintain competitiveness and introduce new products, businesses embrace the latest and greatest technology. This often results in friction between IT and business. Soon enough these organizations have shadow IT—or smaller versions of the IT organization that begin to take independent decisions. This is often referred to as bimodal or multimodal IT. While this is a win-win for the teams, the approach has its pitfalls. Instances of data loss, security breaches and long service outages have been reported because small IT teams overlooked the value of best practices when commissioning their infrastructure. It helps to remember that islands of expertise can become a barrier to organizations putting their best foot forward for service resiliency, recovery or even maximizing some of the existing investments.

There are many structured operating models infrastructure teams can embrace to become more effective. The Digital I&O model proposed by Gartner is a good one for enterprises to adopt. It provides dependable guidance for infrastructure operations teams to take on greater ownership of digital services.

A model we call the hybrid compute fabric for digital operations (see Figure 19) will be needed to handle the scope covering the core, edge, network and security elements of a digital service. The business intents need to be complied at all times to address the value streams across the elements—namely the core, edge, network and security. Operations will have to evolve to highly autonomous systems that granularly observe the systems to catch signals and determine exceptions, apply AI, leverage operational data to self-heal and maintain the system in the desired state.
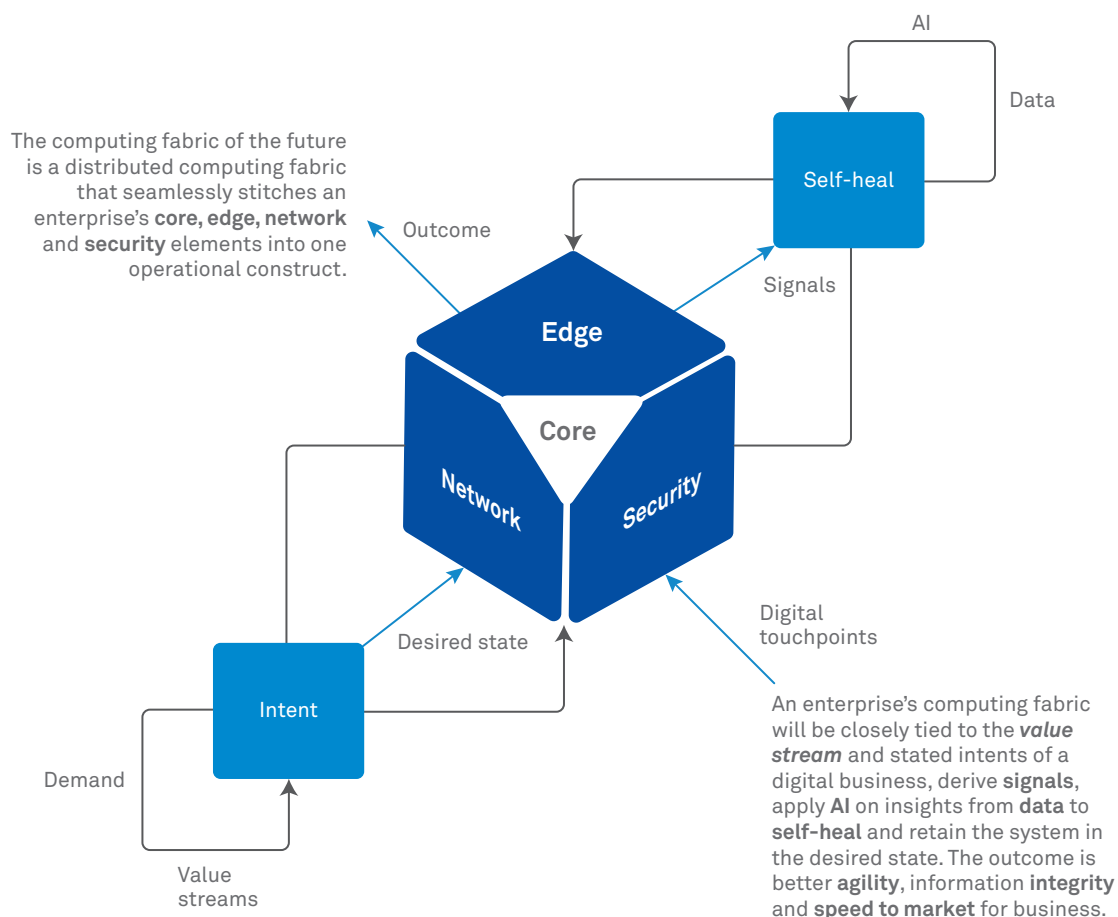
The computing fabric of the future is a distributed computing fabric that seamlessly stitches an enterprise's **core, edge, network** and **security** elements into one operational construct.

AI

Data

Self-heal

Outcome

Signals

Edge

Core

Network

Security

Desired state

Digital touchpoints

Intent

Demand

Value streams

An enterprise's computing fabric will be closely tied to the *value stream* and stated intents of a digital business, derive **signals**, apply **AI** on insights from **data** to **self-heal** and retain the system in the desired state. The outcome is better **agility**, information **integrity** and **speed to market** for business.

Figure 19: The hybrid compute fabric for digital operations

Teri Bruns,
Head of Partner Ecosystem, VMware

While businesses are running at a faster pace today, they often struggle to respond quickly enough to changing market conditions. In a digital world, businesses need to move quickly to increase customer acquisition and retention. By building and deploying cloud-native applications, IT can make quick updates and enhancements which enables the business to deliver products and services at a more competitive pace.

If you are not already running cloud-native apps based on microservices and containers, you will be soon. Cloud-native applications help your business operate with efficiency through automation, self-service, telemetry, and analytics that scale out and up as needed. Whether those modern apps live on-premises, in the cloud or on the edge, they need a unified platform for development, deployment, and operations. Enterprises need an IT infrastructure that can leverage containers, cloud resources and automation without compromising security and compliance.
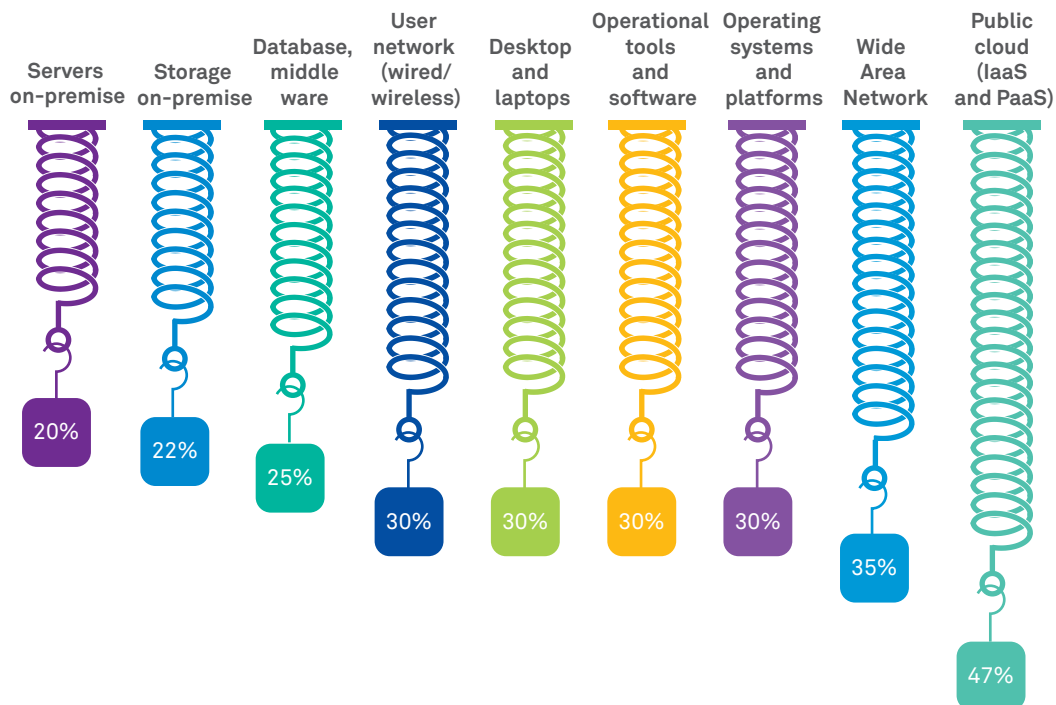
Successful enterprises require a modern IT infrastructure – one that provides the developers with the infrastructure and resources and environments they need to innovate and deliver modern applications faster, whether it be on-premises or in the cloud. With a modern infrastructure, enterprises and service providers can deliver superior Customer Experiences 24x7.

Agile infrastructure

For teams mandated with making IT infrastructure predictable, cost is a major element. Infrastructure cost tends to vary substantially depending on the units consumed. The challenge is to ensure that costs remain the same, regardless of consumption. We asked respondents in our State of IT Infrastructure survey 2020 about the areas in their IT infrastructure where an increase or reduction in consumption does not change the cost per unit (see Figure 20). We found that storage on-premise, public cloud (IaaS and PaaS), operating systems and platforms (47% each) were at the top when it came to cost stability and predictability. It must be admitted that costs must also be related to the value linked with infrastructure elements (and the value changes from business to business). This is why there need not be a hard and fast rule for fixed cost per unit. The survey results shed light on general experience and serve as guidance, not rule of thumb.

Q: What are the areas in your IT infrastructure that are flexible, where you can increase or reduce consumption while the cost per unit remains the same?

Servers on-premise	Storage on-premise	Database, middle ware	User network (wired/wireless)	Desktop and laptops	Operational tools and software	Operating systems and platforms	Wide Area Network	Public cloud (IaaS and PaaS)
20%	22%	25%	30%	30%	30%	30%	35%	47%

Respondents were asked to choose multiple response options

Figure 20

Digital-ready workforce

Emerging digital technology and automation are swiftly changing the workplace requirements. There is a rising demand for newer skill sets. With the explosion of technological advancements, organizations are bound to further face the challenge of retaining niche talent and building a digital-ready workforce. The need for future skills is immediate in many areas like DevOps, Kubernetes, agile, data science, AI, IoT, blockchain and Machine Learning.

As digital businesses grow, the emphasis will be on products and platform-centric operations. These will throw up fresh challenges that will demand new people/ skills, processes and tools. Take the example of a voice-based virtual assistant like Alexa becoming part of the IT infrastructure mix. How will this change self-service processes? IT infrastructure teams will have to use Design Thinking to address these changes. From a people standpoint, we will need manpower that is versatile and believes in being perfectionists (see Figure 21: The evolution of the workforce).
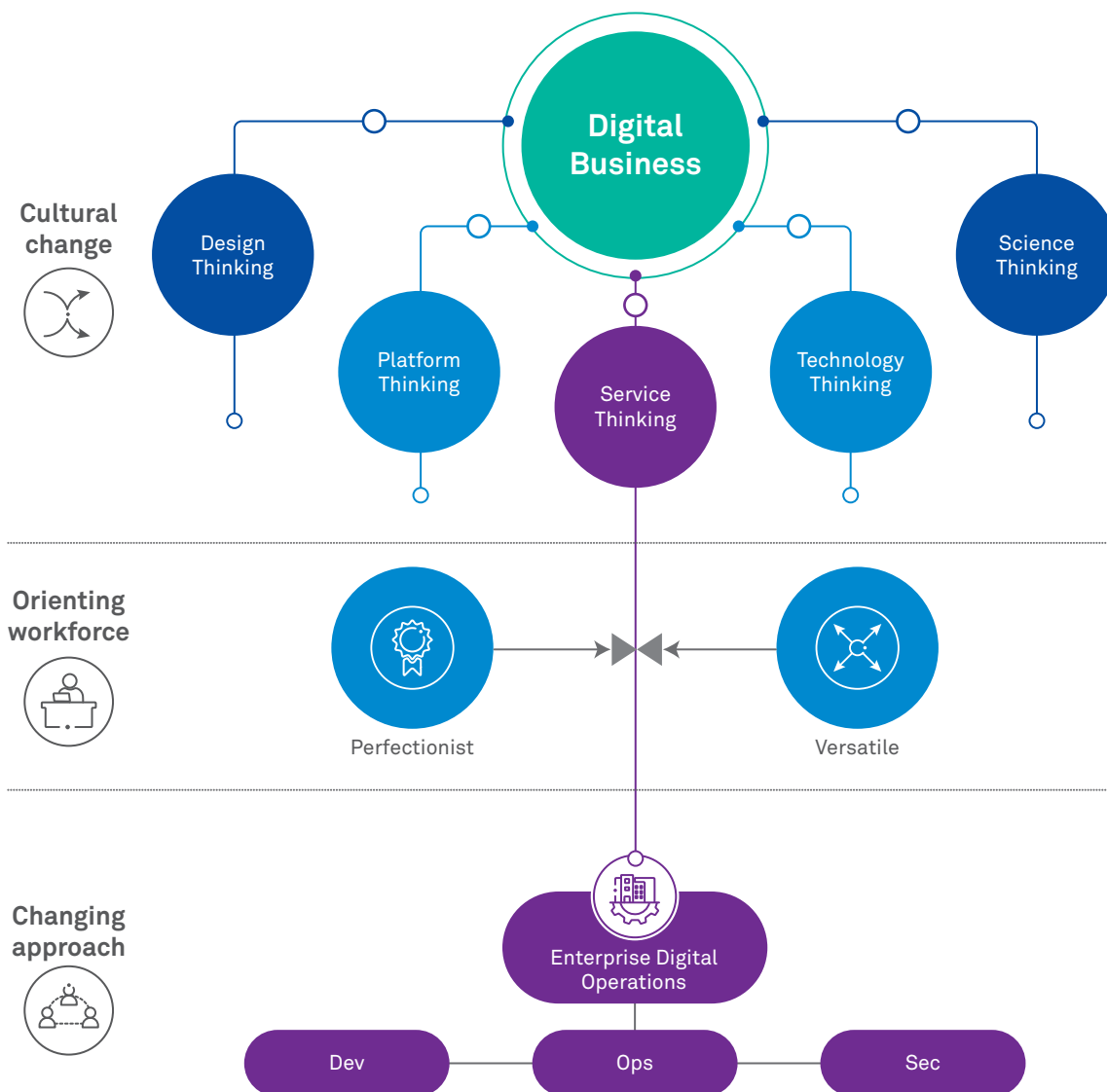
Figure 21: The evolution of the workforce

Platforms make us think of services as engines that drive an ecosystem of users and developers. This model is crucial for companies that think of themselves as software organizations. Therefore platforms hold implications for a digital-ready workforce. IoT is another example of how new technology is opening new possibilities and IT infrastructure skills must adjust to innovating around IoT.

It may appear that blockchain and quantum computing are words that are alien, but soon there will be a demand for a workforce with exceptional mathematical and science grounding that can apply the two technologies to problem solving.

Finally, organizations must take an approach that breaks the silos of development, security and operations. As networks and devices get more

programmable, we will find the need for better collaboration between development, security and operations—or all three practices may start folding into one single function.

All this boils down to:

- **Talent profiles:** Organizations will have to change the way they define their required talent profiles. They will begin to create new job descriptions, incorporate new taxonomies and look at X-shaped and T-shaped skills.

- **Capability upskilling:** Talent will have to be upskilled with new concepts such as CI/CD and full stack, etc.

- **Technology cross-skilling:** With the introduction of new digital technologies, cross-skilling between towers will become the norm.

- **New ways of working:** Organizations will need to leverage automation, DevOps, external collaboration, etc., leading to new cultures and ways of working.

- **Digital enablement:** Infrastructure such as talent hubs, Design Thinking labs and Digital PoDs will be necessary to accelerate new skills development.

- **Human-centered:** Human resource planning will have to bring greater emphasis to talent management, creating career frameworks and identifying critical skills.

We asked respondents in our survey about their priorities for addressing the changes in the technologies associated with IT infrastructure management (see Figure 22: What defines your current approach to creating a workforce that is ready for the digital era?). Re-skilling the existing workforce (81%) was by far the most important method followed by increasing outsourcing with existing partners (43%). It appears that every IT infrastructure head needs to answer one question: "Can my organization re-skill employees at scale and across technologies in an extremely aggressive time span?" The answer will determine how well the future unfolds.

Q: What defines your current approach to creating a workforce that is ready for the digital era?

Re-skilling existing workforce	Increase outsourcing with existing partners	Hiring new workforce	Increase outsourcing through new partners	Insourcing outsourced work	Business as usual, no significant transformation is planned
81%	43%	36%	36%	21%	14%
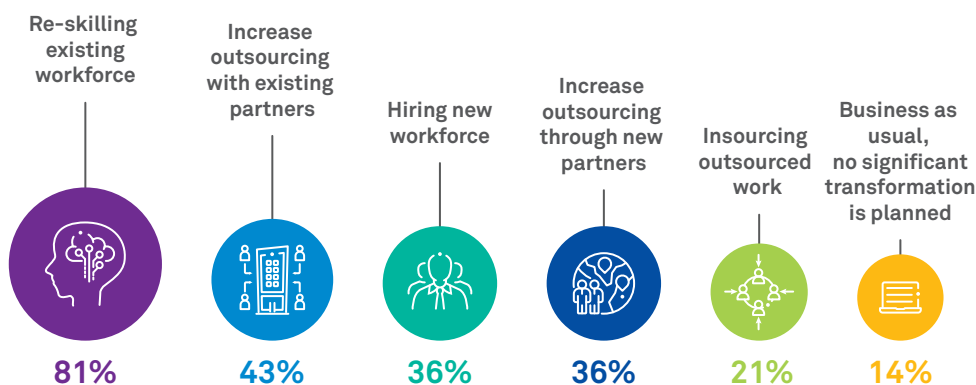
Respondents were asked to choose multiple response options

Figure 22

Peter Bendor-Samuel,
Founder and CEO, Everest Group

IT infrastructure has become the bedrock of business transformation. As IT evolves, it increasingly aligns with business and seeks to measure its effectiveness against business metrics, rather than just the traditional SLAs and pre-digital metrics. As we can keenly observe in this COVID-19 crisis, IT infrastructure needs to dynamically and autonomously adapt to changing business needs, thus creating an **"invisible infrastructure"** model that requires minimal oversight and is highly secure.

Such an infrastructure model is based on three distinct, yet coherent principles:

Intelligence: Autonomously evolve with business needs (self-configure and self-heal), by leveraging AI, analytics, and automation

Interoperability: Offer flexibility, seamless functionality, and ease of management across stacks, via open architectures

Invincibility: Proactively and effectively mitigate the impact of evolving threats and risks by embedding security and trust in the core design

State of infrastructure – cloud

Getting "smart" with cloud

Cloud has become the default mode for business leaders across the world. The top Fortune 500 organizations are leading the trend by moving their workloads and applications to cloud. It is not surprising that the cloud market is booming and is expected to further expand by 80%, from $182 billion in revenue to $331 billion by 2022. Forecasts suggest that 80% of businesses worldwide will migrate to cloud by 2025.[viii] The reason for this is rooted in the fact that investment in digital technologies has been growing and cloud services are making digital transformation simpler; secondly, no business wants to miss out on the cost and scalability benefits of cloud.

Cloud is now available in four convenient models, each aligned to cater to specific business needs:

- Infrastructure-as-a-Service (IaaS)

- Platform-as-a-Service (PaaS)

- Software-as-a-Service (SaaS)

- Business Process-as-a-Service (BPaaS)

The idea behind each is to ensure that businesses pay for exactly what they want and have the required degree of flexibility and control over their infrastructure.

The multi-cloud approach is on top of the list for enterprises and cloud experts. Different workloads

The worldwide market for cloud services is projected to grow 80%, from $182 billion in revenue to $331 billion by 2022.

achieve optimal performance and cost utilization on different cloud platforms and a multi-cloud strategy enables enterprises to create the optimal solution from various best-in-class technologies and services. Decisions could further vary, for instance, a majority of enterprise desire to avoid or minimize vendor lock-in, while others might want to distribute workloads to mitigate downtime risks. Latency, security and compatibility with their existing on-premise tools and applications could be other factors.

The cloud space is also evolving to offer better and smarter options. The demand is for 'as-a-Service' and 'pay-as-you-go' consumption models popularized by public cloud for private cloud as well. The reason is simple: businesses want to right-size their cloud footprint—they want private cloud for mission-critical applications and public cloud for new projects, development and test. We are now entering the era of smart cloud.

Private cloud

●●●○○

The "wait and watch" period for cloud is over. The initial euphoria over cloud has settled down and organizations are moving from a "cloud-first approach" to the "Cloud Smart" paradigm—which is one of the reasons for private cloud garnering considerable attention.

The cloud revolution brought in the 'as-a-Service' and the 'pay-as-you-go' consumption models of IT resources along with automation of IT operations. These two levers promised CapEx reduction, predictable OpEx and agility in IT operations. As adoption proliferated, cloud changed the expectations of IT users. Now, users want the same agility, self-service and visibility from IT as they get from cloud. This has prompted a transformation in the thinking around private cloud.

Private cloud, pioneered by the likes of VMware, OpenStack, HP and IBM, does provide levels of automation and self-service similar to public cloud but the 'pay-as-you-go' consumption model is limited in private cloud. This is why being "Cloud Smart" is important. Large organization and early adopters who rushed to cloud without a clear assessment of their workloads and consumption patterns suffered bill shock. This led to the "smart" trend of right-sizing the cloud footprint.

New strategies have evolved where organizations are adopting private cloud for mission-critical, data sensitive, regulation-bound applications and for applications with steady utilization.

New projects, test and development, cloud-native apps and apps with fluctuating utilization patterns are being moved to public cloud.

As new projects reach a steady state or as utilization increases and as applications/ data become strategic, they are migrated back to private cloud. This, in essence, is a "Cloud Smart" approach.

The consequence has been that while public cloud adoption is increasing at a steady pace, organizations are transforming their in-house IT into private cloud. The advantages of doing this are multi-fold:

• Private cloud empowers IT to move seamlessly to public cloud for selected workloads

• Users get a seamless experience of cloud computing with private cloud

• IT retains full control of all resources in private and public cloud

We envisage that finally when the dust settles, most mid-to-large organizations will be left with a hybrid cloud approach that permits them to retain control of their core applications and data while still leveraging public cloud for dynamic demands.

A majority of the organizations we surveyed were hosting their workload on private cloud environments (see Figure 23: How is your compute workload distributed?). There is still 21% of the compute environment on physical hosting environments. This is mostly for those workloads

Q: How is your compute workload distributed?

- Private cloud/virtualization
- Physical hardware
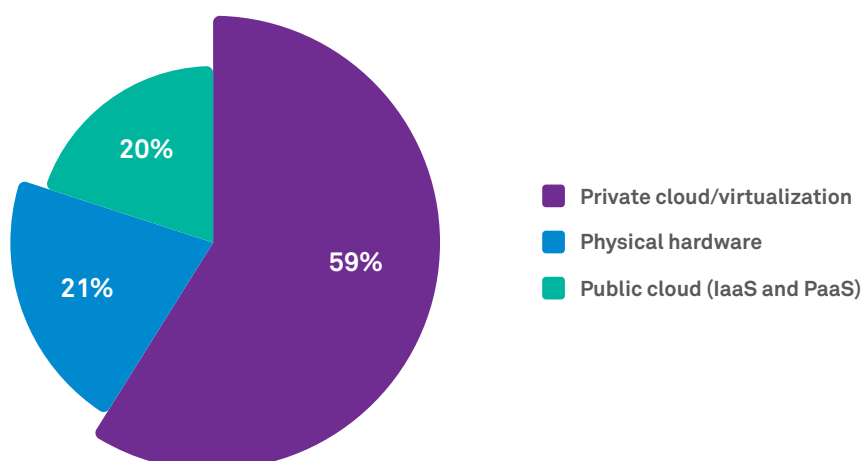- Public cloud (IaaS and PaaS)

59%
21%
20%

Figure 23

where for single instance the resource requirement is so huge that it requires full server resources or in some cases multiple server resources. Public cloud is still utilized in these organizations but mostly for test and development of new projects and office productivity applications.

A pattern is emerging for organizations that prefer private cloud. These organizations have:

- A very large footprint and a variety of applications

- Heavy and steady utilization of IT infrastructure resources

- Large investments in state-of-the-art data center facilities and want to continue with on-premise infrastructure for their core applications

- Sensitive data or for whom data is a core business asset

- Stringent regulations regarding data and a preference for retaining complete control over their core application

It is interesting to note the key characteristics organizations are expecting from private cloud:

- **As-a-Service model:** Exactly like public cloud, most organizations are keen on working with service providers who can offer an "as-a-Service" model for private cloud infrastructure. Within this, there are two classes of organizations:

  » **IaaS in client-owned data centers:** These are organizations with heavy investments in state-of-the-art data center infrastructure. They prefer that service providers bring in their IT infrastructure and management resources to provide IaaS.

  » **IaaS in service provider data center:** These organizations want to do away with their aging data center maintenance and free up the blocked real estate. They prefer service providers who offer hosting space, the associated IT infrastructure and the WAN bandwidth in an IaaS model.

Today, service providers are offering consumption models in different flavors, from a flat fixed-cost monthly OpEx to 80% variability. Based on minimum commitments and minimum lock-in periods, that price can vary.

- **Automation:** The second characteristic that organizations are keen on is automation. The single-most important benefit of cloud is the elimination of manual tasks. The main categories where automation is expected in private cloud are:

  » **Build:** Building new environments has always been a time consuming task. With DevOps taking root, automated provisioning has become the number one priority for most organizations. Many private cloud solutions provide template or blueprint-based methodologies to define and automate the build process. Out-of-the-box integration with applications and hardware devices is what defines their maturity.

  » **Configuration and state management:** While build automation helps with the initial setup, the time of the operations staff is largely spent on reacting to incidents and state changes in the environment. This is where organizations expect private cloud to manage the state of environment as defined by them.

- **Self-service:** This is the minimum basic feature and third characteristic expected from any private cloud solution. Organizations expect that their business and application users should get some level of self-service and autonomy in deciding their infrastructure needs without going through a lengthy manual process of requesting resources.

- **Integration with public cloud:** This is the fourth and last important characteristic that organizations expect. Most have some cloud strategy or vision of how to harness public cloud for their cloud-native application development or for their new projects. Private cloud solutions which can mask the boundaries of private and public and offer a uniform experience using a unified portal are in great demand.

SaaS adoption

●●●●○

Software-as-a-Service is a subscription-based model for software. It is an alternative to the traditional IT model where applications are procured, installed, integrated and productionized for user consumption. SaaS can be availed and consumed on-demand simply by connecting to the service from a public network. Fundamentally, SaaS empowers a business to address its IT needs by offering a variety of choices and reducing the dependence on an IT team to manage, maintain and upgrade applications. Businesses that opt for SaaS find that they can operate with a lean IT department.

There is a definite value in SaaS that goes beyond reducing IT overheads and enabling streamlined distributions and deployment (see Table 01: The pros and cons of SaaS), which is why it has become popular.

The pros and cons of SaaS	
Advantages	**Disadvantages**
• Faster time-to-market	• Vendor lock-in
• No upfront CapEx	• Limited integration
• No hardware issues	• Lack of complete interoperability
• No operations and maintenance	• Limitations in customization
• Scalability	• Lack of control
• Better DR and business continuity	• Compliance issues
• Automatic upgrades	• Performance issues

Table 01

With cloud-first and cloud-only approaches gaining ground, many application software providers themselves are opting for SaaS as their preferred model for delivery, new releases and feature upgrades. This allows them to deliver faster than on their on-premise equivalent. While SaaS eliminates many operational requirements (see Figure 24: SaaS operations), there are areas
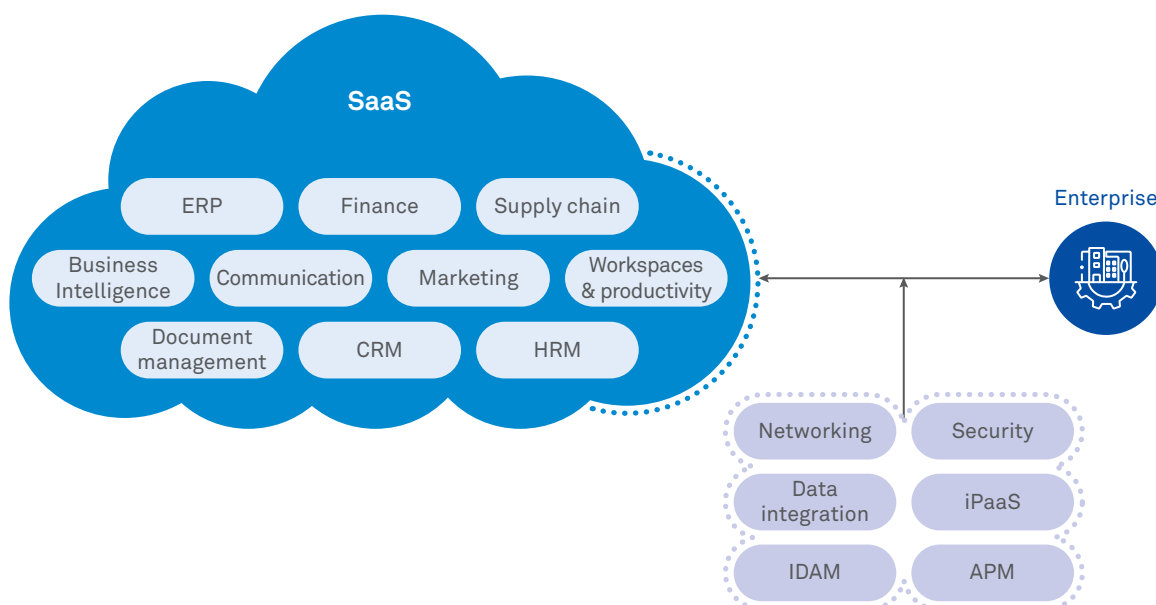

Figure 24: SaaS operations

that businesses have to provision and/or manage. These include:

- **Networking:** Provide optimal network paths to users from all access points

- **Security:** Ensure a secure network between business and provider using Cloud Access Security Broker (CASB)

- **Data integration and operations:** Application data integration, exports, tokenization, etc.

- **IPaaS:** Integration Platform-as-a-Service for applications, data, process and Service-Oriented Architecture (SOA)

- **IDaaS/identity management and SSO:** Cloud-based Identity-as-a-Service or IDaaS for authentication and SSO

- **Application Performance Management (APM):** Application Performance Management that is used to monitor and manage performance and availability of software applications

All of these require additional tools and technologies that must be further complemented by people and processes. Understanding the trends in SaaS and aligning investments to these trends is crucial for IT planners.

At the moment, businesses opting for SaaS appear to be investing heavily in productivity applications such as Salesforce and Office 365. Our State of IT Infrastructure 2020 survey (see Figure 25: Which type of SaaS segment has your organization invested in?) found that 80% of businesses fell in that segment, followed by ITSM (65%). An increasing number of businesses will examine SaaS options, especially as AI and Machine Learning are infused into services to generate alerts on events, anomalies and goals. These capabilities will place more control into the hands of users, making businesses more responsive and SaaS more attractive.

Q: Which type of SaaS segment has your organization invested in?
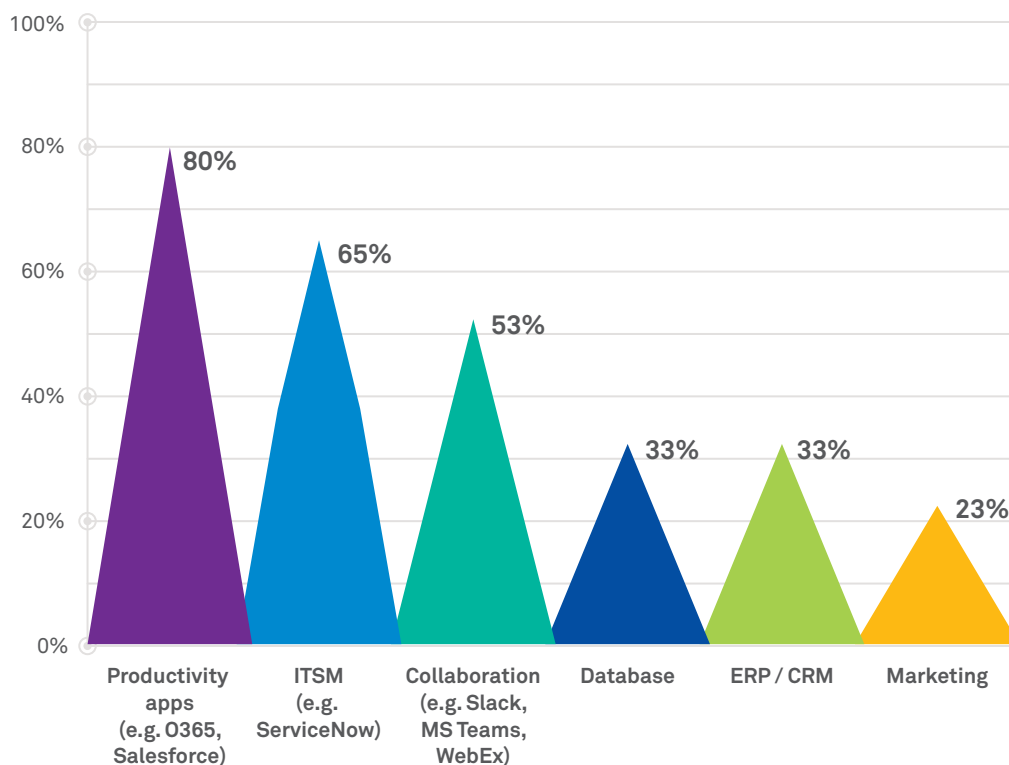
Organizations have invested in multiple SaaS segments

Figure 25

PaaS adoption

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Platform-as-a-Service is a container platform that accelerates and streamlines application development and deployment process, so you can deliver value more quickly to your stakeholders. It is an environment that allows developers to develop, deploy, run and scale cloud-based applications without having to worry about the underlying infrastructure (hardware and software).

PaaS is picking up steam as businesses reinvent themselves and aim for agility. Some of the key business drivers of PaaS are:

• Modernization of IT infrastructure across applications and infrastructure

• Application isolation and server consolidation through containerization

• Enable cloud-native and microservices architecture

• Standardized platform to accelerate application development

A PaaS should provide ready-to-use libraries, tools and services, such as databases, security, user management, monitoring, and analytics, which can be easily integrated with the applications you are developing. It should be able to support applications written using different frameworks and in a wide variety of programming languages.

There are three different types of PaaS (see Figure 26):

• PaaS software that provides additional features to SaaS applications.

• PaaS software designed specifically for certain operating environments (example: IaaS solutions with PaaS features)

• Open-cloud PaaS that does not have dependencies on other applications

The trend is of organizations migrating to PaaS with the goal of supporting DevOps and cloud-sourced business analytics while SaaS users are leveraging PaaS to extend their cloud-based applications. Current IaaS users are attempting to increase the
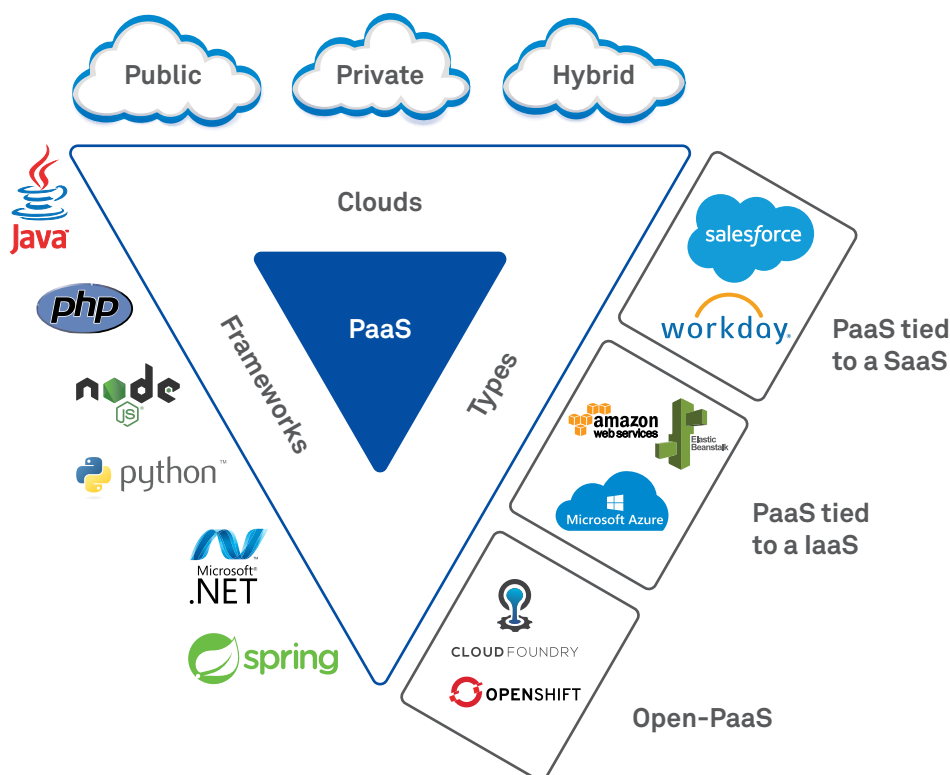

Figure 26: Types of PaaS environments

productivity of their cloud environments to quickly deliver new cloud services.

PaaS can be provided on or off premise, and in a private or public manner. Differing delivery models are being offered. Public-hosted models provide greater agility; private hosted provide greater control. At the moment, businesses are placing their bets on both: just over half the respondents in our survey (see Figure 27: What type of PaaS is being consumed by your

organization?) said that they were consuming PaaS in private and public cloud (57%).

The value proposition for PaaS is faster time-to-market for emerging applications, streamlined management of applications, and reduced complexity associated with the development process. Of course, one of the biggest selling points of PaaS is that it significantly lowers the high costs historically associated with application development.

Q: What type of PaaS is being consumed by your organization?

- Both in private and public cloud
- None
- PaaS on public cloud
- Multiple variants of PaaS in DC
- Single variant of PaaS in DC
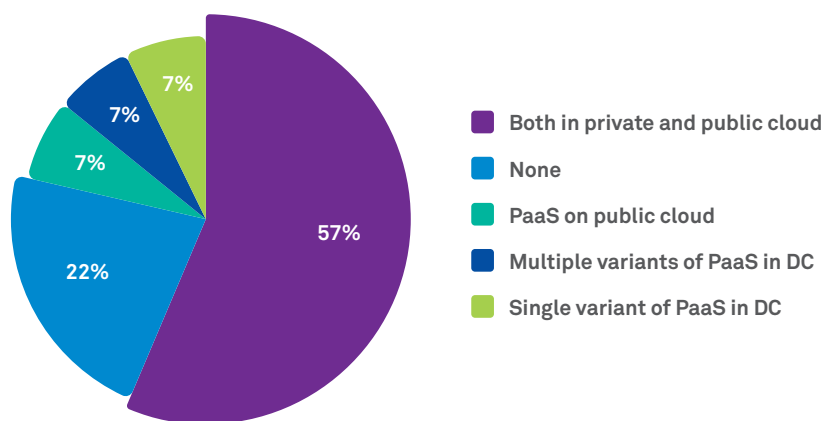
Figure 27

Public cloud adoption

You've read the memo: Cloud is the future. But here is the update: Cloud-native transformation on public cloud is the end state. The signs are all around us. In 2020, the global public cloud market will be US$266B[ix], up by 17% from 2019 with 75% enterprises having moved their workloads to cloud. As many as 61% enterprises cite cost savings as the primary driver for the migration to cloud. Overall, we will see more than 75% of businesses in the banking, manufacturing and retail sectors make a dramatic change in the way business is delivered. Keep an eye on these industries because they will set the pace and lead the way to a boundaryless enterprise.

Wipro's State of IT Infrastructure survey for 2020 shows that having two or more public cloud partners is the dominant trend (46%) for IaaS and PaaS. Those with a single public cloud partner (29%) will also turn to experimenting with multiple partners as their needs grow and the available options become more attractive (see Figure 28: What is the distribution of your workloads between multiple public clouds?). What is surprising is the large number of businesses (25%) that have not ventured into public cloud at all. The most likely reasons for this exist at two extreme ends: it is most likely that leadership in these businesses do not fully comprehend the benefits of public cloud and, at the other end, they are wary of the new processes for monitoring and governances that public cloud demands (and they don't have the resources to address this challenge).

Q: What is the distribution of your workloads between multiple public clouds (for IaaS and PaaS)?

Single public cloud partner — **29%**

12% Two public cloud partners

None **25%**

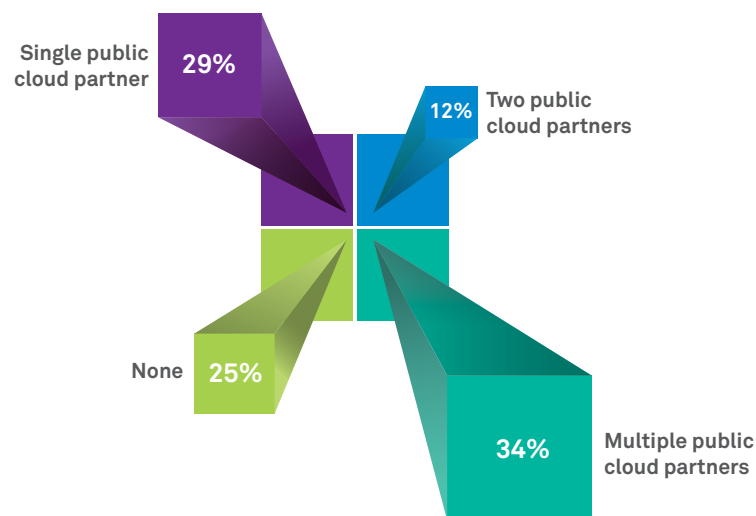**34%** Multiple public cloud partners

Figure 28

A vision for public cloud

A simple lift-and-shift from traditional data centers to cloud, with cost savings as the key goal, is a recipe for disaster. The change won't be successful without a well-thought-out vision, strategy and execution plan. The vision should be around cloud as a strategic lever used to infuse better value into products and services by unlocking innovation, enabling scale, improving efficiency and becoming cost effective. Literally hundreds of KPIs should converge into one vision statement for successful cloud adoption.

The drivers and outcomes are precise but the road to the end state isn't. The process of sequencing and converging different high visibility infrastructure programs like data center consolidation, orchestration of processes and cloud-native transformation of applications are not always mapped to success.

Many organizations make the fatal mistake of believing that pockets of success of their cutting-edge modernization programs and breakneck automation, without governance, indicate a workable plan. This is misleading. The methodology works only as a pilot. It is not a reusable and replicable model.

Hence, there is a need for a Unified Services Platform that drives organizations through the maze of discovery and a migration plan, powered by Agile Application Lifecycle Management (Agile ALM) and DevOps, leading up to a seamless transition of managed day-to-day operations from data center to cloud.

The overarching enabler for the transition is Infrastructure-as-Code with security and compliance built into the Unified Services Platform. The road to a cloud-native end state then becomes simpler (see Figure 29: Road to cloud-native end state).

Cloud-native public cloud migration

Refactor to containerized microservices

Enable agile DevOps

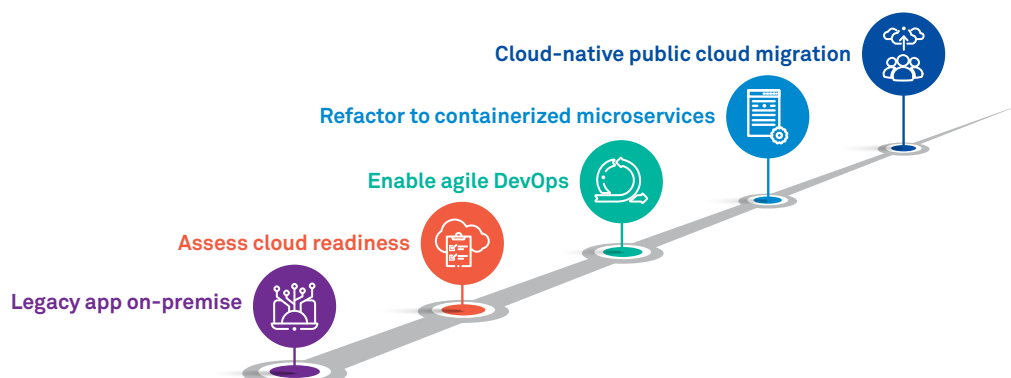Assess cloud readiness

Legacy app on-premise

Figure 29: Road to cloud-native end state

The key decisions and strategies to consider for cloud-native end state would be:

- Maintain business value and cloud-native first strategy for newly launched apps

- Have less critical corporate apps on SaaS

- Thorough assessment of security, scale and functional validation for business critical apps before taking the cloud plunge

- Target a pragmatic end-state goal of less than 5% on-premise, less than 15% private cloud and everything else on multi-cloud

- Plan for scale, prepare for resilience and optimize forever

- Choose each cloud in multi-cloud design for its feature merits mapped to specific use cases

- Cloud adoption needs a mindset change— therefore, evangelize the benefits and address every concern around limitations

Look out for simple public cloud choices

The most important aspect after a strategic cloud migration design is the choice of technology. 2020 could well be the year "when the dust of many solutions for too few problems settles down", leaving us with simpler technology choices that we can select with greater confidence.

With de facto cloud-inspired frameworks like Function-as-a-Service, Infrastructure-as-Code, Kubernetes-driven microservices, secure access service edge and service mesh becoming stable mainstream patterns, the Twelve-Factor App, a global microservices standard (directives chartered by a group of developers from Heroku) for achieving cloud-native applications doesn't seem like an elusive goal. But, while making the goal attainable, it introduces changes to the design, deployment and operations of infrastructure that is activated through this change.

Cloud providers, infrastructure and security platforms will align their design/redesign and strategies around this shift towards a compelling cloud-native future of driving excellence and business at scale.

Apart from the standard availability, performance and reliability metrics, successful public cloud adoption will be measured along the following metrics:

- **Scalability metric:** Systems-defined growth levels

- **Security metric:** Cloud-native security score

- **Latency:** The outcome of multi-geographical hybrid cloud design

- **Average cost per customer:** The inevitable metric that needs visibility in a pay-as-you-grow model

Barring a few strategic and cautious decisions by customers and Cloud Service Providers (CSP), cloud-native adoption is going to be the beginning of an application design and the horizon of infrastructure innovations.

Maran Marudhamuthu,
Global Technology Leader – Strategic Partnerships, Amazon Web Services

Organizations around the world are moving to a cloud-based infrastructure to increase IT agility, achieve nearly unlimited scalability, improve reliability, and lower costs. Moving to the cloud allows customers to innovate faster because they can focus their highly valuable IT resources on developing applications that differentiate their business and transform Customer Experiences instead of the undifferentiated heavy lifting of managing infrastructure and data centers. When deciding which cloud provider to select, companies often base their decision on the quality, performance, and scale of the provider's global data center infrastructure. Companies want to trust their assets and IT infrastructure to a provider that has the most advanced systems, security, processes, and controls in place to deliver the performance, experience, and business return needed by the largest of corporations.

Going digital and open standards

Reinventing your business

The impact of digital has been profound. Established businesses are faced with unprecedented competition, users are substituting products with cheaper and often better options and the value of popular offerings is diminishing. The need for innovations in some of the areas we see in Figure 30 is becoming compelling and immediate. The only way to achieve extreme innovation is by combining internal and external knowledge and engaging with the broader ecosystem that brings in new data, thinking, design, processes and skills. But this isn't as easy as it sounds. Often, achieving success with open standards requires moving away from proprietary technologies and engaging with global communities in evolving standards. Fortunately, the internet has created formal and informal networks and platforms that permit us to collaborate on a global scale, allowing us to combine knowledge and creativity in unprecedented ways. In this section, we examine eight areas that our research suggests are foundational for an enterprise to improve its capability to participate in open innovation and increase its ability to reinvent itself for the digital era.
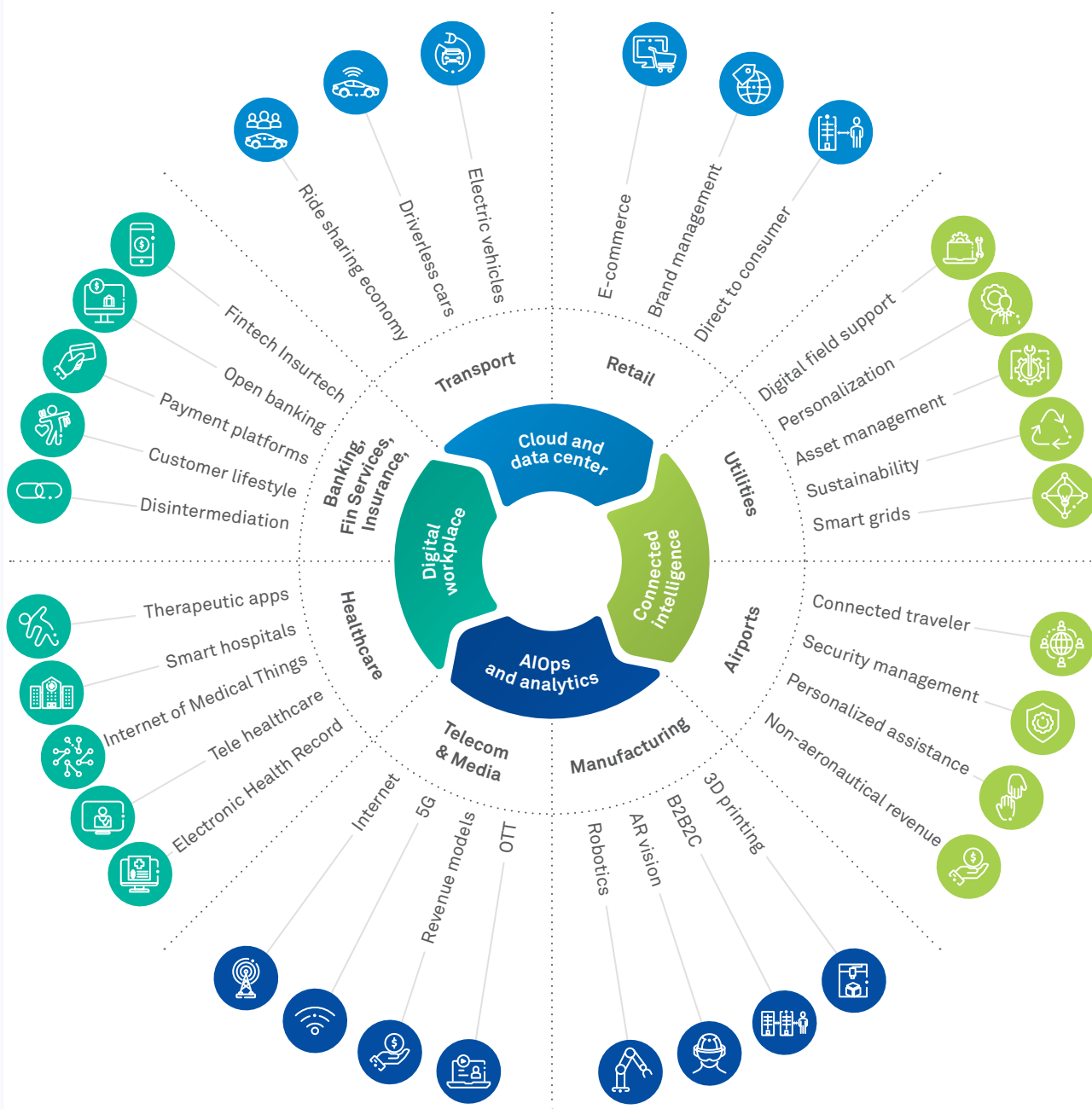
Reinventing your business drivers

Figure 30

Open source adoption

● ● ● ● ○ ○

Open source software has become the cornerstone of the modern enterprise. Most organizations are actively embracing open source, recognizing the value and flexibility to be gained by leveraging and investing in it.

Open source provides compelling, and often better, alternatives to some proprietary software. The options are mature and create dependable choices in a variety of areas such as:

- **Application software development:** Development tools, repositories, development languages

- **Application deployment:** Application server, databases, middleware

- **Platforms:** PaaS, aPaaS, API management, search and analytics, cognitive/AI tools, IoT

- **System and infrastructure software:** Operating systems, hypervisor, container infrastructure, cloud platforms, Software-Defined Storage, Software-Defined Networking

- **Security:** Proxy and load balancer, firewall, SIEM, directory

- **Tools:** ITSM, IT operations management, provisioning, monitoring, orchestration, discovery

The rapid innovation, development flexibility, cost-effectiveness and lock-in-free future are compelling reasons for businesses to adopt open source software. But there are issues of skills, security, complexity and support. These often dampen the overall interest of IT teams when it comes to adoption. Respondents in our State of IT Infrastructure 2020 survey (see Figure 31: What is the adoption of open source technology in your organization?) said that containers were at the top of their open source adoption curve (54%) followed by operating systems (51%). It is easy to see why something like containers (ecosystem of Kubernetes, Docker, PCF) is winning—it is the large and active community backing it that makes it dependable (aside from its lineage!).

The community behind open source makes available the software, under license, like GLP, MIT, Apache, etc. with no commitment whatsoever around performance. Enterprises therefore must evaluate the rewards vs. risks across options and decide on investments related to non-trivial areas and mission-critical workloads. Businesses are exercising considerable caution in the case of mission-critical workloads.

Q: What is the adoption of open source technology in your organization?
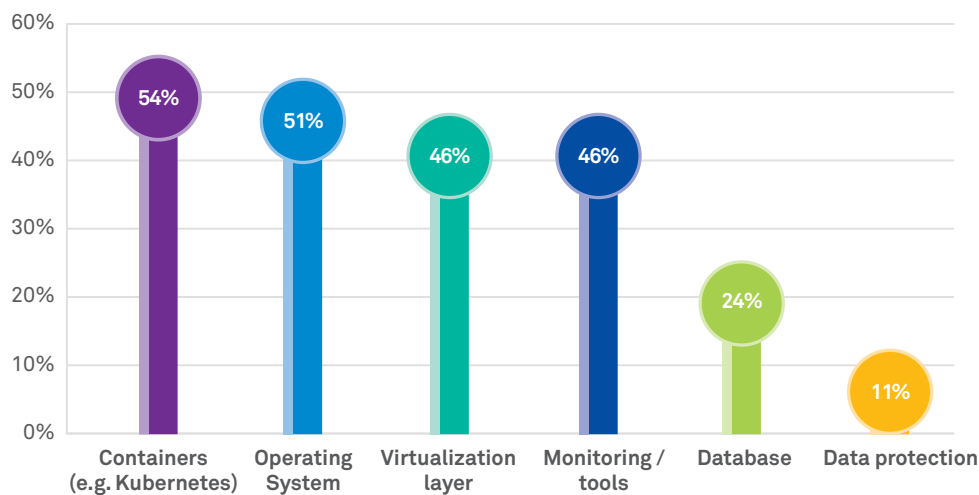
Respondents were asked to choose multiple response options

Figure 31

The larger requirement for the success of open source is rooted in assured support and continuous innovation, both of which provide a business with adequate indemnity from costs and risks. The enterprise open source model addresses this need. It brings the benefits of open source, combining it with the backing of a reliable vendor. Enterprise open source means having vendors that offer support and Service-Level Agreements (SLAs) that spell out what is supported and how quickly you should receive a response and remediation for an issue.

Our survey showed that only 9% were using community editions of open source products (see Figure 32: What is the support model for open source products used by your organization?).
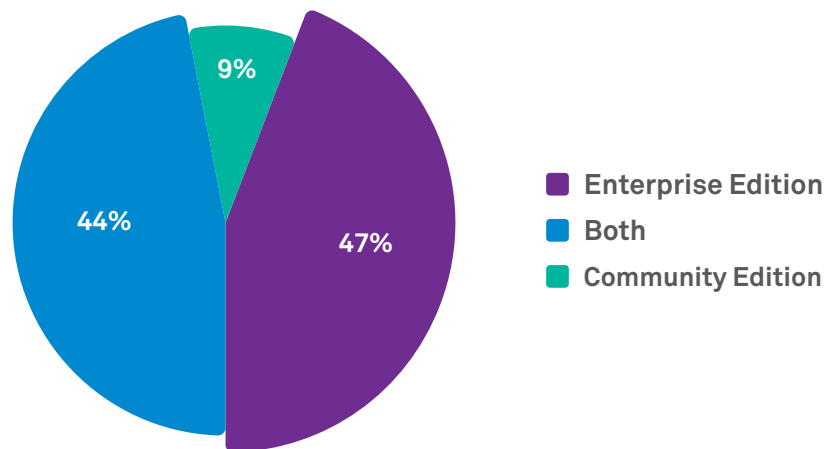
Q: What is the support model for open source products used by your organization?

- ■ Enterprise Edition — 47%
- ■ Both — 44%
- ■ Community Edition — 9%

Figure 32

Software-Defined Everything

●●●●●

We can blame the close coupling of system software and hardware for placing roadblocks in the way of flexibility, agility and nimbleness. Traditionally, applications, system software and hardware were tightly integrated to provide reliable outcomes to business users. As business demands grew and became more dynamic, IT infrastructure and applications have failed to adapt. They have become a drag on business growth. What was once an advantage has now become a barrier.

There were some early initiatives like file systems, symbolic links, Chroot, volume manager and user and kernel space separation meant to provide some degree of flexibility to IT administrators who wanted to manage resources efficiently. But these were IT admin and task focused. Then, along came virtualization, heralding a new era. It first gave life to the vision of totally abstracting hardware resources into common standards and decoupling the hardware layer from the system software. Virtualization was a precursor, before cloud computing took it to an industrialized level.

A growing trend towards SDI/SDx

So what exactly is Software-Defined Infrastructure and how do major SDI providers view it? The fundamental premise of SDI is that hardware only does basic operations; all higher level functions are done by intelligent software

on standard x86 hardware and standard general operating systems.

Thus in Software-Defined Storage (SDS) the hardware is Just a Bunch Of Disks (JBOD) while the storage intelligence is in the SDS software—which can be purchased separately from any vendor and run on standard x86 general purpose compute.

Similarly, in Software-Defined Networking (SDN), the hardware is just a data packet forwarding switch. All the networking intelligence like network segmentation, policies, routing etc., are done by intelligent control software running on standard x86 general purpose compute.

This de-coupling of control plane and data plane opens new opportunities for achieving efficiency, agility and cost reduction in IT infrastructure. Our survey results showed that SD-WAN (63%), content, storage (41%) and security (37%) were the most immediate areas for SDI adoption (see Figure 33: Which are currently the top areas in your organization for the adoption of Software-Defined Infrastructure?). SD-WAN could have its nose ahead of everything else because traditional WANs are unable to meet the needs of today's digital businesses that are becoming heavily dependent on SaaS and cloud. The urgency to upgrade from traditional WANs also explains why there are a vast variety of SD-WAN vendors providing a range of options to match the needs of every business.

Q: Which are currently the top areas in your organization for the adoption of Software-Defined Infrastructure?

63%
SD-WAN

25%
Block storage

41%
Content storage
(e.g. File, etc.)

31%
Network - LAN

37%
Security

80%
60%
40%
20%
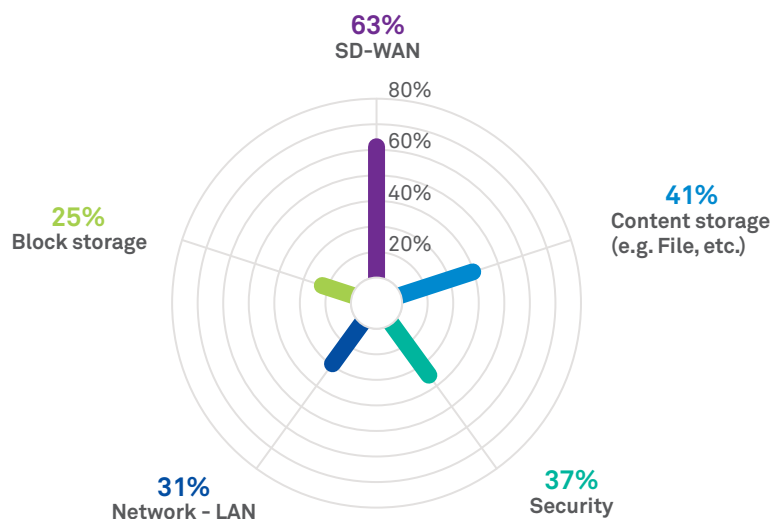
Respondents were asked to choose multiple response options

Figure 33

The trend towards SDI/SDx is sharp. SDI is emerging as a major enabler of the digital revolution.

Our survey results pointed us in the direction of the major drivers for SDI adoption (see Figure 34: What are the key reasons to move towards SDx adoption?). The top three drivers included lower refresh cost (71%) closely followed by automation (68%) and standardization and commoditization of hardware (58%).

• Lower refresh costs: As the SDI model requires only a hardware refresh while continuing to pay support subscription for the software, there is a reduction in CapEx. Also, since hardware and software are independent, there are several choices for hardware and there is no vendor lock-in, thus increasing buying power. This is in contrast to the traditional appliance model of IT infrastructure where appliance refresh involved re-investment in hardware and software as both were tightly coupled in the appliance.

Q: What are the key reasons to move towards SDx adoption?

Lower refresh cost	71 %
Automation	68 %
Standardization and commoditization of hardware	58 %
Freedom from hardware lock-in	50 %

Respondents were asked to choose multiple response options

Figure 34

- Better alignment of IT with business as SDI enables greater automation of processes within the IT environment and also enables greater modularity, thus empowering IT to match demand with supply.

- The scalability and agility required due to proliferation of IoT, analytics and AI--SDI is inherently more scalable, programmable and portable, providing a distinct advantage. For example, a container-native SDS controller scales as more containers are spawned to respond to business needs.

Types of organizations that prefer SDI/SDx

The forecast for global SDI is bullish. The SDI market is expected to hit $96B by 2023, at a CAGR of 23% between 2017 and 2023[x]. This growth will be led by three types of organizations gravitating towards SDx:

- **Organizations on a hybrid cloud journey:** Organizations with an existing footprint on public cloud are expecting similar cloud-native experiences on their private cloud environment. A traditional appliance model where control

logic is built into the device and is at the mercy of the equipment manufacturer is very rigid to provide the dynamic experience expected from cloud. These organizations, in a bid to merge their public and private clouds, to create a unified hybrid cloud experience, are depending on SDI.

- **Organizations aiming to improve productivity:** Manpower and skills still remain the most vital components of IT management. SDI promises a multifold increase in the productivity of IT staff. The traditional linear model of fixed capacity per FTE is breached in the SDI model. SDI allows full-stack management of resources, merging traditional boundaries of compute, network and storage.

- **Organizations ready for innovation:** Digital applications demand a high level of dynamicity and automation across the core components of compute, network and storage. More importantly, this dynamicity needs to be programmable via APIs. Increasingly industries/verticals are exploring SDI for driving business growth by utilizing SDI for innovative business use cases. For example, they are using Wi-Fi for location-based services within closed premises.

Derek Langone,
CEO, XebiaLabs

In 2020 every large enterprise is a software company regardless of their core business. These reluctant software companies are turning to DevOps in an effort to better leverage software to reach and service their customers as well as find efficiency in their business operations.

Unfortunately, the common DevOps approach of using open source tooling as well as some individual point products does not scale to meet the requirements of an enterprise and leads to poor results and massive security and compliance vulnerabilities.

Using an Enterprise DevOps platform like these large organizations to connect all of the individual tools they already use into a standardized and scalable process, which includes state-of-the-art automation to increase speed to market and provides comprehensive reporting for security, compliance and performance measurement.

No longer do enterprises have to settle for homegrown approaches to building and delivering software at scale. With an enterprise DevOps platform, the promised benefits of DevOps can finally be reached.

DevOps

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The path to digital IT

DevOps has become a key initiative for organizations embarking on digital transformation. While DevOps cuts across multiple teams in the software delivery lifecycle (see Figure 35: End-to-end DevOps flow), the operations team is yet to make comparable headway. However, the pace of technological change in the Infrastructure & Operations (I&O) space is forcing drastic evolution. The emphasis for I&O is now on delivering value through services that support digital infrastructure and the organization's core digital strategy.
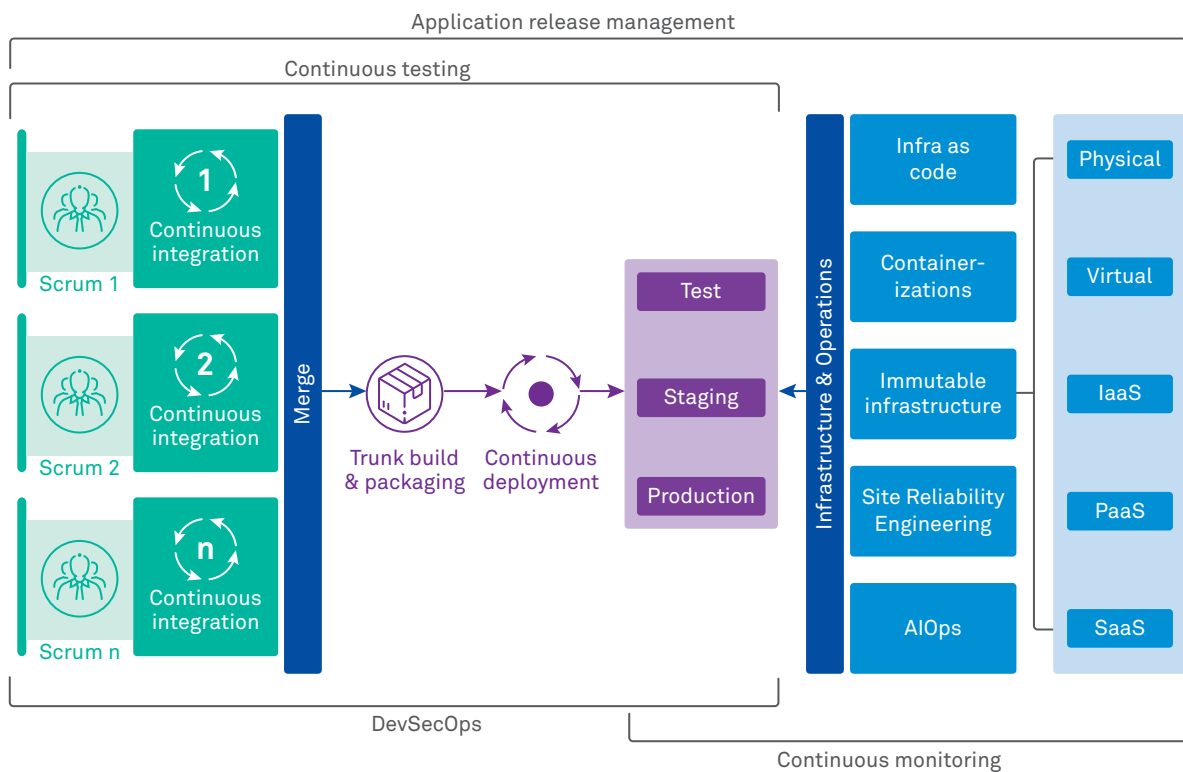
Figure 35: End-to-end DevOps flow

Five key drivers of DevOps have begun to surface (see Figure 36: Drivers of DevOps adoption in the IT infrastructure space).

- **Infrastructure-as-a-Code (IaaC)** that allows infrastructure teams to write code that automates and executes tasks while incorporating software development best practices. This includes automation of compute, storage and network—drastically improving scalability and reliability of the system.

- **Site Reliability Engineering (SRE)**, a discipline that applies software engineering principles to I&O, is creating quite a buzz. SRE enables resiliency of services, an important aspect for organizations moving towards digitization. Expect to hear a lot more about SRE in the coming months.

- **Artificial Intelligence for IT Operations (AIOps)** is picking up steam because it allows the use of analytics and Machine Learning to improve monitoring and supports real-time changes. AIOps will become essential in IT environments that are dynamic and complex, where extracting insights from data is a nightmare.

- **Containerization** is becoming popular with the growth of cloud-native applications and microservices architecture. Containers make DevOps implementation easier because the same tested containers can be leveraged across hybrid environments.

- **Immutable infrastructure** is about starting from scratch rather than modifying existing infrastructure. The infrastructure thus becomes immutable. The maturity of cloud and containers, that allow infrastructure to be created in minutes, is feeding the immutable infrastructure trend.
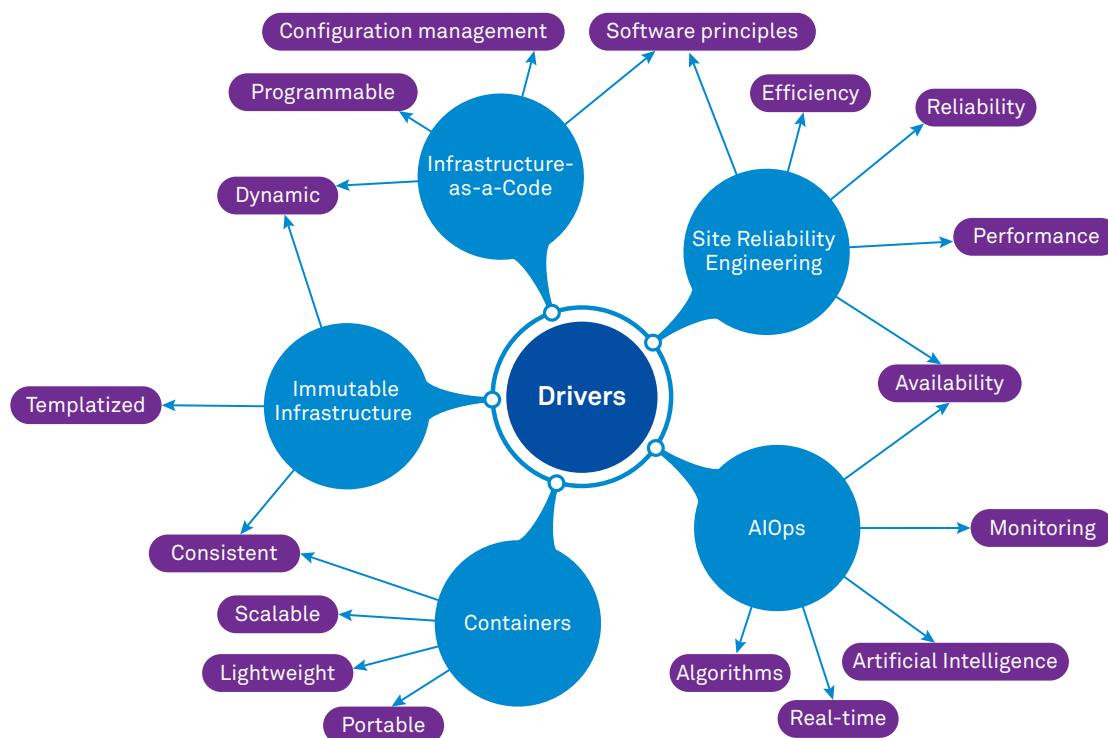
Figure 36: Drivers of DevOps adoption in the IT infrastructure space

Competing with digital natives

Digital-native organizations have already demonstrated the value of DevOps with their extremely mature practices. With DevOps being crucial to digital, automation and innovation, it is apparent from our survey results why 76% of our respondents said they were in the early to intermediate stages of DevOps implementation (see Figure 37: What is the current DevOps adoption maturity in your organization?). These organizations with ambitious digital transformation programs will have to compete with digital-native organizations.

These organizations have started to adopt the principles of DevOps in the infrastructure space thereby enabling self-service, automated, agile and software-defined digital infrastructure. We expect a wave of businesses in the immediate future who will leverage DevOps and gain shorter time-to-market, frequent releases that users demand, cost efficiencies, and a lower failure rate.

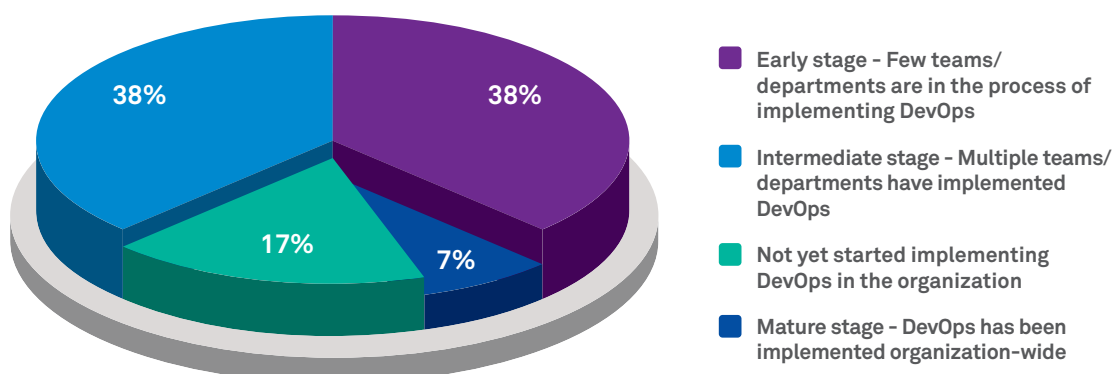**Q: What is the current DevOps adoption maturity in your organization?**

- Early stage - Few teams/departments are in the process of implementing DevOps
- Intermediate stage - Multiple teams/departments have implemented DevOps
- Not yet started implementing DevOps in the organization
- Mature stage - DevOps has been implemented organization-wide

Figure 37

Internet of Things

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IoT is integrating OT (Operational Technology) and IT (Information Technology). This is resulting in a cascade of new data that places a fresh burden on IT infrastructure. The integration also results in the migration of complexity from the edge of the IT infrastructure to the core. The link between the remote sites to the internet becomes more critical, as each device is now dependent on its connection to a server in the cloud. For implementers of enterprise IoT that means a focus on connectivity and a need for failover strategies to cope with link failures.

Enterprise IT infrastructure and IT resource investments are being influenced by the increase in IoT data along with shifts in IoT data strategies and technologies such as edge computing and analysis.

For IT executives and managers, these are exciting and challenging times as they are expected to play the role of catalysts in this IoT journey. They now have an unprecedented opportunity to demonstrate and implement their vision of the future. To do this, they need to bring attention to:

- **Increasing the organization's IoT IQ:** Start the journey by increasing awareness, knowledge and conversations around IoT throughout the organization

- **Building a sandbox infrastructure for IoT:** The IT organization should facilitate IoT innovation by building a "sandbox" for experimentation and proof of concept development

- **Getting infrastructure 'IoT ready':** Evolve infrastructure, processes and policies to not hinder IoT project success, adoption and scaling and address new challenges

- **Partnering for success:** The IoT ecosystem is still evolving and largely fragmented. The need is to collaborate with external partners to learn faster and reduce execution risks

The four simple focal points mentioned here are becoming urgent as our survey results show (see Figure 38: What represents IoT enablement in your organization?). The number of businesses piloting IoT use cases is reasonably large (46%). This is the kind of technology that will see exponential growth as every component required to support it is already in place. These components include low cost sensors that can be retrofitted on devices, new devices that already have a plethora of affordable sensors, edge intelligence that allows devices and gateways to process data and determine what and when it should be sent over the network, reliable high speed networks and cloud-based storage and analytical applications.

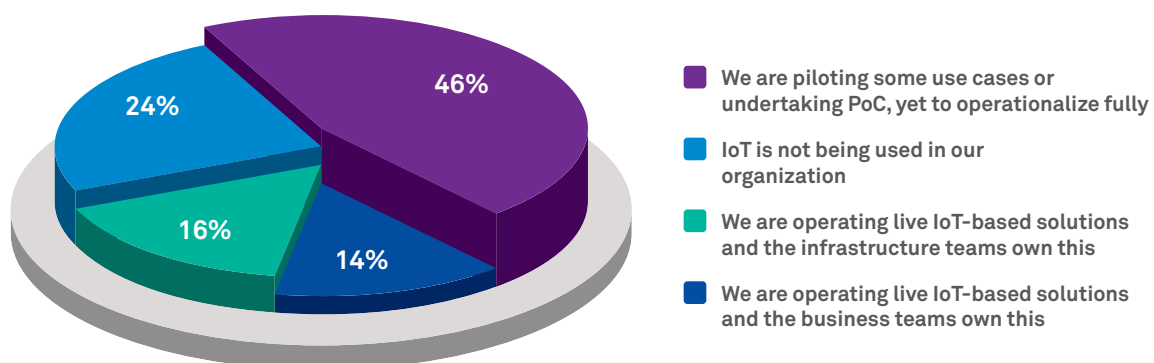**Q: What represents IoT enablement in your organization?**

- 46% We are piloting some use cases or undertaking PoC, yet to operationalize fully
- 24% IoT is not being used in our organization
- 16% We are operating live IoT-based solutions and the infrastructure teams own this
- 14% We are operating live IoT-based solutions and the business teams own this

Figure 38

AI technologies

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Artificial Intelligence is that attribute of a machine that enables it to perform functions that a human mind is capable of, such as discovery, cognition, learning, analysis and decision making. Commonly available features include speech recognition, Natural Language Processing, pattern recognition, reasoning, knowledge assimilation and decision making. AI technologies include robotics, Machine Learning and Deep Learning.

Speech recognition is widely popular today in the form of Siri, Google Talk, Alexa and others. It allows a user to interact with devices and systems via speech and get responses. Applications that convert speech to text, like Dragon Anywhere, Siri, Google Now and Cortana, are also popular.

Virtual agents such as chatbots are available for interacting with users to record a problem, route the problem to appropriate resolution groups or even provide solutions to some commonly occurring problems. These eliminate manual intervention and are usually available 24x7 for the convenience of users.

Biometrics which matches human attributes such as facial features, retina/iris match, voice imprints, fingerprint patterns, etc., to users is growing in popularity and improving security checks as well as identity management.

Robotic Process Automation (RPA) has gained wide acceptance in business process automation where human action is mimicked effectively by robots.

Emotion recognition allows software to scan human facial expressions including micro expressions and audio, process these images and voice to reveal a person's feelings. This type of software is widely used to study customer satisfaction.

Image recognition is typically used in surveillance and monitoring where an object is required to be identified in a digital image or a video, examples include Google Lens, LeafSnap, Cam Find, etc.

Digital Twin is a digital replica of a physical asset – these are connected to each other via sensors to generate real-time data. This technology is widely used in 3D modelling in a variety of industries such as construction, manufacturing, utilities, healthcare and automotive.

Machine Learning (ML) is about enabling computers to learn. These are widely used especially in cognitive automation which requires learning based on patterns and arriving at the appropriate action. This technology is used in prediction software.

Deep Learning is a component of Machine Learning and enables learning from unstructured data. The essence of deep learning is neural networks and learning can be supervised, semi-supervised or unsupervised.

AI technologies have set their footprints across most industries. Today, they are the catalysts for business transformation and IT infrastructure transformation.

Containers & microservices

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Cloud-native applications (microservices) and infrastructure (containers) are essential to modernizing and building innovative, efficient and scalable business applications.

There are four architecture trends we see defining cloud-native architectures (see Figure 39: Four trends defining cloud-native architectures), namely PaaS, microservices, API and serverless. A decade after it was presented by Heroku, the Twelve-Factor App methodology stands highly evangelized by the Developer community for web and modern mobile apps leveraging the four architecture trends.
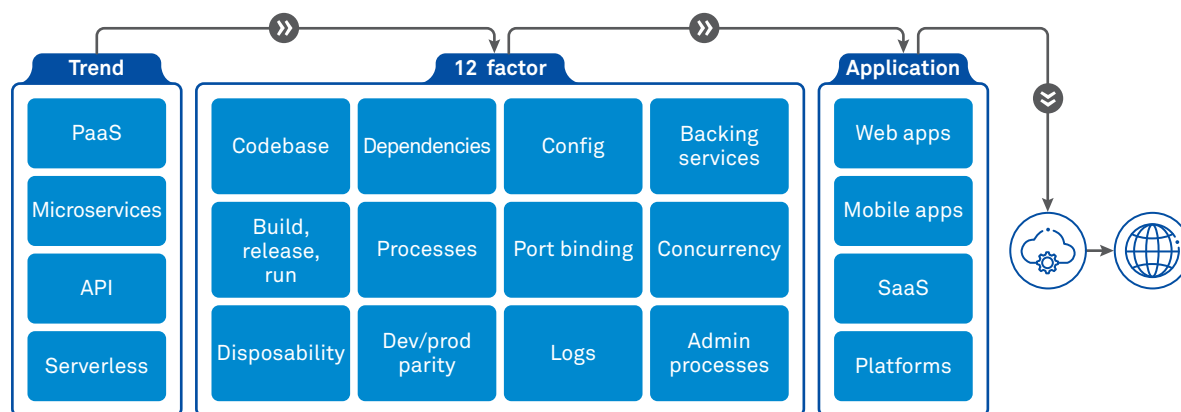
Figure 39: Four trends defining cloud-native architectures

Infrastructure operations teams are required to provide a suitable environment for these applications considering a comprehensive view of virtualization, deployment, runtime, developer environments, databases and networking. Multi-cloud enabled container platforms today promise all these. They abstract the complexity of configuring and managing traditional and cloud-native technologies such as Kubernetes, cluster configuration, and deliver management with data services.

Businesses will be keen to know how widespread the adoption of container platforms such as Kubernetes is. According to studies, the application container market is growing at CAGR of 30.8% and expected to be more than $4.3B by 2022[xi].

Our survey (see Figure 40: What is the level of container orchestration platforms like Kubernetes and Pivotal Cloud Foundry (PCF) in your organization?) shows that adoption had happened in 23% of the organizations. With 37% of respondents claiming it is in a pilot phase, we see a rising wave of businesses clamoring to mainstream microservices. This is likely to grow further as businesses begin to experience the ability of container technology to enable faster application development/deployment and the convenience of scaling.

Q: What is the level of containers orchestration platforms like Kubernetes and PCF in your organization?

- Currently piloting some of these or undertaking PoCs
- No plan to adopt
- Already some adoption has happened
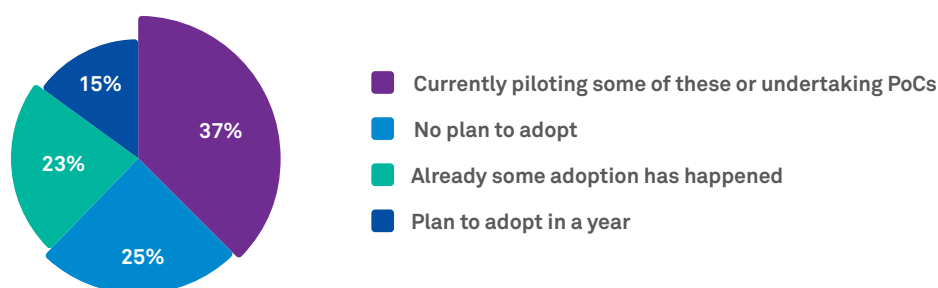- Plan to adopt in a year

Figure 40

Container platforms promise agility by abstracting infrastructure, nextgen application packaging and orchestration with DevOps to deliver faster and cost-optimized development. They also help application teams take ownership to release their code frequently with improved quality and eliminate bugs through automated and detailed testing with continuous assurance.

Enterprises today require services like IaaS, CaaS, PaaS and FaaS. These services leverage common platforms such as HCI software, Software-Defined Infrastructure like cloud volumes, backup, Kubernetes, containers (CRI-O or Docker) and serverless functions in multi-cloud architecture. Cloud-friendly networking like SDN and SD-WAN solutions abstract different network
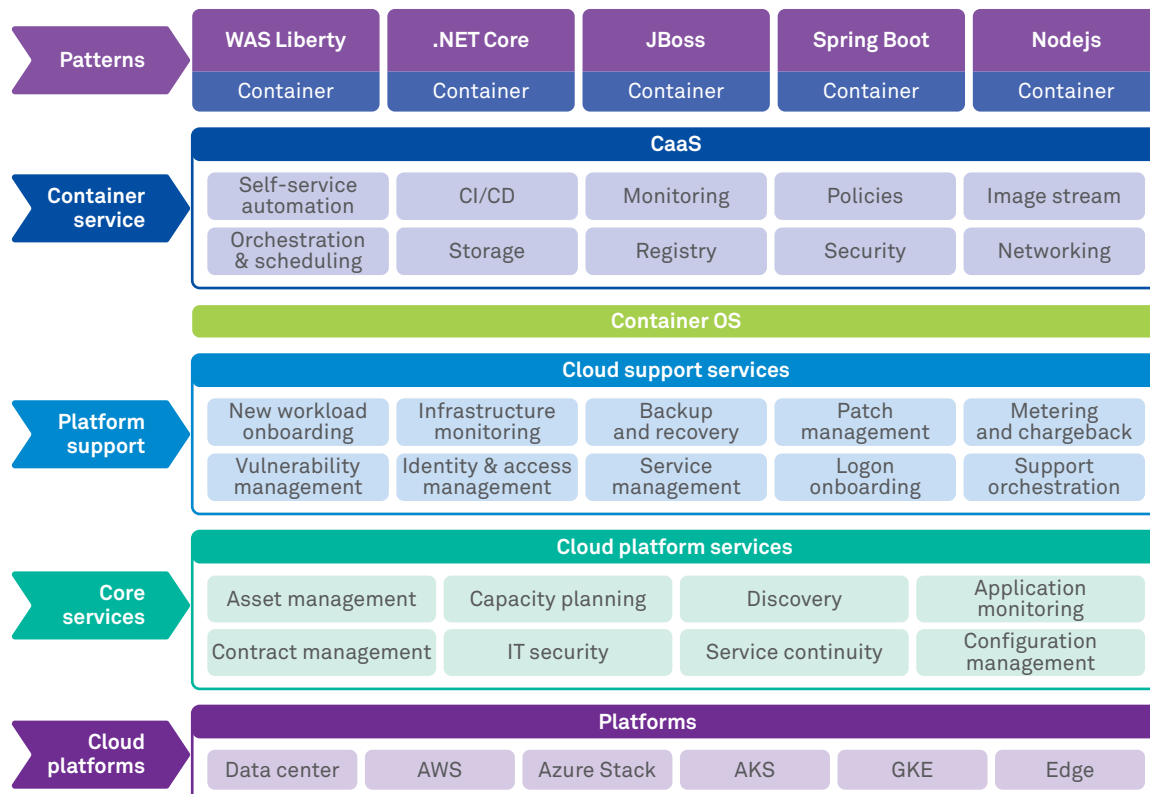
Figure 41: Container management solution

services of hyper-scalers to seamlessly deliver SLA-based services required for a true multi-cloud application. Enterprises invest in creating data fabric and secured network across multi-cloud for delivering seamless data management for stateful container workloads and modern data platforms.

A comprehensive multi-cloud container management solution (see Figure 41: Container management solution) should incorporate unified compliance policies, standardized (agile managed) enterprise images (or container registry) and runtime libraries for workloads. Thus it delivers signed and compliant enterprise applications anywhere.

For empowering DevSecOps, businesses must incorporate interoperable services like data services that unblock the power of storage services to deliver code-driven data services (storage control) and hence deliver data agile operations. Developers get complete freedom to drive data service needs leveraging data services code. For example, they can request storage for development, a copy of data for debugging, move data between environments/clouds, certify applications in multi-cloud, create pipelines inside pipelines (nested) and Disaster Recovery to name a few.

An essential part of container management is the smart logging and monitoring solution with AIOps to bring cross-cloud observability of the resources – cloud-native workloads in homogeneous or hybrid/multi-cloud or CaaS and PaaS solutions.

A further extension for operations also includes options for building and migrating applications anywhere with complete control of enterprise security and compliance. Enterprise can leverage migration toolkits to deliver Data Migration-as-a-Service for on-demand stateful applications across multi-cloud fabric. On-premise cloud-native applications can be securely developed in public cloud and seamlessly moved to on-premise for release in production. Enterprises can leverage Open Container Initiative (OCI) and open service broker API standards along with open data services to deliver business value in multi-cloud architecture.

For the cloud-native applications to deliver continuous assurance during development/build phase and in production, concepts like automated chaos engineering enables differentiated capabilities of application release agility and delivers the assurance of first-time right.

Edge and ambient computing

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Ambient computing aka ubiquitous computing is a term that encompasses many different concepts. At its core, it is the seamless but invisible combination of end-point hardware, software, networks, data centers, user experience, cognitive processing, AI, smart devices, virtual assistants, Human-Machine Interface (HMI) and learning. These combine into an environment that does not require conscious use. The systems and applications in the ambient computing ecosystem respond to computing needs without demanding special attention from humans.

Ambient computing requires sending data to and fro from devices to a cloud or data center, that is thousands of miles away, which is not practical due to network latency and performance. Therefore, an essential part of realizing the benefits of ambient computing will be edge computing. Gartner defines edge computing as "a part of a distributed computing topology in which information processing is located close to the edge – where things and people produce or consume that information."[xii]

The concept is not entirely new for an enterprise. ROBO (Remote Office/Branch Office) IT in the form of small data centers was part of the distributed IT solution for businesses with remote factories, warehouses, retail outlets, sales office, etc. The key change in thinking is the move away from complex proprietary systems to adopting standardized, low maintenance, secured infrastructure.

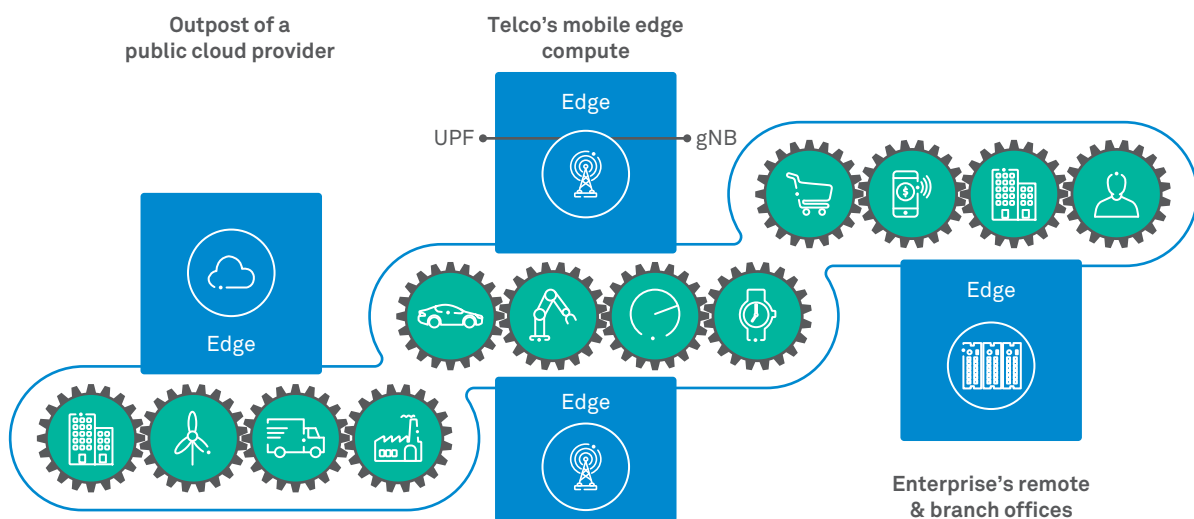There are several options to establish edge computing (see Figure 42: Three patterns of edge computing).

Figure 42: Three patterns of edge computing

- **Outpost of a public cloud provider:** Most public cloud providers today have some sort of small PoDs that can be deployed anywhere in the world and networked to their clouds. These serve the purpose of remote processing in collaboration with their central clouds.

- **Telco's mobile edge compute:** As part of the evolution in cellular technology, 5G rollout by cellular operators will involve deploying micro data centers across countries. These data centers will also provide multi-access edge compute on an open standard that can be availed by any party who wants to deploy any application or its sub component.

- **Enterprise's remote and branch offices:** Enterprises will have unique requirements where they want secure facilities for information processing away from data centers or clouds. An example of this is a factory that requires such private edge data centers, where mission-critical information processing can be undertaken.

Our survey shows (see Figure 43: Are you planning to adopt edge computing? What is the timeline you envisage for adoption?) that more than half the businesses have already realized or are likely to realize edge computing in the next 12 months. This, then, is a trend that needs watching.

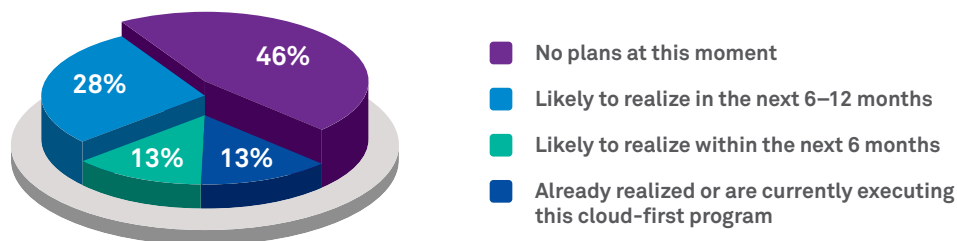Q: Are you planning to adopt edge computing? What is the timeline you envisage for adoption?

- No plans at this moment
- Likely to realize in the next 6–12 months
- Likely to realize within the next 6 months
- Already realized or are currently executing this cloud-first program

Figure 43

Intent-Based Networking

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The foundation for a dynamic network

Intent-Based Networking (IBN) creates a cognitive digital networking infrastructure. The goal is to align the networking infrastructure of the data center, Wide Area Network (WAN) and User Access Network (UAN) to dynamically program according to business policies and intent. IBN enables an automated programmable network by connecting business application to network elements such as Software-Defined Networking, Software-Defined Wide Area Network (SD-WAN), Software-Defined Access (SDA) controllers and traditional networking switches. The IBN platform acts as an orchestrator connecting multiple networking elements with standard APIs. It also enables dynamic network operations and IT Service Management by connecting to ITSM layers such as ServiceNOW.

Business intent translation is achieved, to an extent, using SDN which has capabilities of translating intent. But the intent still remains on the network side. This improves with IBN platforms that align more with business intent.

The IBN platform in action:

- Takes a business policy and converts it into a configuration to be applied to the network or network device

- Automates and orchestrates policies across the network, preferably via programmable interface

- Reports real-time network statistics and assurance data with co-related analytics

- Applies dynamic corrective action before or after a configuration is applied to the network

The benefits of IBN:

- **Ease of network provisioning:** Applications and users can expect automated network provisioning and seamless policy across the network, irrespective of the domain. IBN is known to reduce effort by up to 70% when compared to traditional operations

- **Integrated security:** Like SDN, IBN expects to have integrated security provisioning and monitoring, which can reduce network threats by ~40%

- **Ease of network operation:** Monitoring and troubleshooting can increase by ~80% along with more detailed analytics-based issue resolution

- **Increased end-user experience for applications:** IBN enables a cognitive interactive network which could increase the end-user experience for application access and network by up to 90%

Where is IBN being adopted?

IBN is largely seen as simplifying data centers and cloud networking but other domains such as WAN and Enterprise Access Network (EAN) are seeing adoption with the advent of solutions like SD-WAN and SDA.

More than 50% of the businesses across verticals are expected to realize the benefits of IBN in one to two years. Many customers are already executing pilots or proofs of concept to realize the benefits of IBN.

State of information storage

An evolving pillar of IT foundation

Storage of information has come a long way from IBM punch cards in 1928 to Solid-State Drives. Storage density has stagnated and is now at 1 to 2 TB per square inch for hard drives. Tapes still remain the most cost-effective storage for long-term data archiving. The massive data growth projected for the future, fueled by digital, means information storage is going to consume a large physical footprint along with more power. Also, there is the question of computer information storage media durability. None can match the durability of paper.

Expectedly, this has led to deep research and innovation in storage. The focus of information storage innovation is three pronged:

- **Information storage density:** How much more data can be stored per square inch.

  » HAMR and MAMR (Heat and Microwave Assisted Magnetic Recording) will provide a temporary marginal density increase of 15% over current hard drive technology. Solid-State Drives (SSD) will see some growth in density as we go more nano but will remain relatively costly compared to HDD. Researchers are exploring varied options for dense storage of information like DNA and holographic media.

- **Information storage store and retrieve performance:** How fast data can be stored or retrieved and how often.

  » High performance storage is required for more immediate and hot data. This space continues to be dominated by solid-state technologies. The goal is to reach near Random Access Memory (RAM) performance. Intel DC persistent memory is one such step in this direction.

- **Information storage durability:** How long data can be stored on a medium without affecting the data integrity.

  » Tape continues to rule long-term archiving—upward of 20 to 25 years or even 50 years if preserved in the right environment. Glass appears promising for long-term cost-effective storage. Using laser to etch data in silica promises 360 TB data on a single disk and longevity in billions of years.

Storage technologies
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For quite some time, since the advent of general-purpose computing, the magnetic Hard Disk Drive (HDD) have been the mainstay of storage subsystems in any data center. Processor and memory, the other two important pillars of IT infrastructure, have advanced in performance doubling every two years. HDD has always been a laggard in performance. In fact, HDD performance has slowed down if we compare performance per gigabyte. This

anomaly is because while HDD performance lagged behind Moore's Law, the HDD capacity density broke Moore's Law by several times. First HDD spinning at 1,200 RPM and holding 2,000 bit per square inch in 1956 to 15,000 RPM at half a tera bit per square inch today is a 250 million time increase in density and only a 12-time increase in speed. Over the years this has created an exponential gap between the advancements of CPU and memory, and what storage could handle. This made storage a major bottleneck in IT infrastructure advancement.

To overcome this challenge a new architecture evolved. A centralized network storage created by stitching together massive amounts of HDDs to achieve the required IOPS (Input/Output Operations per Second) and throughput. This heralded a new era of storage as a separate subsystem in the IT environment. These storage subsystems required special skills for design, installation and operations as they were highly varied, specialized and complex pieces of machinery.

But this approach is outliving its utility. While the storage component has always been an important factor in IT infrastructure design, the steady rise in new data generation and increased digitalization, has put storage back on the center stage. According to IDC, worldwide data will grow to 175 zettabytes by 2025 -- that is a massive 61% year-on-year growth[xiii]. At the heart of the digital revolution is data. As more data is being generated so is the need to harness intelligence from that data. Storage subsystems in data centers, as the custodians of this valuable data, are under immense pressure to perform and accelerate the digital journey.

A growing trend towards solid state

SSDs have put storage in line with Moore's Law. SSDs have progressed from 512MB capacity to a whopping 15TB and still growing. Most enterprises are investing in All Flash Arrays (AFAs) to accelerate their mission-critical workloads. Large enterprises have typically relied on big multi-controller shared cache storage arrays to pull in performance and achieve redundancy from multiple points of failure. SSDs have simplified the storage architecture. Massive performance of 100K IOPS from a single drive means businesses are no longer reliant on monolithic mainframe-style storage arrays. Distributed modular AFAs are in hot demand in almost all data centers. The high performance of SSD also enables AFAs to provide de-duplication

of online data. De-duplication of online data before the arrival of SSD was unthinkable. This de-duplication of online data has further made AFA economical to own and operate.

SSDs, although fast, are still connected to servers using interconnect and protocols designed for infamously slow HDDs. Typically, SSDs and AFAs connect to compute platforms using SAS or FC interface. SAS and FC internally are based on Small Computer System Interface (SCSI) command sets. The storage industry has responded with new methods of storage connectivity called Non-volatile Memory Express (NVMe). NVMe is an industry protocol for solid-state storage. NVMe flash will allow storage to communicate directly with a CPU via Peripheral Component Interconnect Express (PCIe) links, bypassing SCSI command sets.

Hyper convergence

SSDs have crossed the performance barrier of HDDs. But exponential data growth and the need of real-time data availability due to AI and IoT applications means storage management still remains a complex operation. Digital transformation is demanding that human intelligence move up the value chain. IT staff attention is required to derive value from IT infrastructure rather than getting bogged down in management intricacies. This push toward simplification of IT infrastructure in general and data storage in particular has caused organizations to turn to the same virtualization technologies which simplified their compute landscape.

Hyper-Converged Infrastructure (HCI) is the new strategy to simplify storage management. The HCI model involves binding together the storage, memory, and compute capacity of every individual node with an interconnection and a distributed virtualization layer. Once setup, these resources can be configured into a virtual server that functions as a private cloud environment.

In HCI environments storage is completely transparent. It is managed through the same server virtualization interface. IT users no longer need to involve storage admins for designing workload specific LUNs and volumes, configuring data protection policies and managing high availability. In HCI environments you specify how much compute and how much storage you need and the rest is taken care of by the underlying infrastructure itself.
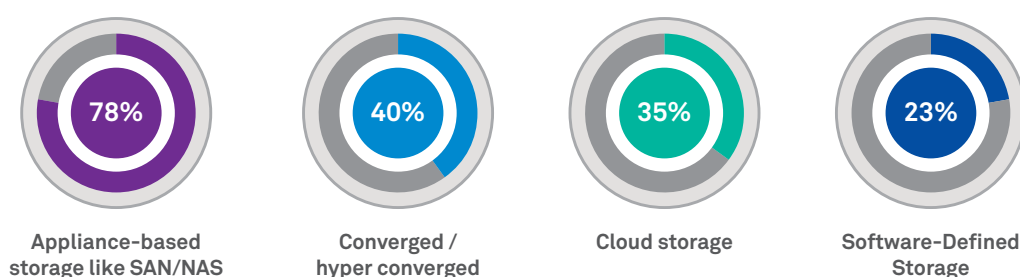
We see a clear trend of moving towards HCI, cloud and Software-Defined Storage (see Figure 44: What storage technology holds most of your organization's primary storage data?). While large organizations still prefer appliance-based storage models, the shift is towards HCI models.

HCI solves storage infrastructure management to a great extent. But how do you deal with massive data growth? In the last five years, we have seen data growth on multiple fronts. RDBMS and

files were the only original growth contributors. Now unstructured data, objects and logs have taken a huge jump and will continue to do so as the results of our survey show (see Figure 45: How is your information storage scenario likely to change?). Analytics is the key growth engine for digital and logs have proven to be a source of great insight into IT and business operations, security and risk analysis, etc. As organizations struggle to make sense of their growing data, there have been intense efforts to impart some

Q: What storage technology holds most of your organization's primary storage data?

Appliance-based storage like SAN/NAS	Converged / hyper converged	Cloud storage	Software-Defined Storage
78%	40%	35%	23%

In an organization, multiple storage technologies can be used

Figure 44

Q: How is your information storage scenario likely to change?

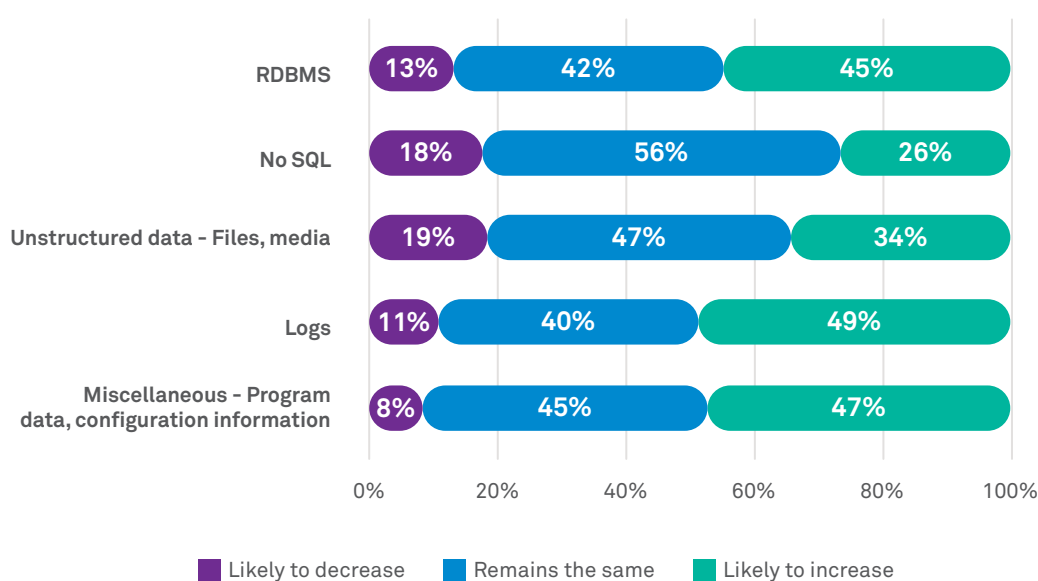|	Likely to decrease	Remains the same	Likely to increase
RDBMS	13%	42%	45%
No SQL	18%	56%	26%
Unstructured data - Files, media	19%	47%	34%
Logs	11%	40%	49%
Miscellaneous - Program data, configuration information	8%	45%	47%

Figure 45

structure to unstructured data. This enables organization to use time-tested tools that tame wild data. Due to this we see a growth on the RDBMS front.

The digital revolution is prompting businesses to retain as much data as possible in a bid to harness some insights. The value of data is a function of its age. As data ages, its value decreases. Keeping data online is expensive.

Another approach to tame data management is seen in the data archiving trend. Here, the idea is to extract the metadata about old data and keep the metadata online while original RAW data is archived to cheaper offline or nearline storage.

The enterprise organizations we spoke to for our survey said 52% of their data is archived and only 48% is kept online (see Figure 46: What percentage of data is in online storage?).

Q: What percentage of data is in online storage?

48%	52%
Online	Archived

Figure 46

Data protection

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Data loss, data leak and data stealing are challenges in the world of electronic data. In a data loss scenario, data is no longer available to an application to either function or give meaningful results. In a data leak or where data is stolen, you have the data with you and the applications can continue to function but someone else also has a copy of your data. This is a breach of data privacy. Here we deal with data loss and its recovery.

Data backup has been treated like an insurance policy by most organizations in the past. This is no longer the case. As more and more organizations realize the value of data and its protection to the health of their business, their approach to data backup is also changing.

The important parameter for data backup has been 'how much data loss can be afforded by the business?' because as we narrow this data loss window, the cost of backup and recovery solutions increase exponentially. Data backup is not only costly from a financial point of view but

it is also taxing to application performance and IT staffing. Hence organizations have tried to strike an optimal balance of application performance, IT budget and data loss. But as Disaster Recovery (DR) is becoming more mature and widely adopted and is developing to be an inherent part of business, the focus of data backup is shifting to provide rapid recovery with near zero data loss from localized failure (like storage component failure), application corruption or human errors. On the other hand, DR solutions focus on data availability and application uptime from wider failures. To this effect, we see organizations are keeping a recovery copy of the data close to their application for immediate recovery. Backup inside the DC is a must for almost all participant organizations of our survey (see Figure 47: What are the various data protection solutions used by your organization?), while a second copy of the backup can be offsite.

Organizations are also increasingly adopting a secondary storage strategy for data backup where data is replicated locally to a secondary storage. This enables near zero loss recovery, data consistency from an application perspective and immediate availability of data even without

Q: What are the various data protection solutions used by your organization?
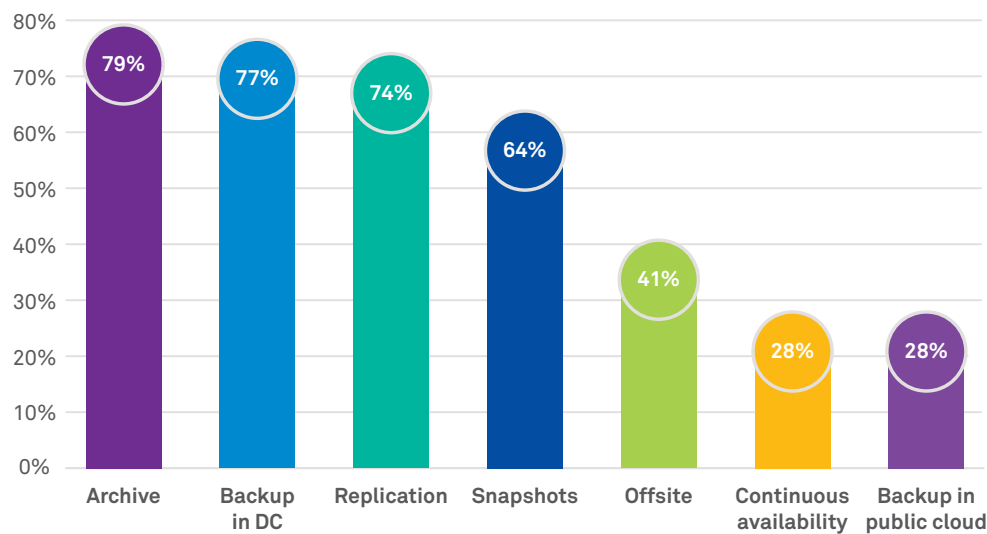
Respondents were asked to choose multiple response options

Figure 47

a recovery process. Immediate availability of data on secondary storage due to replication is also giving rise to the trend of using this data for testing, QA, and analytics without impacting production performance.

Local snapshots of data on online storage itself are found to be used as a means of data recovery or temporary data versioning during important change processes. The test and development teams especially rely on local snapshots of data for quick restoration to a point in time.

As observed earlier, data backup is taxing to application performance. How do you minimize backing up the same data repeatedly? This is where most organizations have been resorting to data archiving. Archived data need not be backed up again as it is frozen in time. Data archiving has emerged as the widely adopted trend to minimize data backup and enable faster recovery processes for most immediate hot data.

Backup to public cloud is still not very popular among large enterprises due to massive data volumes and bandwidth requirements. Backup to cloud has been restricted to specific and tactical project requirements.

Disaster Recovery and Business Continuity Planning

For modern enterprises, downtime is not an option. Business opportunities are 24/7 and competition is stiff. Downtime and data loss can erode brand reputation and result in negative business impact. In view of this, Disaster Recovery and Business Continuity Planning (BCP) become important to IT infrastructure management.

The traditional solution for DR has been offsite backup. Barring banks and some other industries that have stringent regulations, most businesses have been content with rudimentary tape backup at an offsite location. Tape backup may still be a good solution in some instances but mission-critical applications need data and application recovery within a few hours of a disaster strike. Today, there are businesses that even need recovery in a few minutes.

A DR plan is the outcome of BCP. DR focuses on the recovery of the IT setup and is based on the Recovery Point Objective (RPO) and Recovery Time Objective (RTO) determined by the BCP. RPO

determines the data loss (in terms of time) a business can afford; RTO determines how much time a business can afford to remain down post a disaster strikes.

An extremely large number of respondents (95%) in our survey said that their infrastructure met RPO/RTO requirements fully or partially (see Figure 48: Does your current IT infrastructure

meet your Recovery Point Objectives and Recovery Time Objectives?).

While this is good, it hides a chilling reality. Most businesses jump headlong into DR implementation without a proper BCP. When disaster strikes, realization dawns that the DR solution did not comply with business objectives. By then, it is too late.

Q: Does your current IT infrastructure meet your Recovery Point Objectives and Recovery Time Objectives?

54% Infrastructure deployed meets current RPO/RTO

41% Infrastructure partially meets RPO/RTO

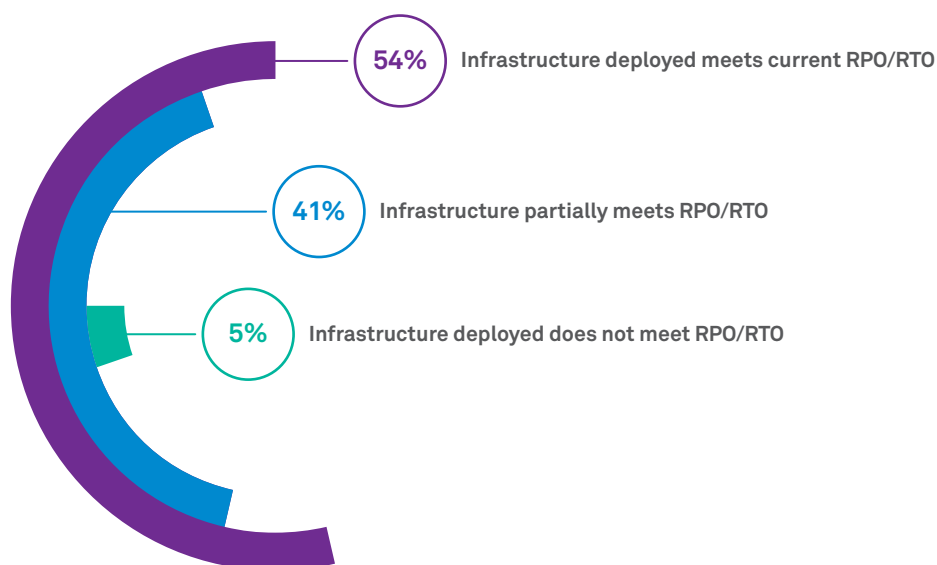**5%** Infrastructure deployed does not meet RPO/RTO

Figure 48

The blurring lines between backup and DR

The lines between backup and DR have been blurring. Organizations have been steadily using DR sites as backup in order to reduce the load on their primary sites. With continuous backup technology, organizations are able to achieve almost total data replication and are adopting a RPO approach to data protection:

- **A local copy with lesser RPO** is maintained using a local secondary storage with continuous replication, sometimes synchronously. This copy is used for immediate recovery from local failures or for test and development refresh.

- **A remote copy with optimized RPO** for which the same backup/replication technology as in #1 is used for maintaining a remote copy on remote DC storage with a larger time lag, adjusted to meet business objectives. This copy is used for recovery from major disasters at the primary site.

Tips and tricks for cloud-based DR

Another trend has been to use cloud as a DR solution. Cloud-based DR does not require upfront investment in infrastructure. But cloud OpEx is not cheap. Here, the strategy is to use cloud as an offsite store for application and data snapshots. In the event of a disaster at the primary site, this is used to restore the compute infrastructure. Using this route, organizations avoid cloud expenses--as long as they don't want to bring up the application on cloud DR.

Another trend is to use a similar approach as on-cloud for on-premise. Most storage vendors have tied up with hyperscalers to provide natively their storage technology on cloud. This allows organizations to use native storage replication to the cloud instead of third-party software.

This approach requires intelligent and efficient image conversion tools which can, for example, convert on-premise VMware image to AWS

EC2 image. This adds to the RTO but can be alleviated by using similar virtualization on cloud as on-premise. Hyperscalers are also providing native virtualization using which enterprises can avoid the VM conversion step.

DRaaS, addressing the challenges of DR

On the heels of cloud DR, we are observing the emergence of managed DR-as-a-Service (DRaaS). There is rising interest in SLA-based contracts where a third party manages the DR site, the solution, and takes complete responsibility of RPO/RTO-based failover and recovery.

DR has always been a labor-intensive and complex process requiring coordinated efforts across myriad products, applications, departmental boundaries and third-party service providers.

This has also been one of the reasons why most organizations shy away from conducting regular DR drills. DRaaS is an approach that overcomes these challenges.

Protection from malware and ransomware

A few high-profile cases of ransomware attacks have exposed the vulnerability of traditional backup and DR solutions. Sophisticated malwares transcend the boundaries of DR and backup to infect the replicated data as well, resulting in recovery failure. To address this, some organizations are adopting air-gap separation methods to protect their backup, some are adopting a more sophisticated approach of using data diodes and some are introducing a process-based approach to maintaining a golden copy on their remote sites.

State of end-user services – digital workplace

Reimagining how we work

The traditional workplace with its rigid attributes of one device, one platform, one network and one provider is history. The digital native generation, millennials and now centennials, want unrestricted access to advanced technologies that aid collaboration; that provide anytime, anywhere, any device access to drive efficiency. The new goal for CIOs is to meet these expectations by providing hyper-resilient, agile, workload-centric solutions. This is in addition to device, platform, network and provider agnostic infrastructure.

The challenge for the CIO is to deliver varied end-user experiences and outcomes to business and employees using a combination of social, mobile, cloud, touchscreen, high-definition, voice-driven and analytical technologies.

This demands a strategy to support an adaptive, fluid and industrial-strength workplace that keeps pace with expectations, the demands of innovation and business growth objectives.

How to build a fit-for-purpose digital workplace

The new digital workplace stresses upon using modern tools, policies, technologies and workload delivery models. The key characteristics of the digital workplace include the following:

Today's technologies allow the CIO to unleash the creativity that workplaces demand. They can bring down field support and enable cost savings of up to 20%.

- IT service provisioning

- Storefront for service enablement

- Intelligent SSO (Single Sign-on) and IDaaM (Identity and Access Management)

- Workload delivery

- User-centric security

- Unified device, apps, data

- Self-help, self-heal and self-aware

- User experience

The enterprise IT team, along with architects and business IT users, should create three maps:

- **Strategy map** that presents the overall vision with future capabilities
- **Roadmap** with details of project initiatives, timelines and target outcomes
- **Journey map** with a holistic view of how transactions/interactions will be fulfilled

The overall focus should be on user-centricity, BYOD, data and user security (not device security), and a walk-in café or technology parlor to socialize and resolve issues.

Today's technologies allow the CIO to unleash the creativity that workplaces demand. They can bring down field support and enable cost savings of up to 20%. But best of all, they can become the pivot for a happy and productive workforce.

New ways of collaboration

End users' expectation of their enterprise experience is continuously evolving. If the period between 2000 and 2005 was about service experience, and the time between 2005 and 2010 was all about the device experience, the time period between 2010 and 2020 has been mostly about the collaboration experience (see Figure 49: The evolution of enterprise experience).

Enterprises have invested heavily in all manner of collaboration tools. From Skype to Teams to Slack, effective collaboration seems to be the cornerstone of all enterprises. However, despite the stupendous investment that enterprises have made, the adoption rate of collaboration remains middling to low across geographies and enterprises. The clue to this low adoption can't however be found in technology but in the human-centric nature of how people use these collaboration tools and the fragmented nature of the collaboration landscape.

The fragmented nature of collaboration landscape

Nir Eyal, author of *Hooked: How to Build Habit-Forming Products and Indistractable: How to Control Your Attention and Choose Your Life* states that "many innovations fail because consumers irrationally overvalue the old while enterprises irrationally overview the new." And if that's true of all technologies, it is specifically true for collaboration technologies. End users typically use collaboration tools to fulfill two requirements:

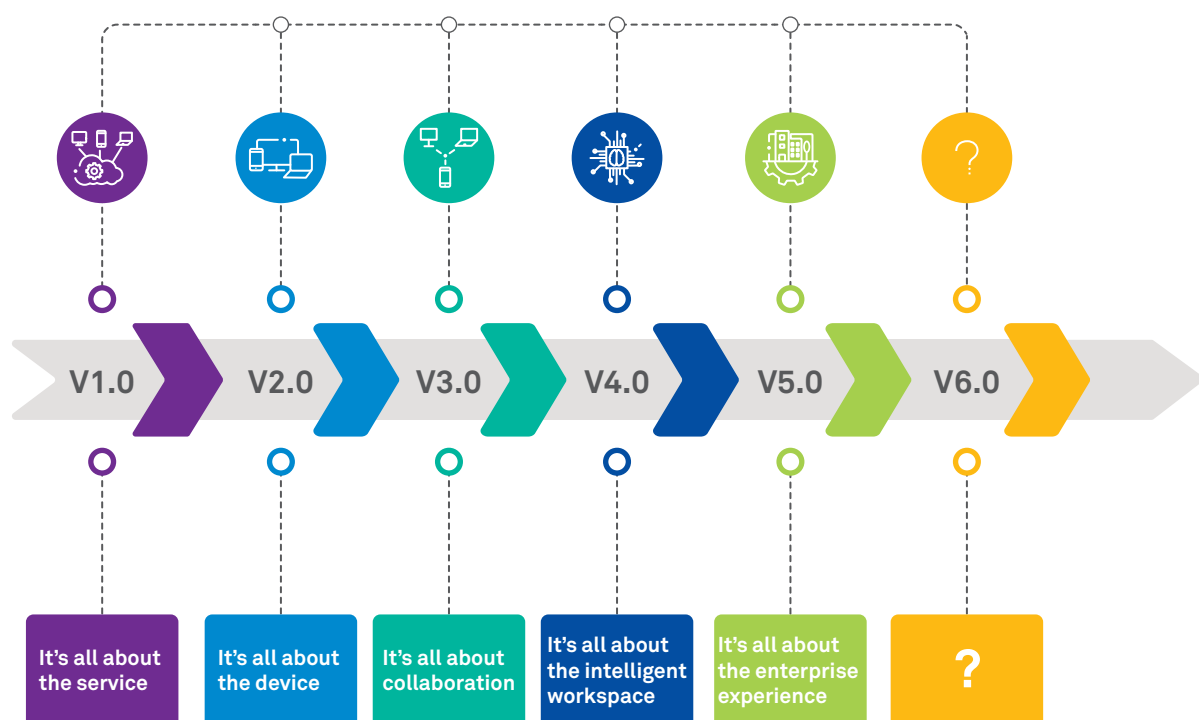| V1.0	V2.0	V3.0	V4.0	V5.0	V6.0
It's all about the service	It's all about the device	It's all about collaboration	It's all about the intelligent workspace	It's all about the enterprise experience	?

Figure 49: The evolution of enterprise experience

- **To discover information:** This can be unstructured information spread across the enterprise or structured information which is available in an application.

- **To connect with people:** This can be in an offline format, through information that people have created or in real-time to discuss and produce more knowledge.

While enterprises expect new collaboration technologies (like Slack, Zoom or Teams) to solve both of these problems, a closer look at these technologies reveals that most enterprise technologies only solve a small part of the use cases that end users are interested in. Figure 50: Collaboration matrix: Expected and actual use cases fulfilled by collaboration

technologies maps the use cases that users expect from their collaboration tools and the actual use cases that are fulfilled by modern collaboration technologies.

This makes it clear that the collaboration landscape is extremely fragmented and that different technologies only cater to specific use cases out-of-the-box. This landscape makes end users irrationally prefer their existing toolsets for collaboration, as they have literally developed the processes for their current collaboration chain by themselves and unless the new technology is willing to cater to all their use cases, it becomes difficult to wean users away from their existing technology landscape, leading to low adoption rates.
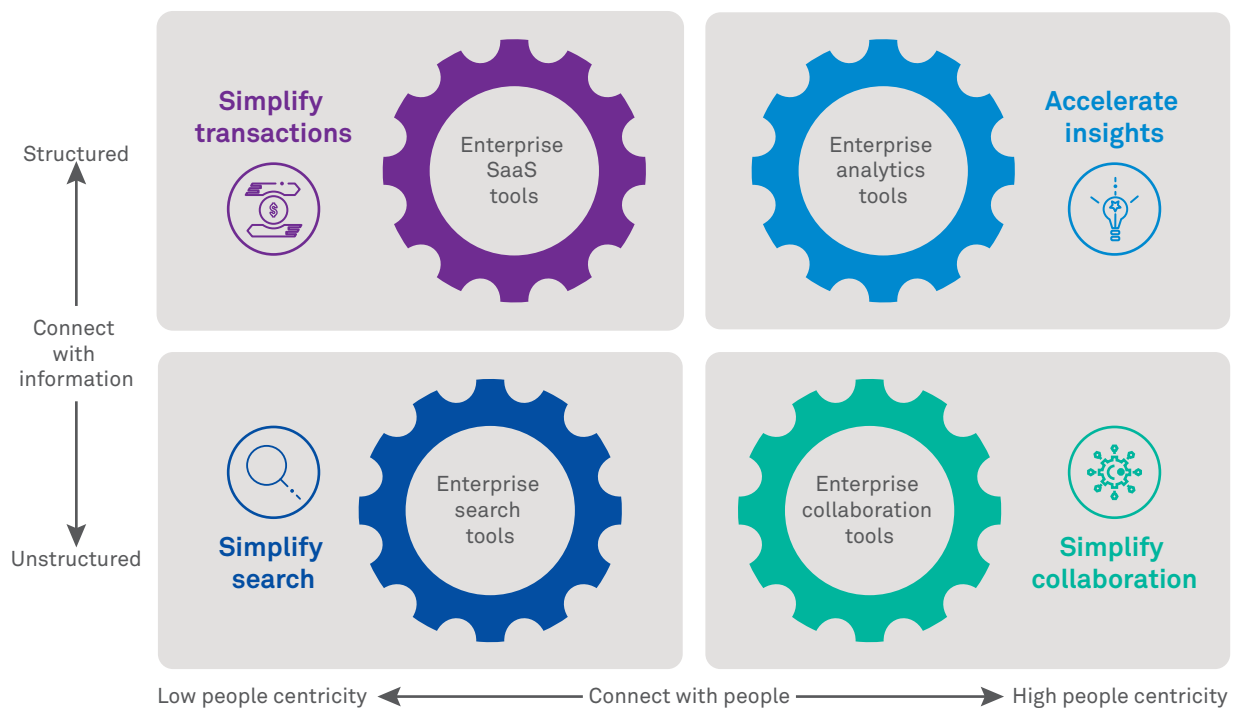

Figure 50: Collaboration matrix: Expected and actual use cases fulfilled by collaboration technologies

Our survey shows that enterprises expect voice communication to increase the most (see Figure 51: How do you see the voice communication needs in your organization?) when collaboration between outside businesses, partners and suppliers is needed (54%), followed by between businesses and functions (46%). However voice communications cover the entire spectrum of interactions and a double click on the data reveals the following: Enterprises

increasingly expect collaboration tools to replace voice communications (see Figure 52: What likely represents your future collaboration modes?). However, the underpinning nature of whether that involves people to people collaboration or searching for information is still not clear, something that neither voice nor collaboration tools easily facilitate. So, what does the future of collaboration look like? New age collaboration technologies offer enterprises a simplified way

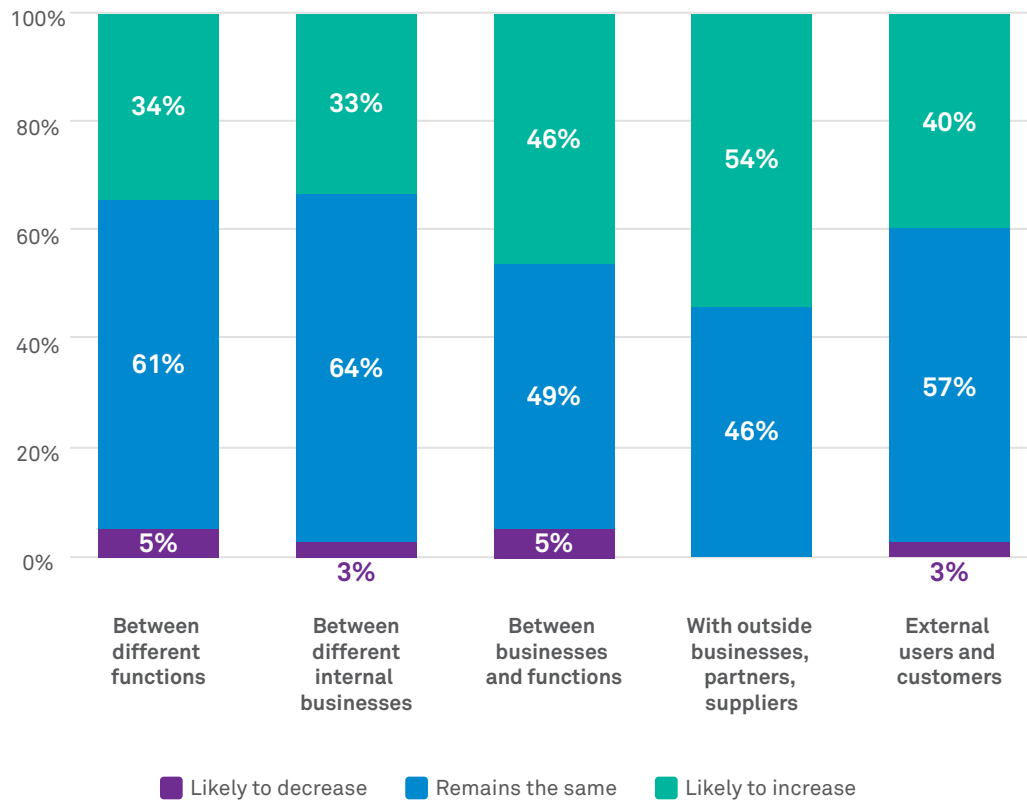**Q: How do you see the voice communication needs in your organization?**

Figure 51

Q: What likely represents your future collaboration modes?
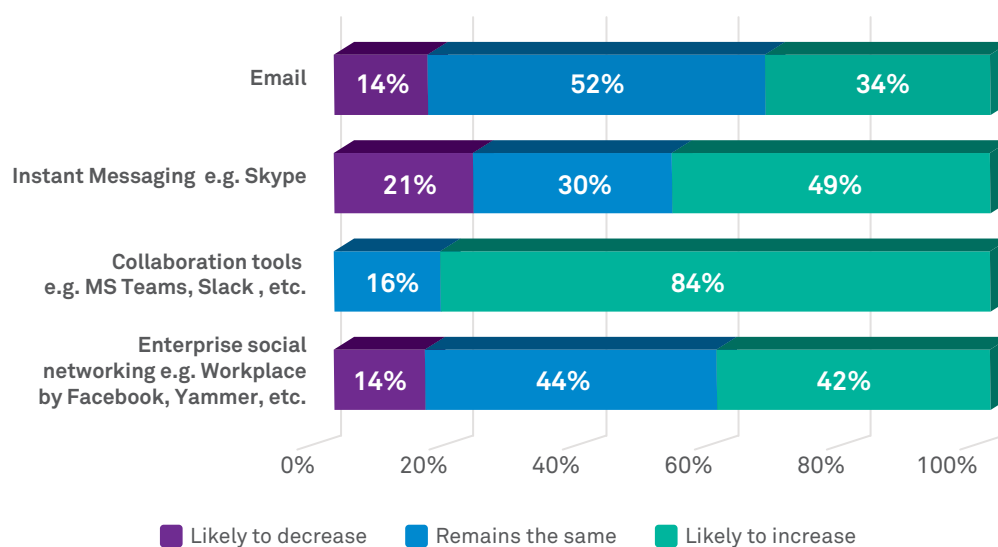

Figure 52

to connect and build use cases across all of the user requirements from enterprise search to accelerating insights.

They do this by providing a platform that can connect to the microservices APIs provided by different collaboration technologies which can be used to create a seamless experience that can:

- Surface the relevant data for end users

- Surface the relevant transactions for end users to interact with

- Allow users to collaborate with each other for the data and the transactions

- Provide AI-based services that can help generate insights for the user in terms of:

  » How they can improve their daily productivity

  » How they can minimize the cycle time for collaboration activities

Having a platform by itself is great but this leads to the same problem as before, that the platform itself has capabilities but not the use case. While individual platforms continue to evolve and aggregate more use cases, it is necessary to have an agile development methodology backed by user research to ensure users requirements are being met by your collaboration strategy and users are adopting it.

Desktop virtualization

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Many large enterprises have deployed Virtual Desktop Infrastructure (VDI) for thousands of users with the intent to transform their workspace. The focus of VDI still remains around securing data and applications for internal users or to reduce cost. However, the growing (and often unaddressed) requirements are:

- To enable collaboration between internal and external stakeholders of the enterprise (see Figure 51: How do you see the voice requirements in your organization)

- To provide users the flexibility to switch between devices based on their profiles

- To provide a unique set of use cases that VDI can answer effectively, but rarely does because of the very sporadic and transient nature of these workloads. External vendors may require access to the application once a quarter or once a month, and employees may need access to a VDI machine when their end point goes down once every two years. How then should IT meet these challenges?

The answer lies in the cloud. Lately, most ISVs have started offering cloud-native VDI instances of traditional end points that can be fired up on-demand and connected back to internal

Service management

Billing, chargeback, reporting & performance management

Service monitoring & automation

Cloud agnostic proactive monitoring & management across applications, network & infrastructure

Enterprise marketplace

For businesses to publish services to internal and external stakeholders

Service evergreening

Services to automatically build, test, remediate applications and infrastructure to ensure service compatibility
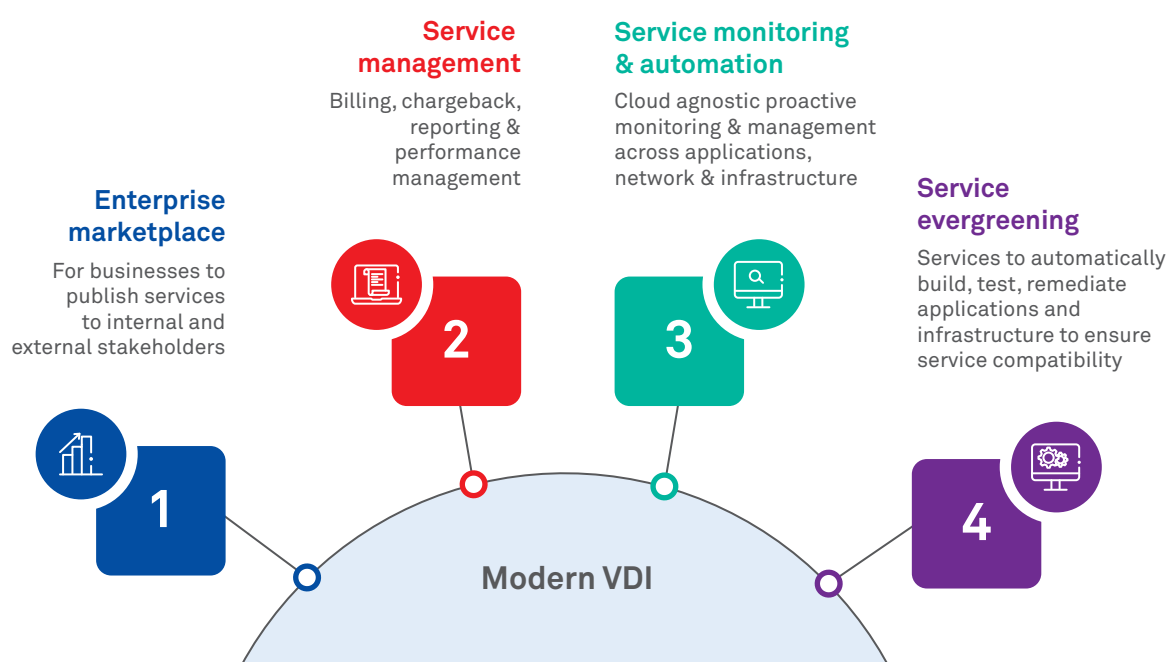
1

2

3

4

Modern VDI

Figure 53: Key services for a modern VDI

applications to handle the sporadic nature of the above workloads. However, to ensure that these services are easily accessible by business within the enterprise, some key IT services need to be incorporated in this new paradigm (see Figure 53: Key services for a modern VDI).

Incorporating these new services and adopting the cloud centric VDI offerings in the market will ensure that enterprises can make the best use of VDI, not just as a tool to bring down workplace costs but as a tool to foster and simplify collaboration and productivity across the enterprise.

Device and personas

●●●●○

The workplace has undergone a tectonic change, work hours have become flexible, employees can choose to work from any place in the world and the 'workplace' is alive with the buzz of a multi-generational workforce. Manual handoffs and excessive clicks to complete routine tasks drives frustration within employees; it creates dissatisfaction and retention issues. In the digital world, where there is a war for talent, this causes organization drag.

Business & transaction apps
Restricted access 800+ applications

Employee self-service legacy app	Quality management system
Immigration management system	Admin legacy apps
Manager apps	Application management system
	CRM

Collaboration & engagement

| 1-on-1 | |
| External | Social |

No enterprise profile

Limited SSO

No context, personalization

No mobility

Manual handoff

Not accessible

Learning
5 different knowledge apps in silos

Online courses	Learning & dev app
KM	Training app
Sales KM	

Analytics
Insights only through excels

6 different helpdesks

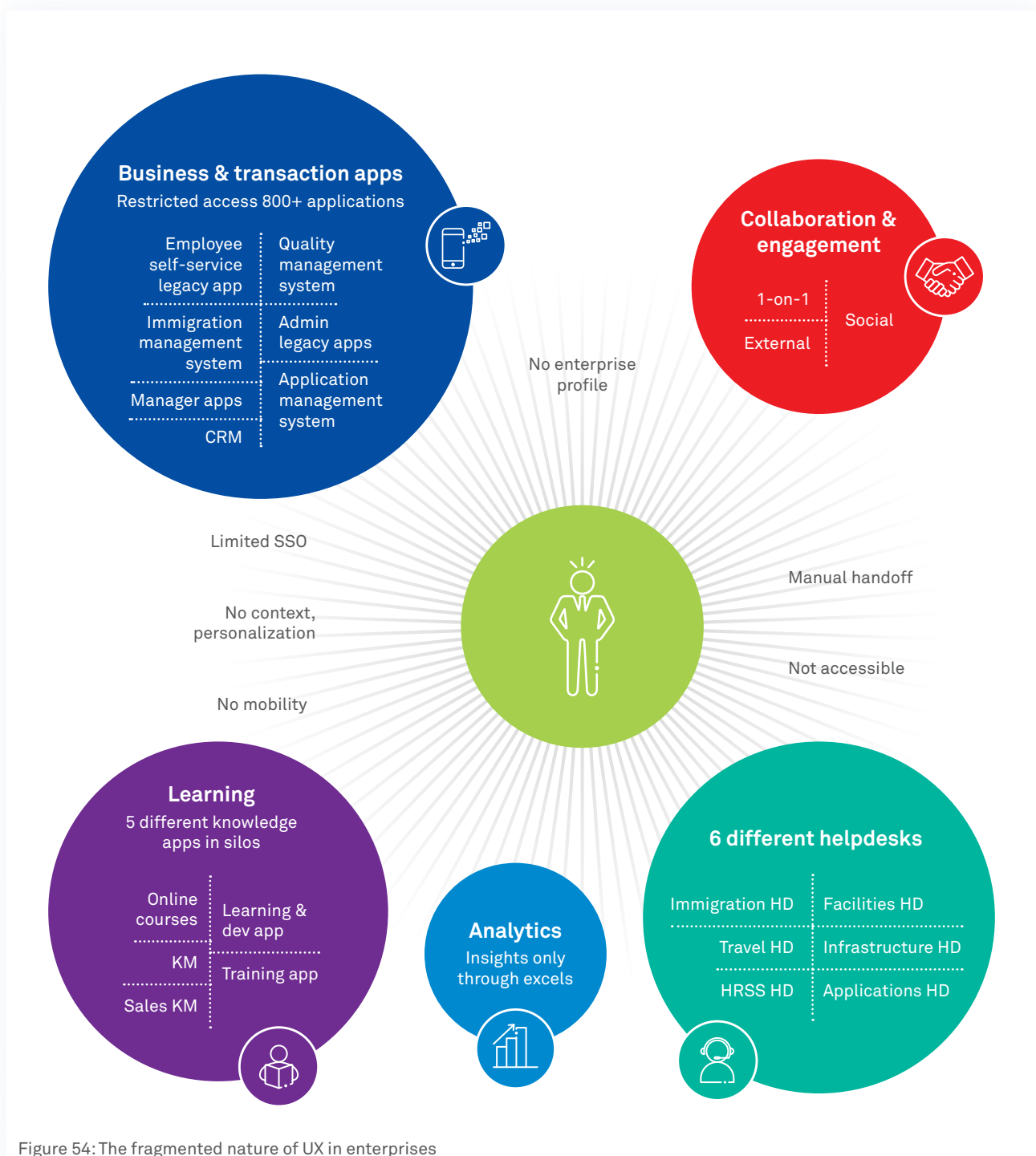| Immigration HD | Facilities HD |
| Travel HD | Infrastructure HD |
| HRSS HD | Applications HD |

Figure 54: The fragmented nature of UX in enterprises

This now brings us to the most pertinent question – how will organizations which are large and complex agree to a set of personas that are agreeable by all and then plan for services that are linked to the personas (see Figure 54: The fragmented nature of UX in enterprises)? For this organizations must plan for a central analytics service which continuously evaluates the feed from multiple critical sources and creates a

holistic view of the user behavior and needs (see Figure 55: User experience and analytics service - schematic). A critical call out organizations should ensure are security (risk score) and network performance. These two are going to be of paramount importance. Also, all services need to be catalog-driven so that when the same user persona changes, services can be augmented accordingly.
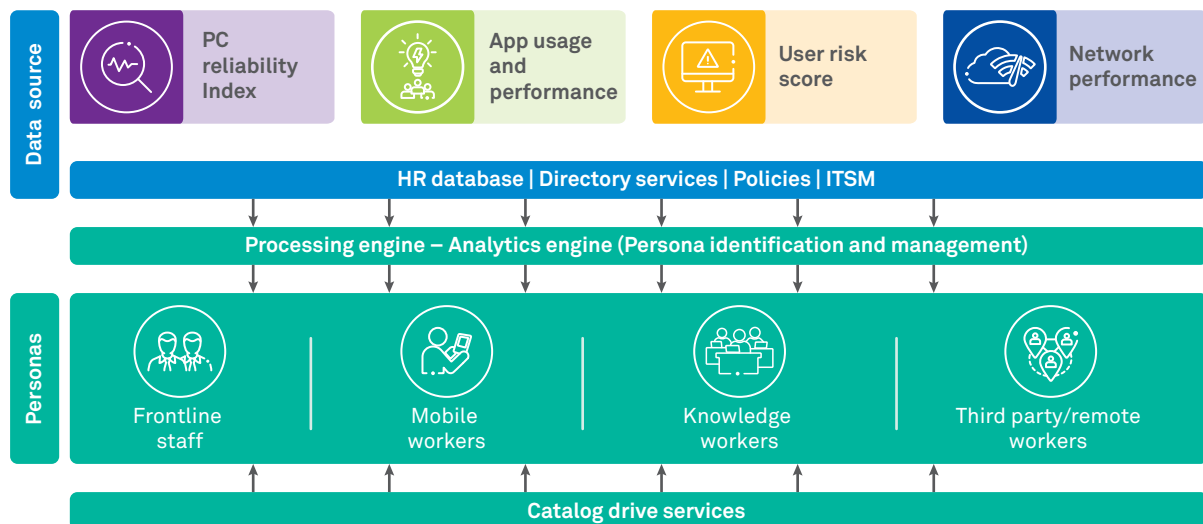
Figure 55: User experience and analytics service - schematic

As a mechanism to modernize the workspace platform, organizations must introduce the concept of workspace flavors that ties in user personas (see Figure 56: Sample personas) to

enable the end user to get the best UX possible and prepare for a bi-modal existence.

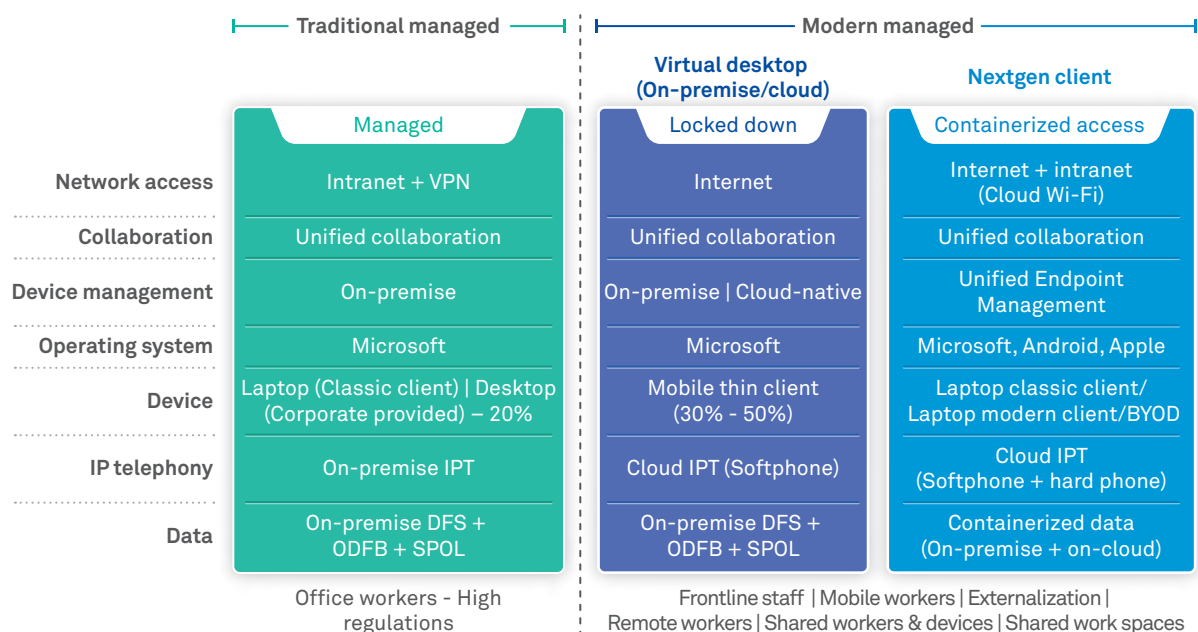Bottom line: Devices, personas and services should evolve together.

Figure 56: Sample personas

Software and tools

●●●●●

The ability to deploy cutting-edge technologies is crucial for maintaining a competitive advantage in the current marketplace. However, enterprises are increasingly looking at a wide variety of tools to provide the magic elixir of productivity and user experience for employees.
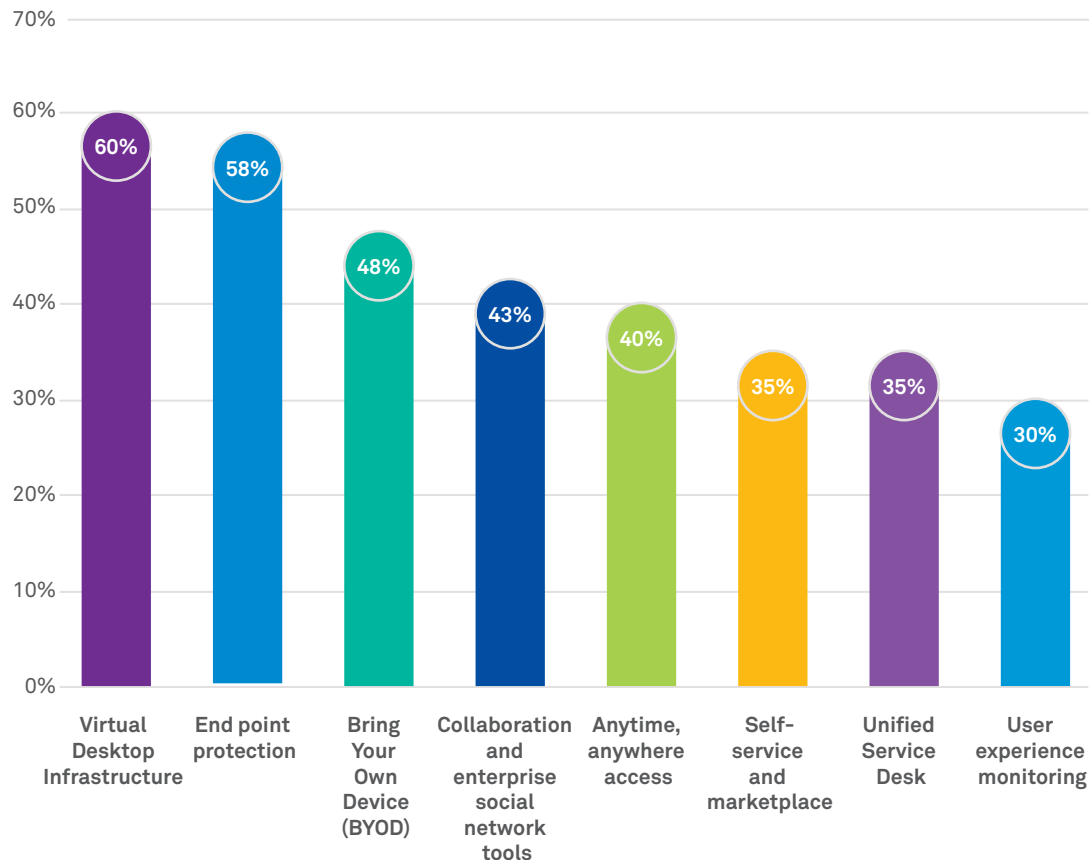
As can clearly be seen (see Figure 57: Which solutions have you implemented to increase employee experience and productivity?) the technology landscape is wide and not easy to choose from. The challenge for organizations remains in:

• Driving greater personalization and effectiveness of user engagement

• Provide an enriched change experience

• Drive faster and improved adoption of new solutions

The digital workplace for any organization is going through the fastest change and hence it's critical that organizations keep the following in mind to be able to successfully manage the plethora of options:

• **Adopt an agile methodology** to ensure that IT is able to match the pace of change of the market (see Figure 58: Agile change management to handle software complexity in the workspace)

• **Zero-touch change** to focus on user adoption of change rather than the technology rollout. Provide a digital hub for users and leverage valuable visual and real-time change insights

• **Focus on end-to-end business journey maps** rather than point tools/software – JML automation

• **Implement XLA dashboards**

Q: Which solutions have you implemented to increase employee experience and productivity?

In an organization, multiple solutions can increase employee experience and productivity
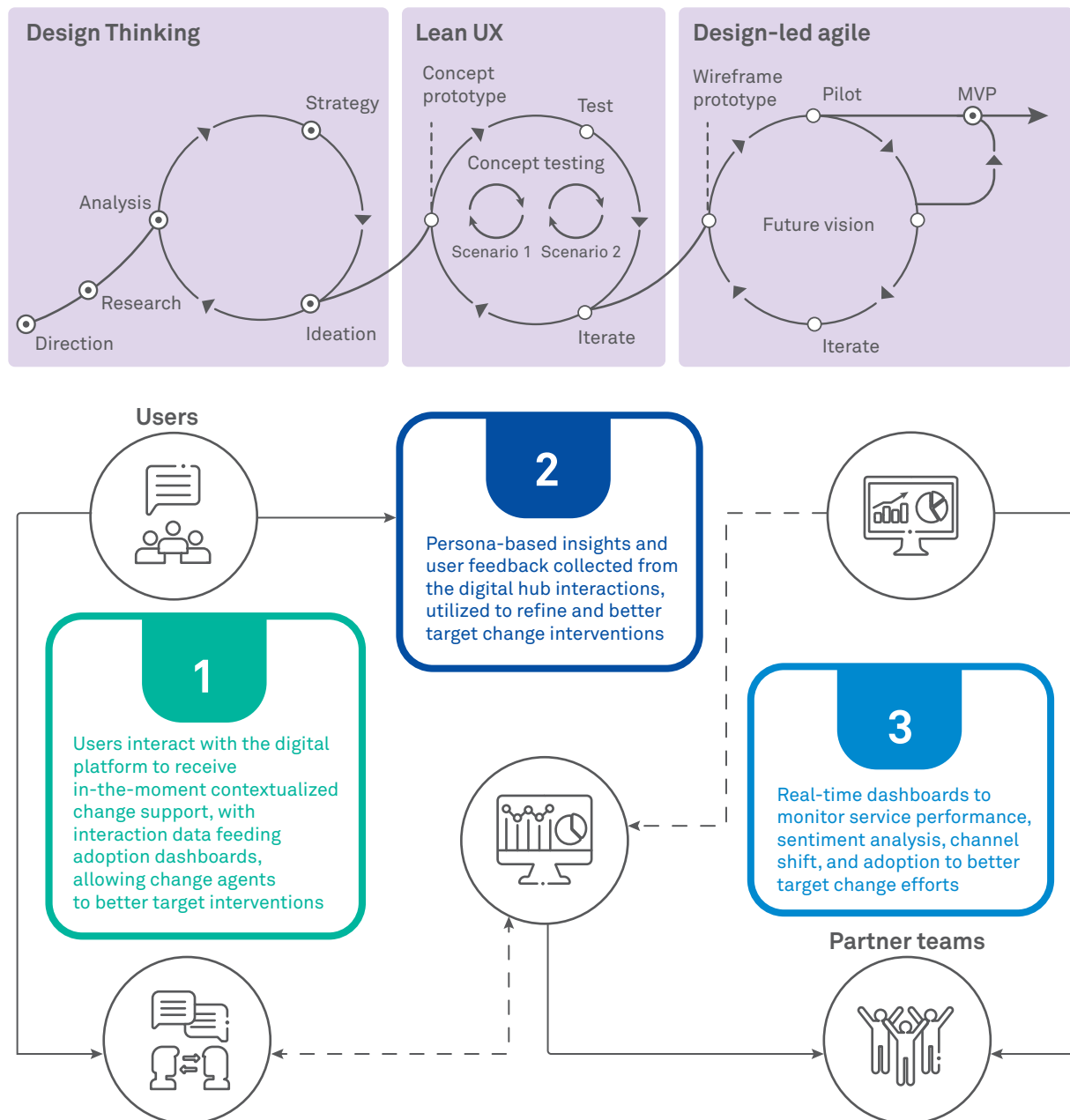
Figure 57

Design Thinking

Strategy

Analysis

Research

Direction

Ideation

Lean UX

Concept prototype

Test

Concept testing

Scenario 1   Scenario 2

Iterate

Design-led agile

Wireframe prototype

Pilot

MVP

Future vision

Iterate

Users

2

Persona-based insights and user feedback collected from the digital hub interactions, utilized to refine and better target change interventions

1

Users interact with the digital platform to receive in-the-moment contextualized change support, with interaction data feeding adoption dashboards, allowing change agents to better target interventions

3

Real-time dashboards to monitor service performance, sentiment analysis, channel shift, and adoption to better target change efforts

Partner teams

Figure 58: Agile change management to handle software complexity in the workspace

Productivity tools

●●●●●

One of the crucial things that enables user adoption is ensuring that services and tools introduced by IT are available to users in a predictable and consistent manner and do not have any performance issues. Proactive monitoring tools provide a simplified way for IT to figure out if crucial tools and services are available to end users and provide IT with a single unified heads-up-display through which they can track these services. However, whenever an issue

crops up, it is crucial that IT has a simplified way to not just track the issue but also solve the issue. Given the complexity of modern IT systems, this requires co-operation between multiple teams and different service providers. However, the current IT systems separate distributed teams across network, infrastructure and applications and achieving this kind of co-ordination becomes close to impossible. It is crucial enterprises adopt the following best practices to ensure that not only monitoring but remediation and resolution are effective and immediate (see Figure 59: Managing UXM and remediation).
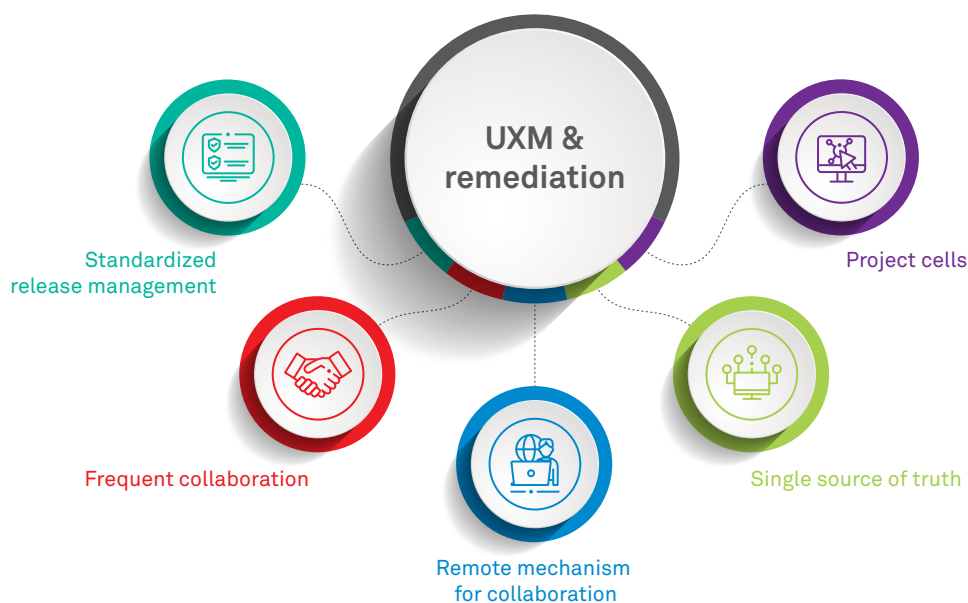
Figure 59: Managing UXM and remediation

- **Create short-lived project cells:** Ensure that there is enough dedicated capacity across providers to focus on remediation and resolution of these issues and named resources are available to ensure faster time to value

- **Provide a single source of truth:** Ensure there is a single source of truth. Other tools help but be clear what the primary source of truth is

- **Provide a remote mechanism for collaboration:** Given the international nature of IT support, mandate what the remote collaboration toolsets are

- **Collaborate but not just for remediation:** Ensure that there are other CIP problems on which these teams work, so that roles, areas of expertise are clear to all teams and are readily identified before a high priority incident lands up in your queue

- **Standardize release management plan:** While server components have a readily available release management plan for how fixes can flow from dev to pre-prod to prod environments, these are simply not available for workspace elements. Ensure they are in place

Having a user experience monitoring platform is essential, but ensure you have the above elements in place so that your end-user productivity tools are effective.

Dr.Christopher Tresp,
CIO, thyssenkrupp Materials Services GmbH

IT today delivers innovative technology and digital solutions that work for thyssenkrupp Materials. It is helping us drive a vision to be a strategic partner for our business, provide fuel for growth and be the technology differentiator. Our rapidly changing industry demands the need to bring material services solutions to life, combining strong business relationship management, topics like Industrial Internet of Things and an agile organization are very essential. Technologies like cloud, software-defined solutions, Artificial Intelligence, microservices, new customer technologies etc., are foundational for us to deliver these demands along with the next generation of products to our businesses globally. Practices like DevOps and architecture based on Zero Trust Security are also extremely critical to deliver on our goals. IT infrastructure must reboot itself, become more agile, take on ambitious goals and embrace innovation so that it can transform the enterprise, demonstrate visible business value and bring great user experience with reliability, speed and agility.
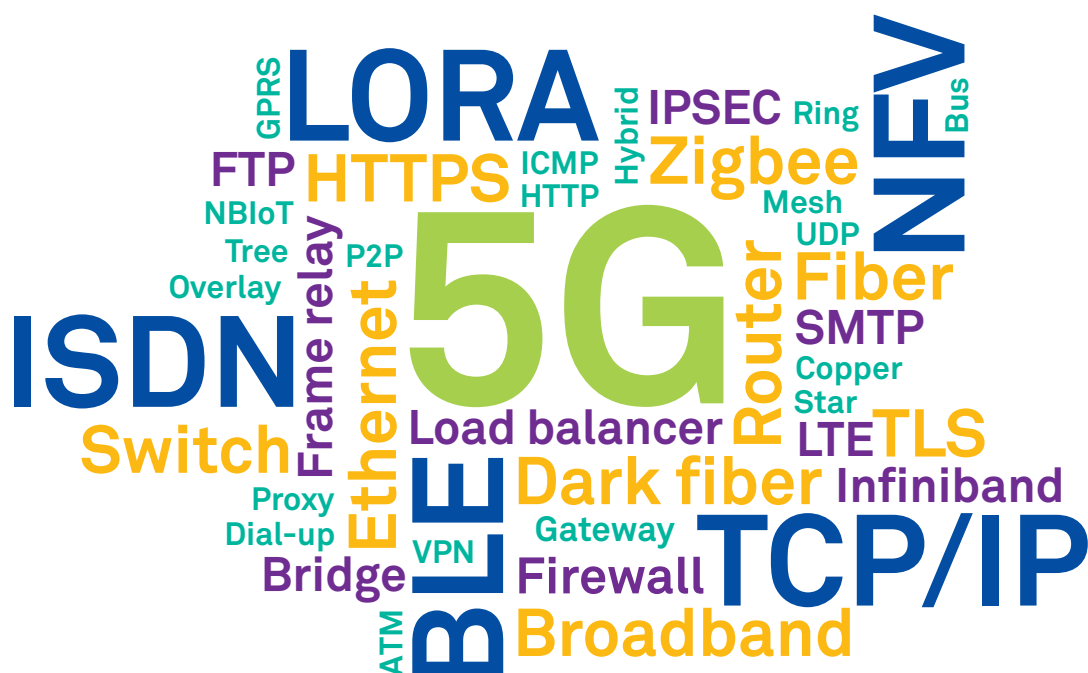
State of network

The arrival of super-intelligent networks

The objective of networks was to provide reliable and secure connectivity. They have achieved this by adhering to standards defined under the 7 Open Systems Interconnection (OSI) layers. There has; however, been a big change in the expectations from networks. Application and services riding on the network have evolved, completely changing the requirements placed on networks. The dynamic nature of services

and the evolution of the end points demand a different level of flexibility, intelligence and granular control that can only be fulfilled by programmability and business context awareness at the core of the networks. This demand has given rise to Software-Defined Networking that change the fundamental way networks operate.

SDN is a technology that separates the control plane management of network devices from the underlying data plane that forwards network

GPRS LORA IPSEC Ring NFV Bus
FTP HTTPS ICMP Zigbee
Hybrid HTTP Mesh
NBIoT UDP
Tree P2P 5G Fiber
Overlay Frame relay Router SMTP
ISDN Ethernet Copper Star
Switch Load balancer LTE TLS
Proxy BLE Dark fiber Infiniband
Dial-up Gateway
Bridge VPN Firewall TCP/IP
ATM Broadband

traffic. Until the arrival of SDN, networking was a hardware controlled world. It used to be dominated by hardware vendors designing purpose-built hardware chipsets which control the way data packets flow in the network. SDN changed that.

The SDN principle has now become a defacto choice in data center networking and cloud. SDN brings flexibility to network provisioning, responding to workloads as they are being created, changed or deleted. Networks are no more a roadblock for workloads to consume. The SDN has also moved from data centers and cloud to other parts of the network domain such as WAN and access networks.

Programmability is the key: OpenFlow (OF), one of the earliest communication standards of SDN, determines how the data plane handles the packet. The availability of new age methods—such as Application Programming Interfaces (APIs), sample code, and reliable Software Development Kits (SDKs)—has made new ways of programming the network possible. With the adoption of DevOps into the network, called NetOps, the network has become completely programmable. NetOps and network automation go hand in hand.

SDN has enabled a higher level of network programmability and automation. Along with

open hardware, this has led to many new ways of configuring and operating the network, even for those that operate in a traditional distributed data plane and control plane mode.

Programmable network to Intent-Based Networking: The programmability has enabled higher layers of networks, such as applications and orchestration, to be aligned to business and infrastructure intent without knowing the complexities of the network. The application or business need not know how to translate their intent into a configuration which must be done in the network using CLI or API etc. This has created the concept of an Intent-Based Networking that is now being deployed across various network domains.

Self-healing networks: The SDN and the programmable network lead to a network which operates on its own, provisions according to the business or application intent, makes it available all the time and rectifies faults on its own. This is called a self-healing network. Today networks have gained maturity with the capabilities of SDN, programmability and IBN for self-healing. A majority of the networks that have matured to SDN still require quite a bit of manual intervention to operate. But when programmability matures further and interoperates with the rest of the infrastructure, application and orchestration networks can become completely self-healing and self-operated.

Kumar Ramachandran,
Founder and CEO, CloudGenix

Software-driven networking is being fueled by rapid SD-WAN adoption. SD-WAN is a foundational capability for cloud adoption across the enterprise. SD-WAN provides secure and reliable access to public and private cloud resources. At the same time, customers see anywhere between 50%-70%+ reduction in WAN costs by taking advantage of heterogenous forms of connectivity including internet broadband, LTE, 5G and MPLS. SD-WAN is also leading the charge with a DevOps/NetOps model for agile management of the network.

The feedback we see from SD-WAN customers is that SD-WAN also creates the basis to eliminate hardware appliances from the remote office. SD-WAN offers the ability to consume best-of-breed security, voice, performance management and operational tools as well as cloud-delivered services. With SD-WAN, enterprises can deploy a new model of cloud-delivered security that is critical to secure the modern remote office from evolving threat vectors.

SD-WAN impacts businesses across verticals - retailers are able to roll out omnichannel applications, banks are deploying "bank branch of the future" initiatives, manufacturing is enabling IoT to proactively avoid failures – every industry is being transformed by SD-WAN. The agility, cost savings and operational capabilities that SD-WAN delivers is a competitive advantage for the digital enterprise.

Adoption of IBN in various network domains

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Intent-Based Networking is an approach that brings intelligence and automation to networks.

At a high level, it generally means a system in which the end user describes what the network should do and the system automatically configures what is needed to carry out that intent or policy (see Table 02: IBN in different network domain).

IBN in different network domain		
IBN for data centers	**IBN for access networks**	**IBN for Wide Area Networks**
IBN for data centers simplifies the fabric, aligning it with business intent and cloud orchestration. DC intents are more aligned with the workloads in private cloud or hybrid cloud and translate workloads or applications or platform requirements from networks such as application construct policies, network segmentation provisioned from the DC or hybrid cloud network.	Access network is aligned with consolidating the User Access Network (including wired and wireless network). It ensures network intent is automated for users, devices and IoT access to network. The access network increases security and simplifies network designing and provisioning and stays aligned to network or infrastructure intent. It also simplifies operations with analytics, assurance and reduces resolution time.	Intent for Wide Area Network is aligned with Software-Defined WAN where business intent is translated to application policies and priorities into WAN. It also ensures that deep analytics provides service-level availability for business applications.

Table 02

It is evident from the response to our State of IT Infrastructure survey for 2020 that more than half the businesses (54%) are ready to realize IBN in the next year or two (see Figure 60: What is your adoption plan for IBN?). We believe that the ability to eliminate manual configuration of devices and tasks—in essence using AI and

Machine Learning to provide consumer grade access to enterprise grade systems—is turning IBN into a hot trend. As the tools for IBN grow over the next two years, making networks super-intelligent, we will see more businesses abandon their "dumb" networks of yesteryears.
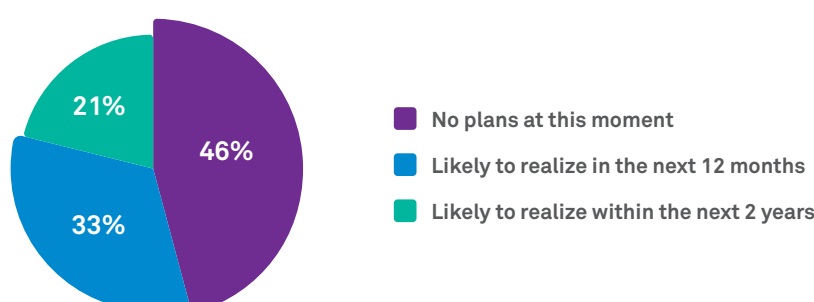
Q: What is your adoption plan for IBN?

- 46% — No plans at this moment
- 33% — Likely to realize in the next 12 months
- 21% — Likely to realize within the next 2 years

Figure 60

Leveraging public networks

●●●○○

Business applications are rapidly moving to public cloud and SaaS. With this, the internet is becoming the new WAN.

Typically, businesses experience an increase of about 25% in bandwidth consumption each year. This increase has been on MPLS bandwidth, but is now changing completely to the internet, which is also a cost effective option. The availability of the internet in various forms like business internet, stable broadband and 4G/LTE makes it easy for businesses to make the switch. With the arrival of 5G and its promise of low latency and higher throughput, businesses will stop upgrading MPLS and their point-to-point private networks.

However, our survey of the State of IT Infrastructure for 2020 shows that 26% of businesses have no plans to adopt the internet as WAN (see Figure 61: What is your plan to adopt the internet as WAN using SD-WAN technologies?). Clearly, MPLS as WAN is going to have a slightly extended life.

There are some basic features that make the internet a preferred method for WAN:

• **Local internet breakout with security integration** becomes a default choice for sending SaaS out directly from the branch to the internet rather than backhauling to DC. Integrating with cloud-based security and cloud firewall solutions makes it even more secure than on-premise solutions.

• **Application-based routing becomes possible** and businesses can segment applications into secure internet and recreation internet.

• **Analytics and cognitive capabilities can be applied** to each application thus helping improve application performance.

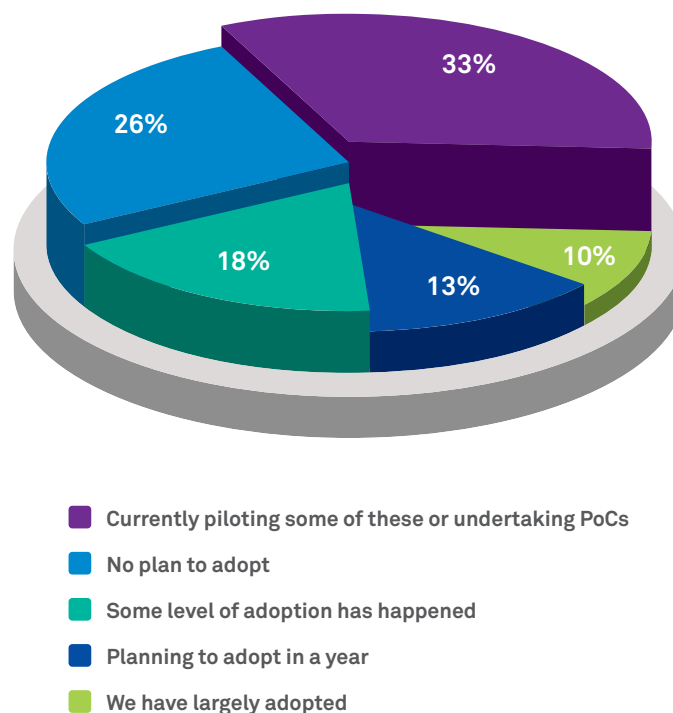**Q: What is your plan to adopt the internet as WAN using SD-WAN technologies?**

- ■ Currently piloting some of these or undertaking PoCs
- ■ No plan to adopt
- ■ Some level of adoption has happened
- ■ Planning to adopt in a year
- ■ We have largely adopted

Figure 61

Software-Defined Networking

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Software-Defined Networking are everywhere —in cloud, DC, WAN and access networks. Manufactures are creating different approaches to SDN in a bid to cater to differing business requirements. This is logical and is reflected in the response to our State of IT Infrastructure survey for 2020: 76% of businesses said they had either adopted, were piloting or undertaking PoCs or would adopt it within a year (see Figure 62: What is your adoption of SDN in data center and public/hybrid cloud?).

It helps to examine SDN under the hood to get a sense of the pros and cons and understand why there is steady adoption.

Q: What is your adoption of SDN in data center and public/hybrid cloud?

- 30% Currently piloting some of these or undertaking PoCs
- 24% No plan to adopt
- 22% Planning to adopt in a year
- 19% Some level of adoption has happened
- 5% We have largely adopted
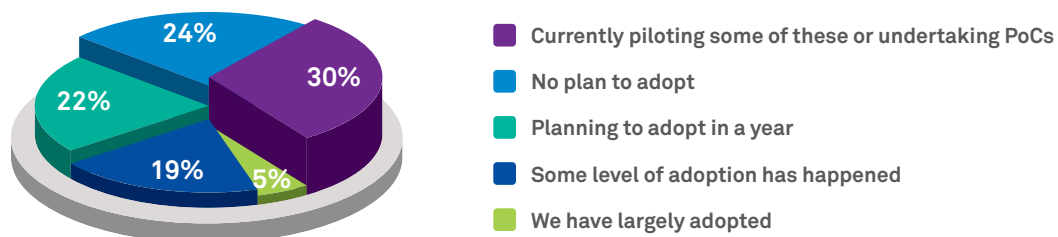
Figure 62

SDN in DC and cloud

The SDN in DC is evolved and continues to exist in the hybrid cloud model. The traditional problem of managing networking in the distributed data plane and control plane for switches is solved by SDN with its policy-based central control plane for configuration and monitoring (see Figure 63: The evolution of SDN). But with workloads moving from DC to public cloud, connectivity with public cloud has become a challenge.
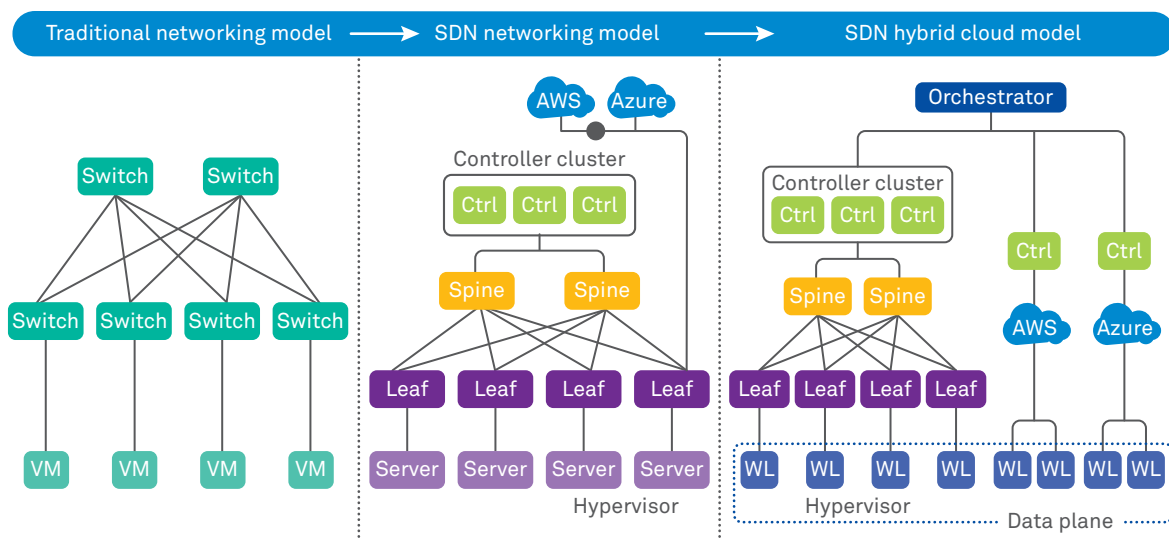
Figure 63: The evolution of SDN

Software-Defined WAN

SD-WANs transform traditional networks. The service provider-driven market of routers and CPE with MPLS as the stable connectivity for WANs is disrupted by SD-WAN with its simplified management and transport-agnostic way of sending traffic, by creating an overlay for application traffic (see Figure 64: Software-Defined WAN architecture).
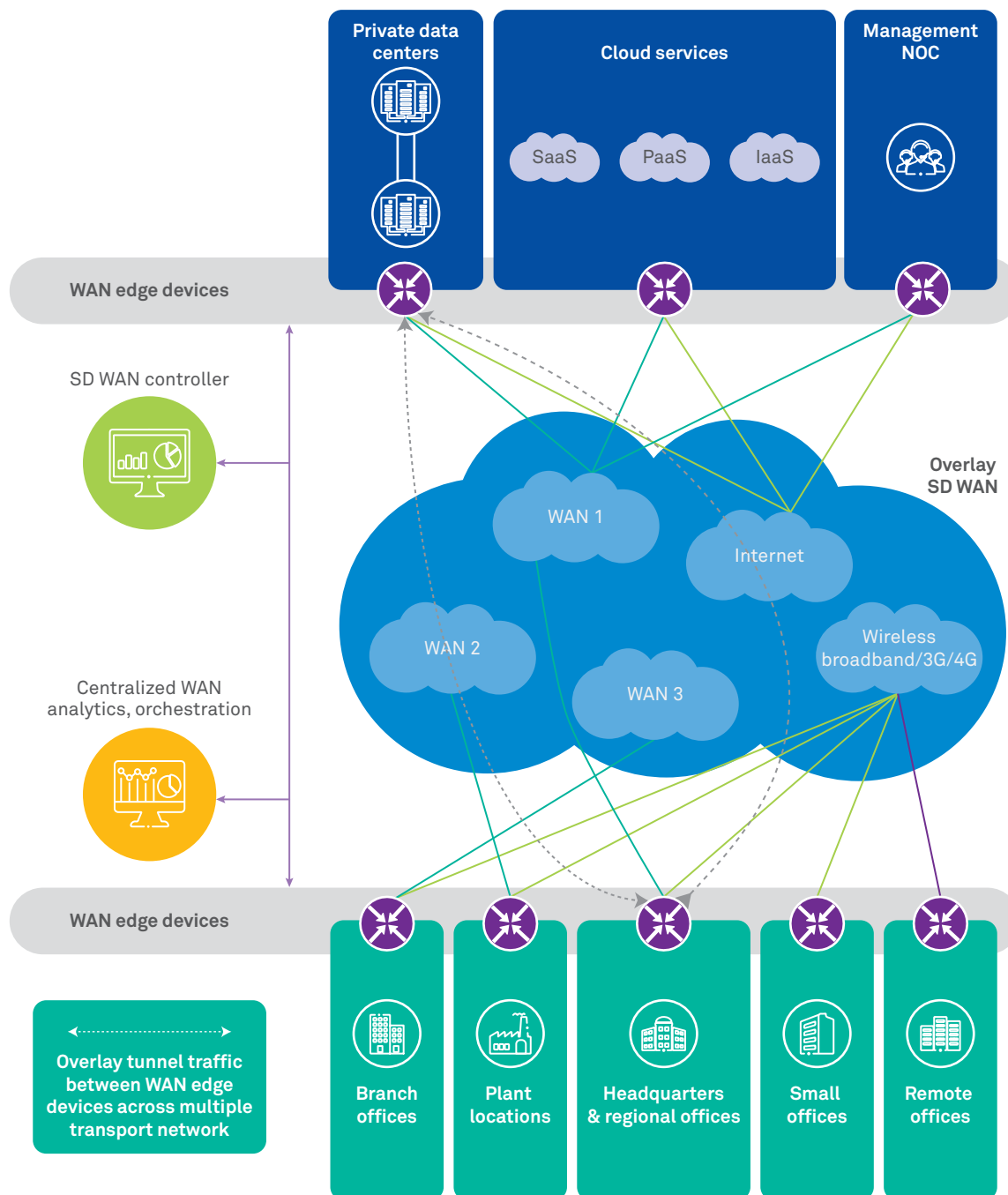

Figure 64: Software-Defined WAN architecture

The software driven approach makes it possible to further segment the WAN on top of existing MPLS or internet or even future possible methods of transport and decide what traffic to send through links. This provides flexibility and efficiency in the way traffic is managed, thus improving user experience for applications, and reducing operational costs. SD-WAN can cut operational cost by as much as 30 to 40%, provided SD-WAN is engineered the right way.

SDN in Enterprise Access Networks

In enterprise IT infrastructure, an access network (wired and wireless) is considered to be the least critical compared to DC and WAN. However, this is a vital part of the enterprise network—it is here that user experience decides the perceptions about the network. The dynamics of user traffic are changing, especially with IoT devices, content heavy social media, voice, video and data coming into the access network. These put considerable stress on access networks. It is here that IT Service Desks also face more than 70% of the tickets, irrespective of whether the root cause lies within the access network or not.

Software-Defined Access is a method based on SDN principles to deliver fast and secure network access for users. SDA provides access to applications in minutes, without compromising on security; it allows businesses to gain better awareness of what is accessing the network, irrespective of whether it is an intelligent user or an IoT device. SDA is achieved by creating a secure network fabric across devices in the network. A typical campus or branch office network looks like Figure 65.
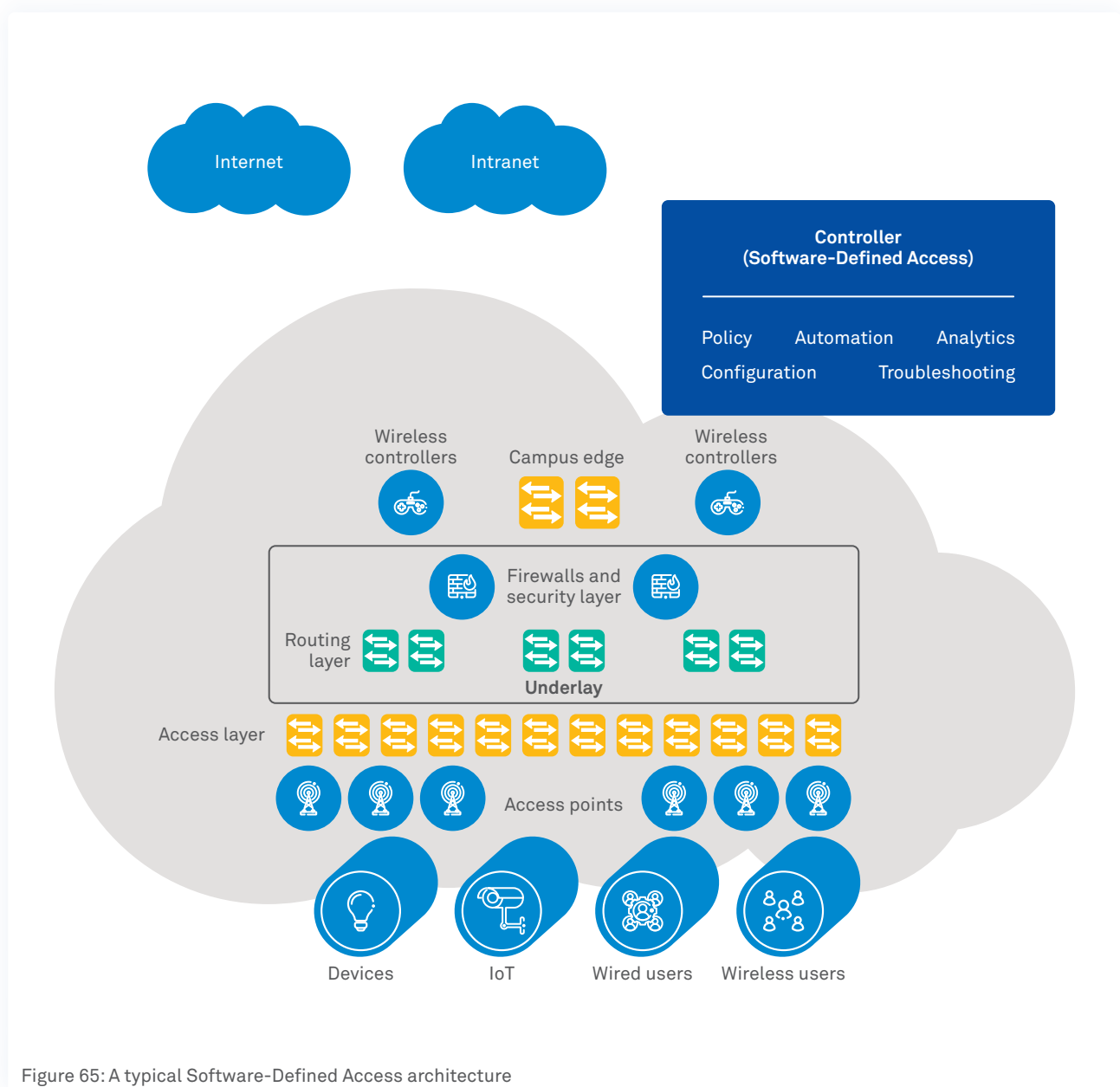

Figure 65: A typical Software-Defined Access architecture

In the new SDA method, a controller is introduced, which controls the whole network and makes all access and edge layers into a single logical fabric.

All business and network policies are applied to the access network at once through a single, centrally controlled console.

The need of multi-domain orchestration and management

While there are different approaches for different network domains such as SDN for DC, SD-WAN and SDA or SD-LAN for access networks, businesses struggle to have single pane visibility and policy management across a network domain. To overcome this, Multi-Domain Orchestrator (MDO), which understands the network domain is able to talk the domain language of the network and translate the business intent and policies to the respective network domain in its own language.

The key expectations of a MDO include (see Figure 66: A typical MDO layer):

- E2E control and visibility of network services across any mix of physical and virtual domains: SD-Access, SD-WAN, multi-cloud

- Centralized policy control

- Intent-based orchestration of services across layers, touchless provisioning

- Autonomic operations and predictive care

- E2E visibility or insights correlated across SDA, SW-WAN, multi-site, multi-cloud and applications

Figure 66: A typical MDO layer
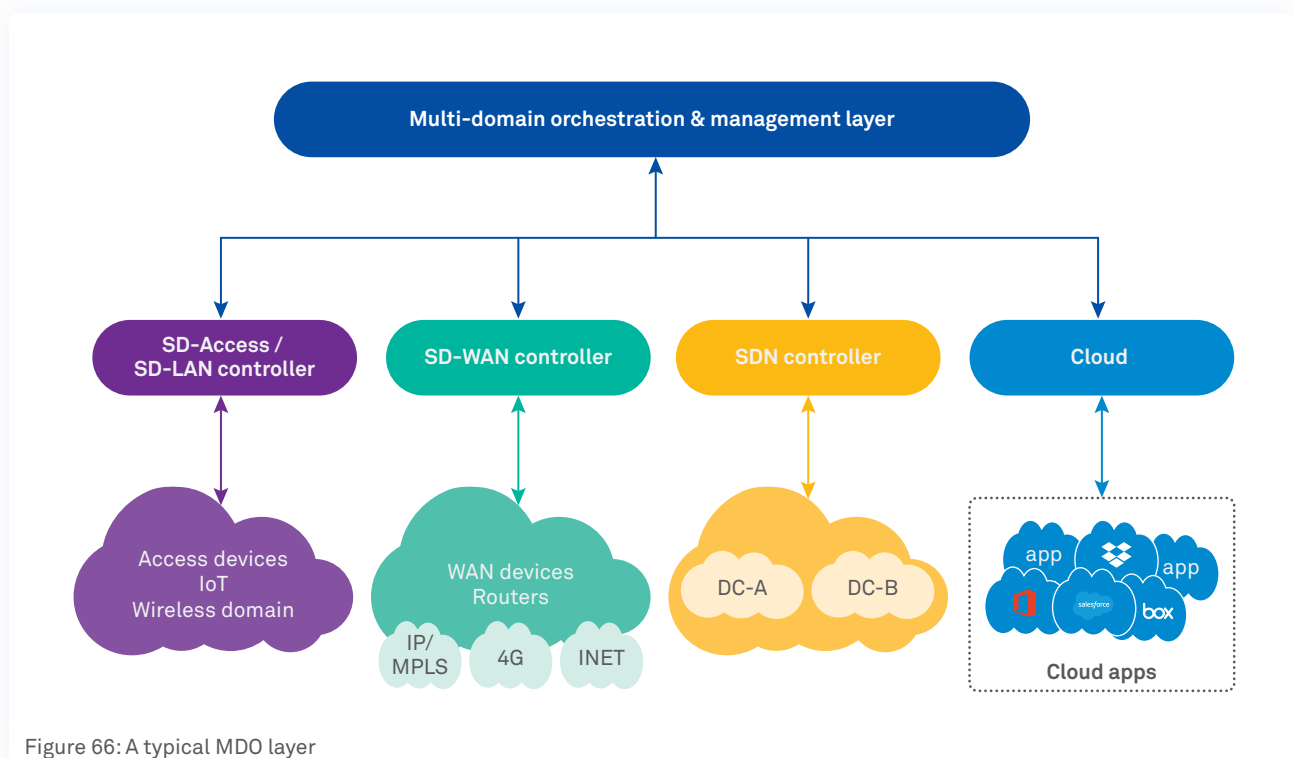
Network Function Virtualization

Network virtualization and Network Function Virtualization (NFV) are central to an enterprise network. The key objectives businesses want to achieve using NFV are:

- Reduce cost

- Increase scalability

- Increase performance

Some of the common Virtual Network Functions (VNF) are firewalls, load balancers, intrusion detection or prevention systems and WAN accelerators.

NFV in DC or cloud is the key to have distributed functions when the DC workload is distributed across the network. The workload can be within the DC or across DC or even in the public cloud. NFV ensures that the function is available from a single orchestration to ensure seamless access and experience for the specific function.
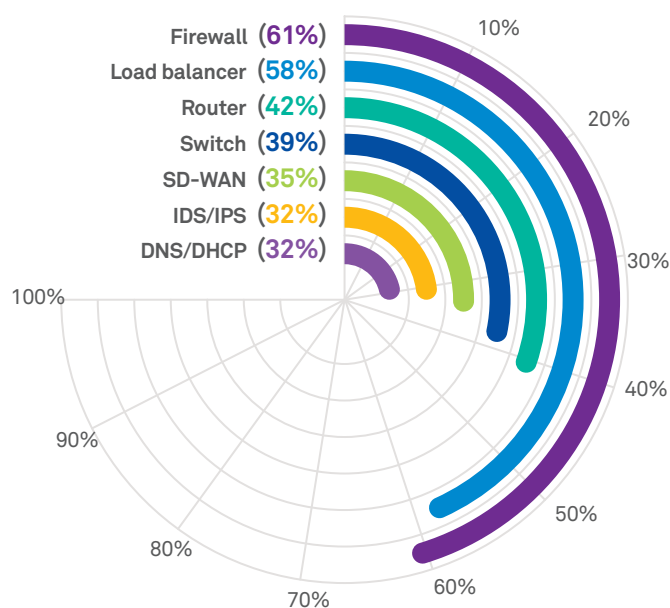
Network Function Virtualization Infrastructure (NFVI) is the hardware which the VNF runs. NFV runs on general purpose infrastructure and not purpose build infrastructure. But it is important to select the right set of hardware with the right performance specification for the VNF. The NFVI can be distributed across DC wherever the VNF is required.

NFV and SDN are symbiotic in nature. NFV complements the SDN function. NFV orchestration becomes simplified and integrated with SDN. The native integration of the VNF with SDN controller makes it easy for the NFV orchestration layer to manage the network functions seamlessly.

A majority of businesses adopt firewalls and load balancers – and this is reflected in the response to our State of IT Infrastructure survey for 2020 (see Figure 67: What Network Function Virtualization dominates your network?): 62% respondents said it was firewalls and 58% said it was load balancers. This shows that NFV adoption is more at the DC and the cloud, aligned with the SDN strategy. Some of the other common VNFs are routers, switches, SD-WAN CPE (Customer Premises Equipment), and DNS, DHCP services.

Q: What Network Function Virtualization dominates your network?

Firewall **(61%)**
Load balancer **(58%)**
Router **(42%)**
Switch **(39%)**
SD-WAN **(35%)**
IDS/IPS **(32%)**
DNS/DHCP **(32%)**

Respondents were asked to choose multiple response options

Figure 67

Business Service Management

The rapid evolution of service management

Business Service Management (BSM) allows supervision and evaluation of business IT. A set of tools, templates, workflows and methodologies empowers the IT team in this endeavor and helps unlock value by aligning business services with the IT infrastructure. The goal of BSM, stated simplistically, is to ensure that IT and business are aligned in a manner that satisfies users. BSM and ITIL work in tandem, converging and allowing the organization to implement ITIL best practices.

BSM witnessed widespread adoption in the mid-1990s. Over a period of time ITIL recognized BSM's structured processes as the preferred way to take IT Service Management to maturity. Today, organizations have begun to realize the value of using BSM as a layer between IT and business to improve the cost of IT management and drive innovation that improves core business processes.

The BSM methodology organizes IT departments by service, rather than individual items or silos, allowing effort prioritization while progressively enhancing an organization's managed business services.

It can be fairly claimed that the concepts of BSM laid the foundations of automation leading to Artificial Intelligence and now AIOps. An evolutionary result of BSM has been to drive IT

> It can be fairly claimed that the concepts of BSM laid the foundations of automation leading to Artificial Intelligence and now AIOps. An evolutionary result of BSM has been to drive IT services towards lean and cost-effective operating models along with gradual maturity in the effectiveness and quality of the services.

services towards lean and cost effective operating models along with gradual maturity in the effectiveness and quality of the services.

Before BSM, IT management was more or less scattered and without centralized control or governance which resulted in businesses maintaining redundant and unnecessary IT costs. With BSM coming into the picture, businesses began introducing centralized control, resulting in huge cost savings. Over years, BSM has proven its value. Our survey for the State of IT Infrastructure report 2020 showed

that 71% organizations had a BSM strategy with over 13% saying it was in an advanced state (see Figure 68: Does your organization have a Business Service Management strategy or approach?).

The upcoming trends in the BSM evolution journey is now to widely make the whole IT landscape application-driven since most of the businesses are moving on to SaaS models.

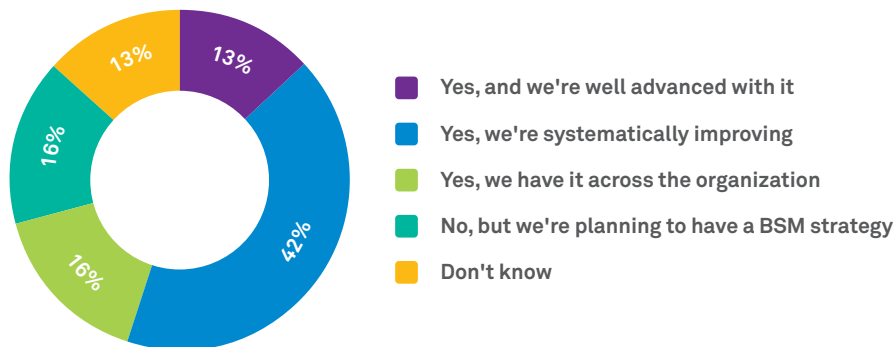**Q: Does your organization have a Business Service Management strategy or approach?**

- 13% Yes, and we're well advanced with it
- 42% Yes, we're systematically improving
- 16% Yes, we have it across the organization
- 16% No, but we're planning to have a BSM strategy
- 13% Don't know

Figure 68

ITSM systems

Enterprise Service Management (ESM) and Enterprise Monitoring Services (EMS) are critical components of any IT environment. The next evolutionary step in ESM and EMS is AIOps that provides smart and sustainable methods of managing the IT landscape.

Service management, as a concept, is not restricted to the IT industry. However, over the last four decades of growth in the IT industry, IT Service Management has been playing an increasingly important role (see Figure 69: The path of ITSM evolution). Today, the ability to use predictive recording and predictive analytics to eliminate business disruptions makes it essential to the IT industry. Current trends point to a future

40 years of ITSM evolution

AI cognitive
Process automation and elimination by cognitive AI predictions and continuous optimization

Multi-cloud
Centrally governed capacity management, discovery, cloud cost-control, DevOps, security

Single-point solutions
Cloud, SaaS and PaaS adoption for centralization and consolidation

Distributed systems service management
Bridge between business and IT for alignment of objectives

Mainframe technologies
Established global adoption of mainframe technologies for consolidation and central governance
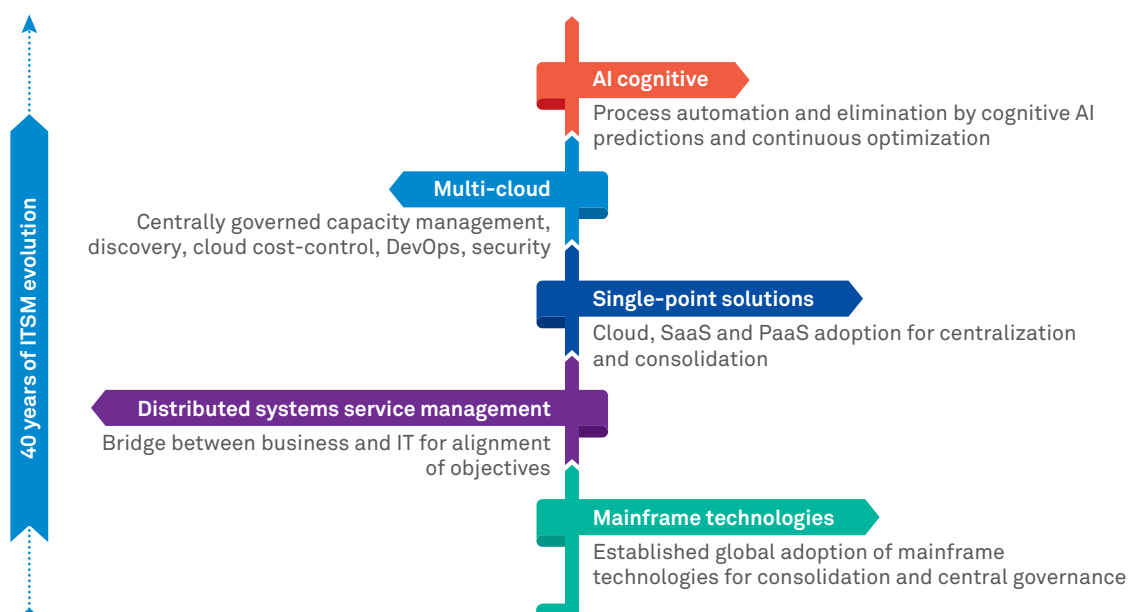
Figure 69: The path of ITSM evolution

where L-0 and L-1 tasks will be completely eliminated, thanks to predictive detection, self-healing methodologies and advanced ESM and EMS tools. L-2 tasks will be automated by AIOps and Machine Learning.

We asked our survey respondents if their ITSM tools provided capabilities beyond IT operations (see Figure 70: Does your ITSM tool provide capability beyond IT operations and addressing business-centric requirements?). A majority (68%) said the tools either already addressed business areas or they were planning to use them to address non-IT areas. About a third of the respondents (32%) said they were not expecting ITSM to address non-IT requirements. We expect these businesses to also eventually leverage ITSM to reduce the burden placed by administrative tasks on employees with the added advantage of acquiring visibility into what is happening within the business and take accurate data-based decisions.

Q: Does your ITSM tool provide capability beyond IT operations and addressing business-centric requirements?

32% 36% 32%

- 🟣 Planning to extend ITSM to address business related non-IT areas
- 🔵 Not expecting ITSM to address non-IT requirements
- 🟢 ITSM already addresses many business areas
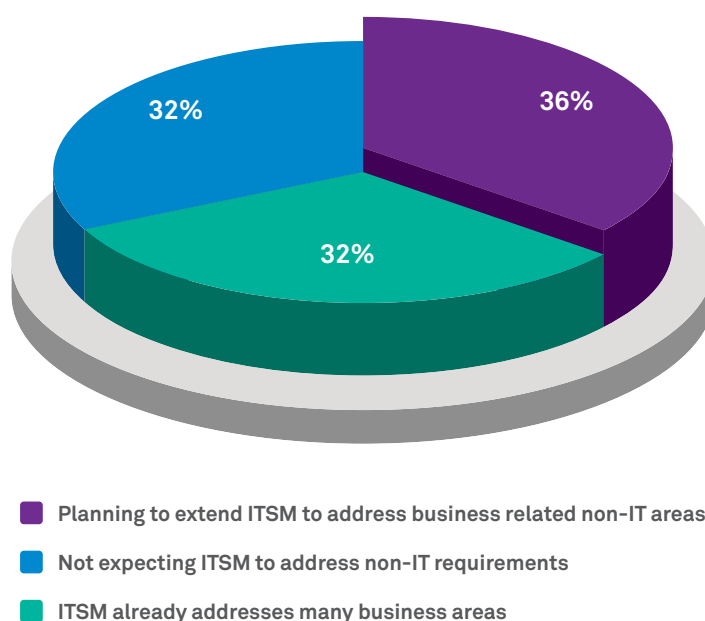
Figure 70

Performance and capacity planning

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Performance and capacity planning can be directly linked to the prominent role of IT services in supporting modern business processes and functions. The challenge today is to optimize resources and plan/manage/deliver capacity based on performance.

Regardless of whether it is on-premise, cloud or multi-cloud infrastructure, performance/capacity/availability continue to remain at the core of the IT landscape (see Figure 71: The role of performance and capacity planning) and it is evident that ITSM systems play a critical role in enabling this, raising service quality and in enhancing customer experience.

The rise of data as the new capital has also raised expectations from the underlying infrastructure which must be able to process, maintain and secure the data in addition to extracting the highest possible ROI from infrastructure investments. It would be correct to say that infrastructure has become the new bank while performance and capacity planning has become the new investment banking.
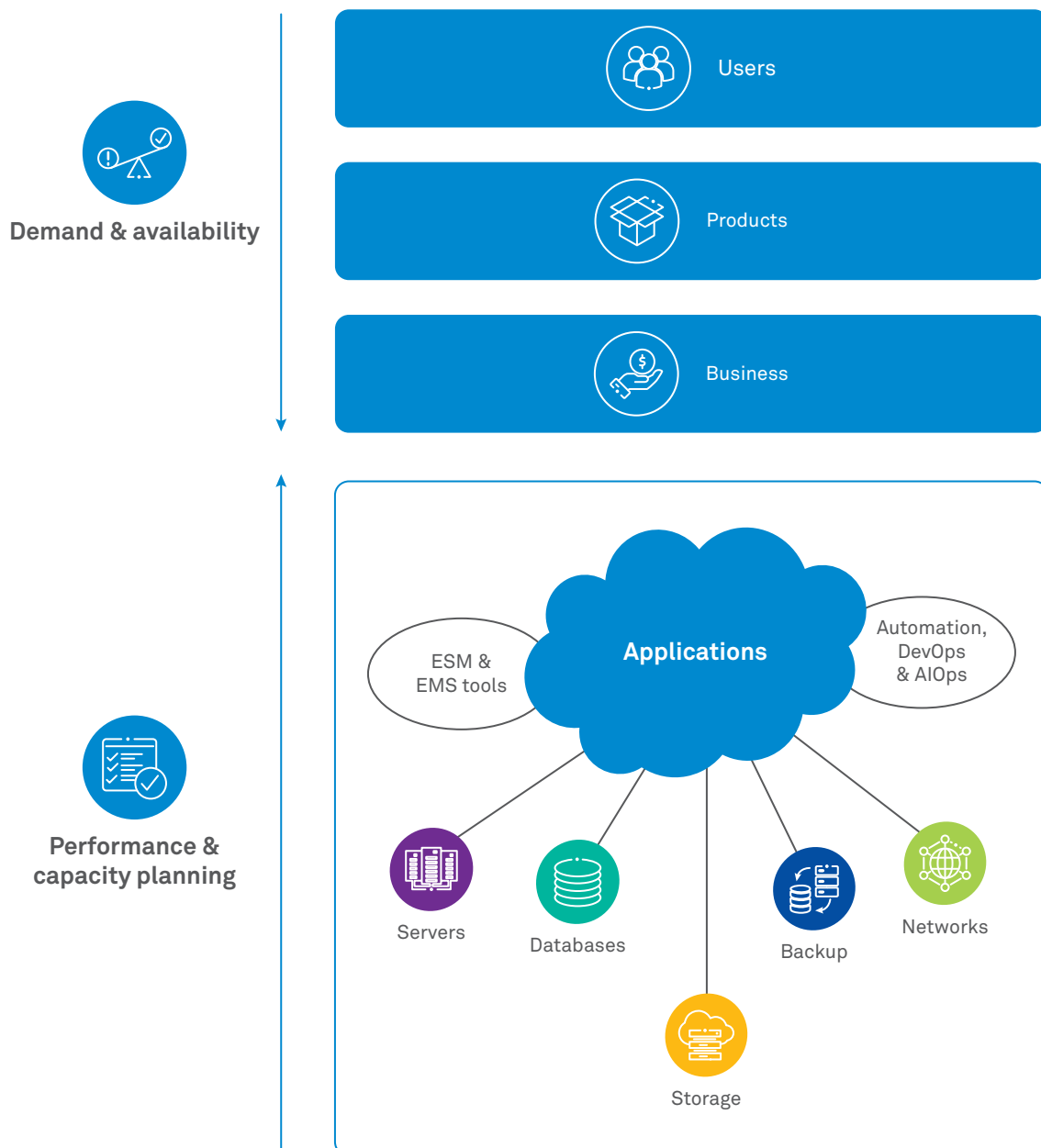
Figure 71: The role of performance and capacity planning

Asset management

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With data becoming the new capital, infrastructure becoming the new banks, performance and capacity planning is becoming the new investment banking, the IT infrastructure components where the data is processed and from where the data is used or created will be the prized assets. Asset management hence plays a pivotal role in business success.

Asset management is categorized as either Hardware Asset Management (HAM) or Software Asset Management (SAM). Assets always have a lifecycle—starting from when they are inducted to maturity and retirement. HAM will apply to devices on which the data is processed or used or from where the refined data is used/supplied (see Figure 72: Lifecycle of IT Asset Management). Examples where HAM is used include servers, networks devices, laptops, mobiles etc. SAM applies to assets which play vital roles in data processing and data access.

Figure 72: Lifecycle of IT Asset Management

Configuration management

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Configuration makes typical IT infrastructure such as servers, databases, storage, networks, applications, security systems, devices, operating systems, property files, binaries, etc., work in a

manner that business and end-users want. We are all familiar with a simple example of configuration management: when we open the "settings" menu of any software or device and tweak it, we are, in effect, engineering the software or device to deliver mission objectives in a predictable, consistent, optimized and efficient manner.

Configuration management is the foundation stone of the IT universe. However, given the complexity of today's systems, where configuration drift and compliance become focal points, it is no longer possible to manage configuration manually. Automation is becoming critical to configuration management in the increasingly popular Infrastructure-as-Code environments, where configuration files are used to bring up and decommission systems almost instantly (instead of physical hardware configuration).

Automation has gained traction within the configuration management practice especially with the rise of DevOps, agile and cloud where configuration caters to dynamic needs and promotes innovation velocity. The goal is multi-fold: to make change impact analysis reliable, eliminate human error, control configuration drift and support compliance.

Service request and self-service

AI driven automation is at the core of allowing end-users to easily leverage IT services, empowering them to be independent. AI and automation combine in a powerful way to create self-service, eliminating the need for end-users to rely on IT support teams. When necessary, end-users can also interact with IT teams using accurate information—thereby leading to more effective interventions.

The role of AI and automation in creating self-service and managing service requests with greater efficiency is being increasingly recognized (see Figure 73: The self-service workflow). Not only does it improve end-user experience but also enables organizations to handle fewer tickets, tickets can be resolved
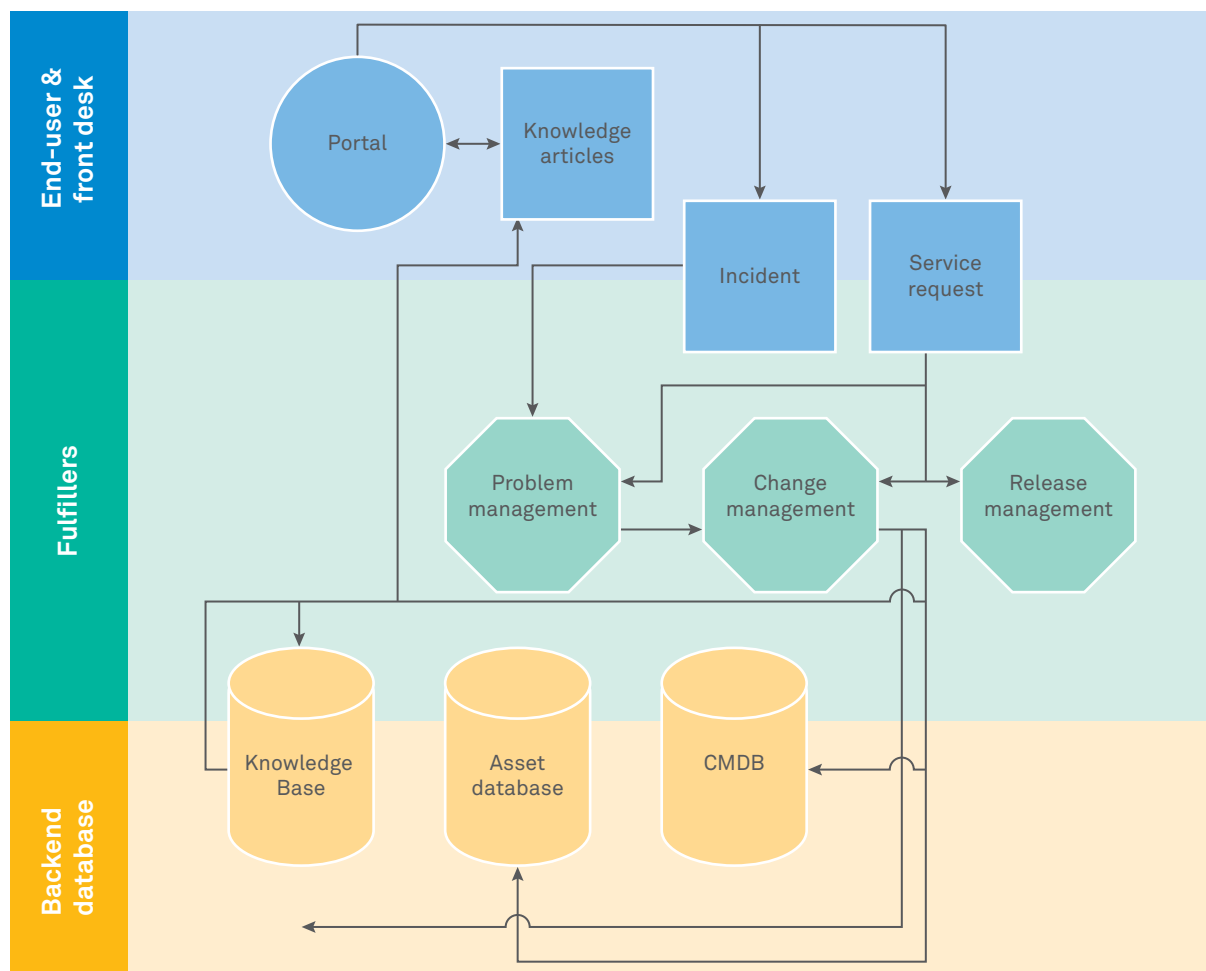

Figure 73: The self-service workflow

before reaching an agent, and there is an increase in one-touch resolution rates.

Organizations are setting up self-service support portals in a bid to drive a drop in the number of tickets vis-à-vis organizational growth and boost end-user satisfaction.

How are businesses placed in relation to performance and capacity planning, asset management, configuration management and self-service and service request on the ground? The good news is that for each of the functions, businesses said they were using mature tools and processes (see Figure 74: How mature are the performance and capacity planning, asset management, configuration management, self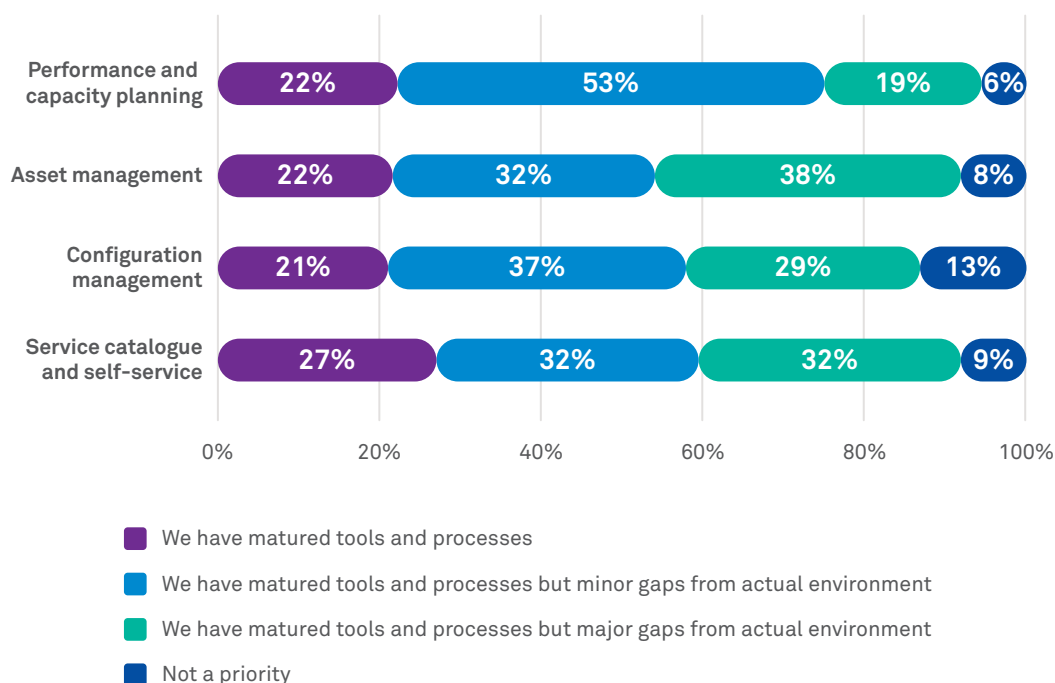-service and service request practices in your organization?). There were major and minor gaps, but the fact that they were off the starting block will feed into improving IT infrastructure.

Q: How mature are the performance and capacity planning, asset management, configuration management, self-service and service request practices in your organization?

Figure 74

Artificial Intelligence and automation

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Artificial Intelligence and automation have been growing in our day-to-day lives. Business is getting tightly integrated with these technologies and infrastructure services have not lagged. AI technologies like chatbots, self-help and self-heal techniques, robots, voice recognition and Natural Language Processing (NLP) are being built into IT infrastructure.

Infrastructural problems were traditionally resolved manually and were time consuming. With the penetration of cloud and Software-Defined Infrastructure, recognition of data-lakes as sources of decisions and growth of analytics, we see dynamic changes in all aspects of infrastructure services.

What has necessitated change in the infrastructure space? Today's world is intricately linked by social media and the fast pace of communication – this has made user experience the most important driver coupled with efficiency and economy.

Furthermore, businesses are going digital and a business can only go as fast as its IT infrastructure. This means the underlying infrastructure also needs to go digital.

Data management and insights extraction have become a necessity, accelerating the evolution of data science, analytics, Machine Learning and Deep Learning technologies.

The change in the infrastructure space has been radical: the rise of Infrastructure-as-a-Code is paving the way to the availability of anywhere, everywhere, and always-on IT infrastructure. Gartner calls it the "brave new world of agile infrastructures"[xiv] where physical boundaries between front, middle, and back offices are giving way to a connected and fluid enterprise.

Accordingly, the single pane of glass view with real-time reporting is becoming the norm. Single sources of truth from heterogeneous data sources have become critical. Proactive, predictive analytics is changing the way business is conducted. There is a call for zero-touch operations without human interventions.

Data center operations are moving to cloud and DevOps is driving automated provisioning (see Figure 75: Infrastructure management landscape with automation touchpoints).
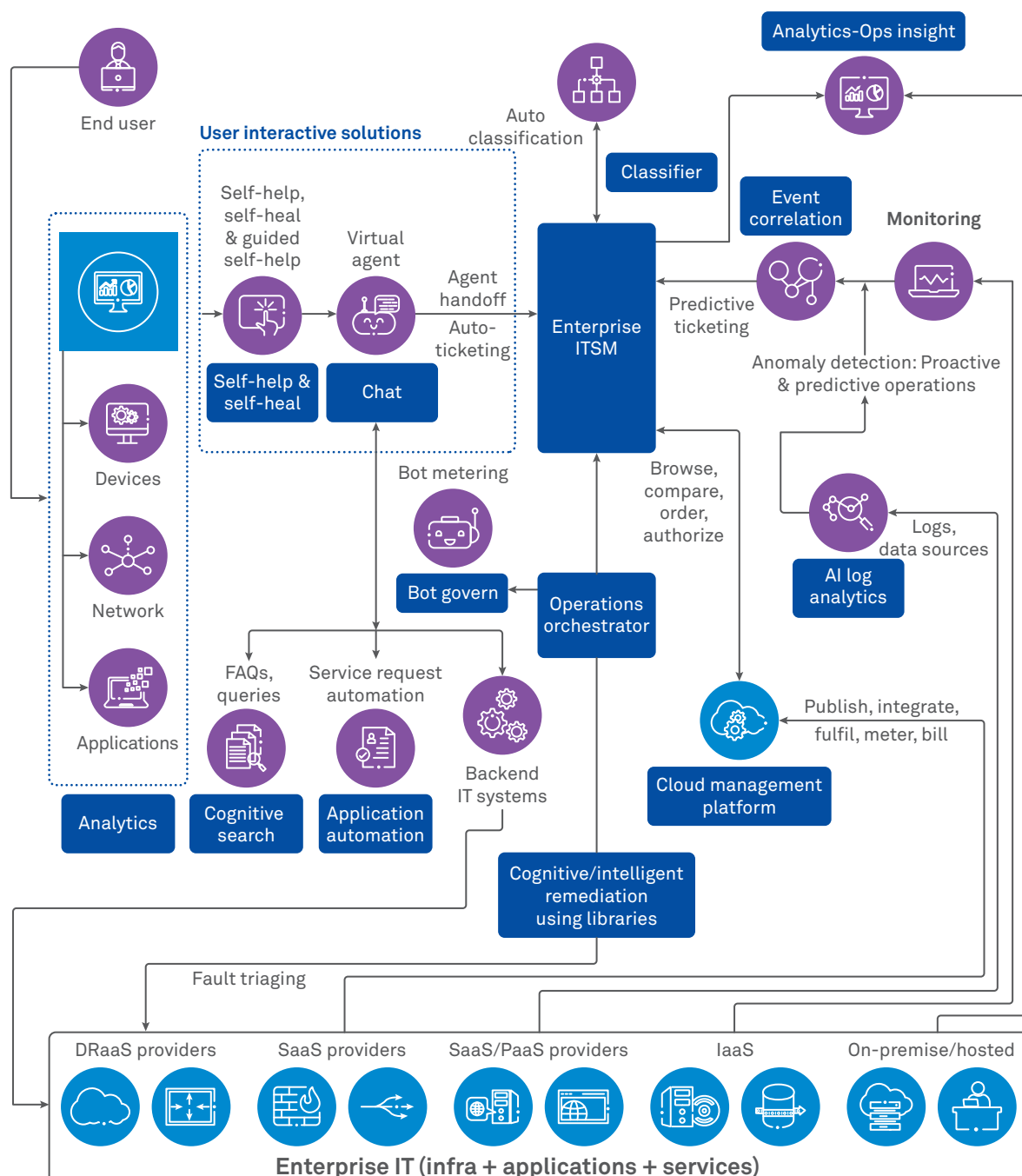

Figure 75: Infrastructure landscape with automation touchpoints

Service management has moved to automated correlation and classification leading to automated service fulfilment.

Self-help, self-heal, virtual agents and persona-based user profiling have taken over the end-user segment. Auto-ticketing and auto-remediation have enhanced user experience.

Our survey shows that while a majority of businesses have adopted automation, the usage is more on decentralized scripts and siloed accumulation of automation tools adding complexity to the technology landscape. A relook on essential end-to-end automation needed to enhance user-experience and achieve business targets with scalability and economics is

imperative (see Figure 76: What is the mode of automation in your IT infrastructure?).

The future of IT infrastructure looks exciting. AI-enabled automation tools are emerging to drive speed, scalability and agility in every business. Software-Defined Infrastructure is enabling automated policy-based provisioning and management, catering to complex technology landscapes. Infrastructure will not be confined to commoditized hardware. And ultimately, intent-based infrastructure will serve to focus on outcomes.

From our survey results, it is apparent that AI and automation in IT infrastructure is picking up steam. Watch the space closely as it promises a revolution at the heart of IT infrastructure services.

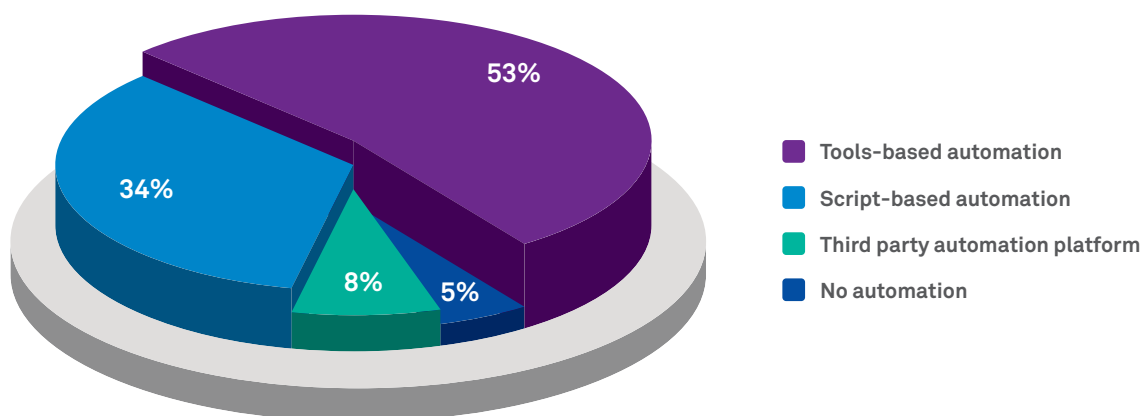**Q: What is the mode of automation in your IT infrastructure?**

- Tools-based automation
- Script-based automation
- Third party automation platform
- No automation

Figure 76

AIOps
●●●●○

Digital transformation is mandating a rapid change in the way underlying IT operations are managed. To cater to new trends (such as cloud and IoT), the IT ecosystem is harnessing the power of AI in IT operations resulting in a sudden explosion in AIOps.

AIOps is a paradigm shift in the way day-to-day operations are managed. The first thing that comes to mind is the move from manual tasks to automated workflows. But there's more to AIOps. The very essence of reactive problem-

solving is moving away to accommodate proactive and predictive identification of issues and prescriptive methods of problem solving. This is also giving rise to an integrated approach of continuous monitoring, analysis, remediation and improvement in operations.

Our IT infrastructure survey showed that 47% of businesses have no AIOps implementation (see Figure 77: Have you adopted AIOps in your IT operations?). From conversations with businesses across the world, we understand that the reason why many of the businesses are yet to adopt AIOps is because they have not yet accepted the idea

Q: Have you adopted AIOps in your IT operations?

- No AIOps implemented
- AIOps has been piloted in some areas but not yet in production
- AIOps has been implemented in production for some areas only
- AIOps is centric to our operations
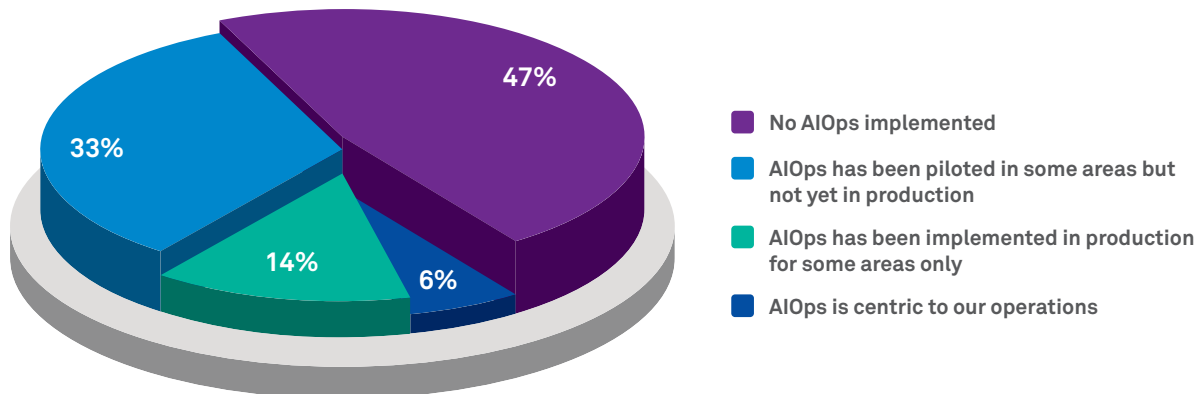
47% · 33% · 14% · 6%

Figure 77

that AI-enabled automation would be the basis of all operations in future. Many organizations are not ready to embrace the changes needed in IT operations with the deployment of automation.

AIOps uses data that is continuously obtained from the monitoring tools and analyzes this data for anomalies. Machine Learning facilitates

correlation of these anomalies to come up with useful actionable insights, foreseeable issues and business insights. Automation capability in AIOps picks up these issues and resolves them. Historical data is applied to train AI components. This enables predictive and prescriptive capabilities, which further provides a Continuous Integration/ Continuous Deployment (CI/CD) model.

Phil Tee,
Founder and CEO, Moogsoft

Today, AIOps enables IT operations and service assurance for modern IT, and will ultimately determine which companies can drastically improve customer experience as they digitally transform.

The infrastructure powering digital services is constantly changing amidst mass adoption of cloud and containerized IT and it is scaling to unprecedented levels as businesses deliver more services online. While these shifts look different for each company, the common denominator is operational complexity and scale, which generates volumes of IT data and change, manageable only using Machine Learning and Artificial Intelligence.

AIOps allows ITOps and DevOps teams to regain visibility and control over these modern IT environments. It streamlines and automates the collection and analysis of IT data for problem detection, diagnosis and resolution — helping businesses meet Service-Level Agreements with their customers and build continuous assurance into digital experiences.

In 2020, this democratization relies on the accessibility of AIOps' critical advanced algorithms and collaboration capabilities. Advanced data science is not a common skillset, so AIOps platforms must simplify it to the point of hiding as features for ITOps and DevOps. Ultimately, future enterprises will see ITOps transformed into a broader monitoring platform that continually assures availability while underlying infrastructure rapidly changes.

AIOps is applied on all layers of the IT landscape, including the application and infrastructure layer, monitoring layer, event management layer, IT

Service Management layer and operations layer in order to support business (see Figure 78: AIOps and the IT landscape).
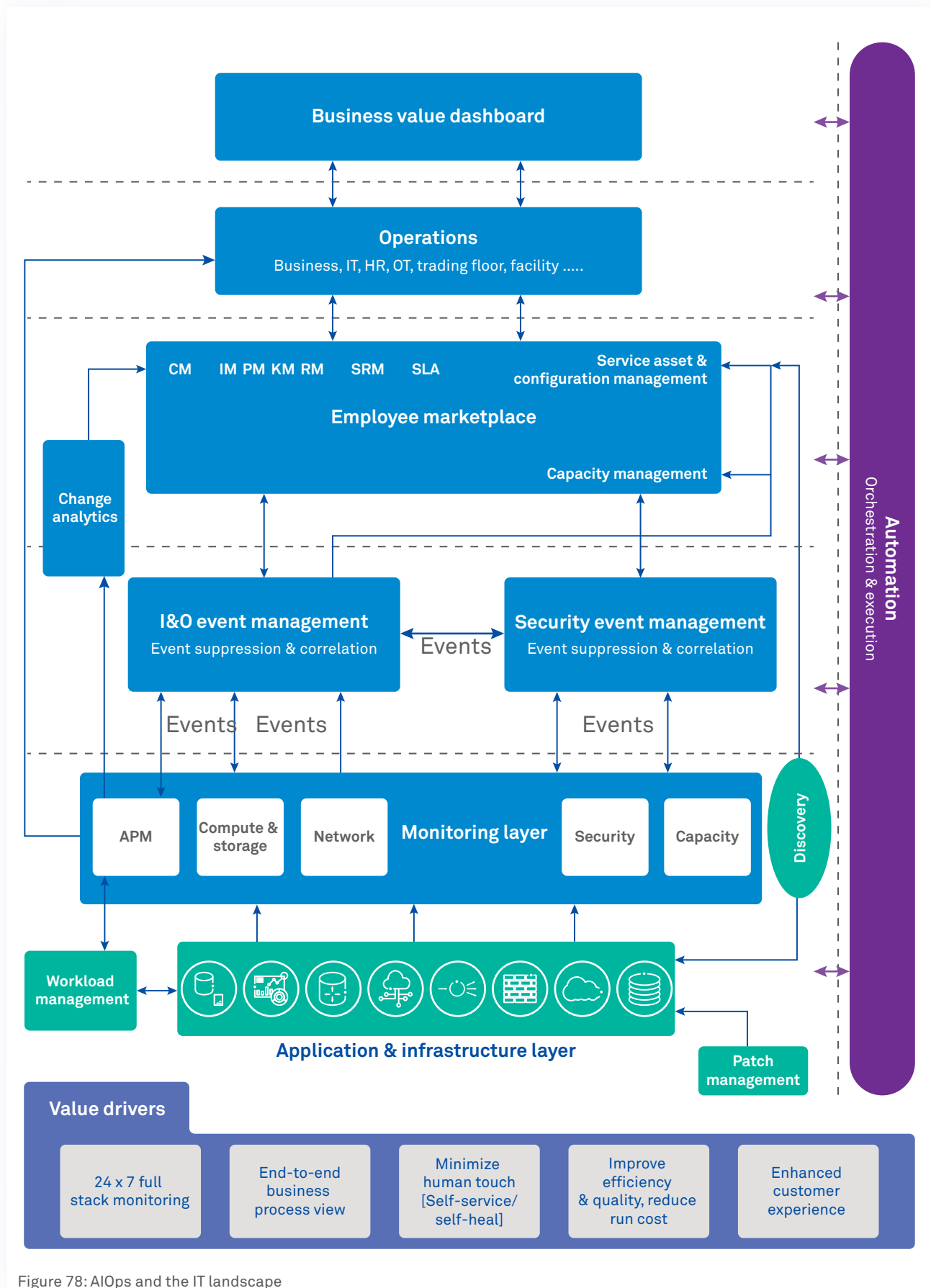

Figure 78: AIOps and the IT landscape

AIOps addresses the major challenges faced by CIOs today (see Figure 79: What CIOs want):

- Single source of truth

- Holistic and centralized visibility of metrics – or a single-pane of glass view

- Real-time service availability

- Auto-ticketing/auto-remediation

- Auto-discovery of changes in various components

These challenges translate into providing solutions for efficiency, data management, business effectiveness, actionable insights, faster adaptation to change and as a result, enhancement of user experience.

AIOps is here to stay. It addresses today's challenges related to speed, scale and efficiency and is ready to address tomorrow's complex needs. And as the business environment and underlying IT landscape get more agile and digital there is a clear call for AIOps to play its role.
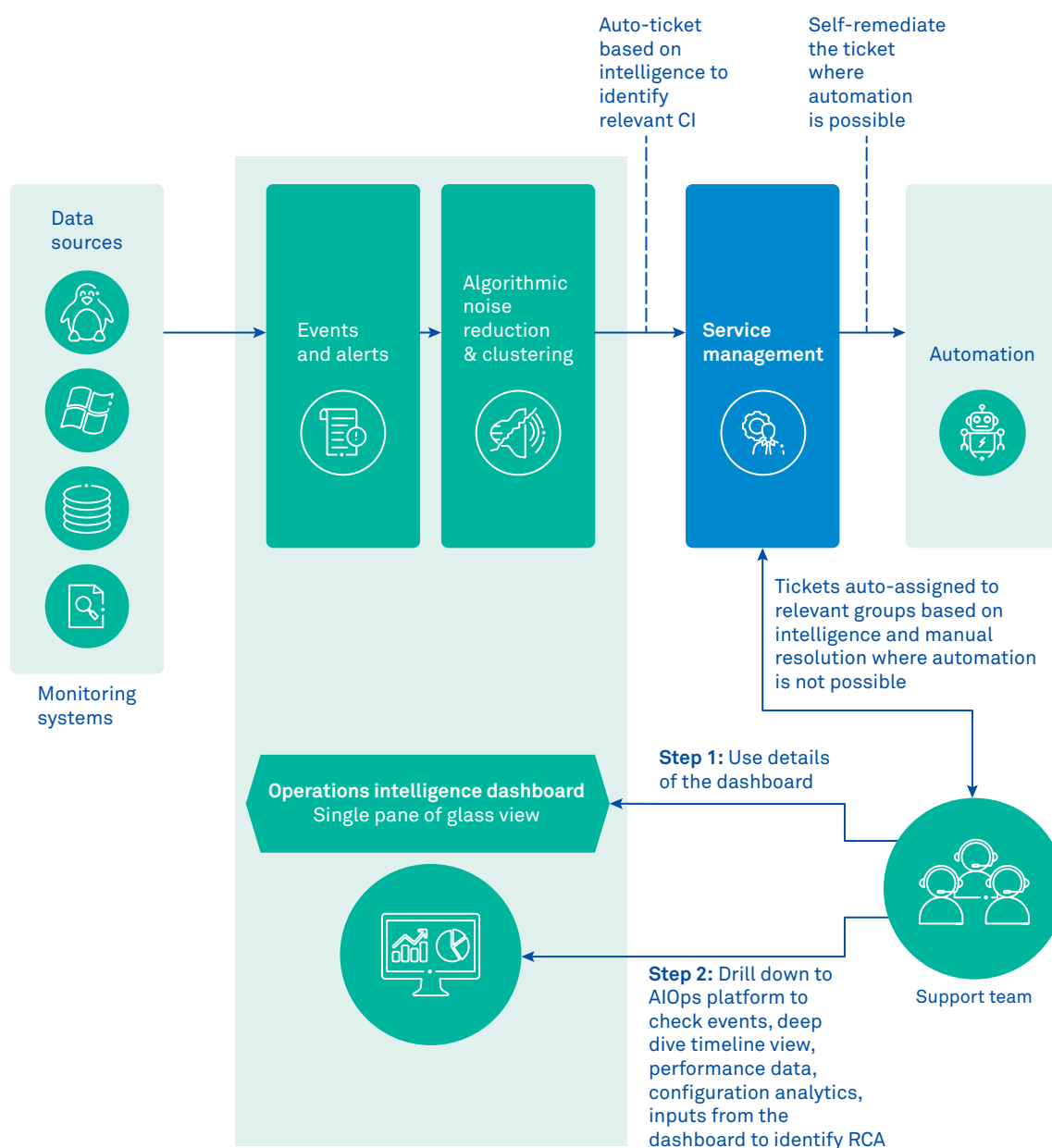

Figure 79: What CIOs want

Crowdsourcing

A clever way to deliver at 3 times the pace

Imagine developing and delivering 3X faster for your business. Or, your analytics team having nearly unlimited access to top data scientists. What if your team had its own crowd-powered QA program they could use for every deployment? How might it change your life? You may call it the future of work, the gig economy, or simply, crowdsourcing.

The concept of crowdsourcing is not new. It has been revived in the digital age with bells and whistles. The ability to define a problem and then harvest the responses of a wide base of independent contributors has become immensely easier with the onset of social media, digital communications and a new generation of consumers and employees who value engagement with businesses. Crowdsourcing innovation is a sharp tactic and has been used as a clever way to refine products or services and engage directly with stakeholders—all at a low cost.

Wipro is seeing an increased adoption and acceptance for Topcoder, its crowdsourcing platform. Enterprises are leveraging crowdsourcing platforms primarily for digital application development, website development or modernization, UI development and enhancements, QA and testing, analytics and data science, AR/VR and several niche and complex areas. Of late, the interest in crowdsourcing is being extended to the IT infrastructure domain for areas such as bot development, system integration/migrations projects, infrastructure testing, audit and assessment, change and Incident Management, troubleshooting, etc.
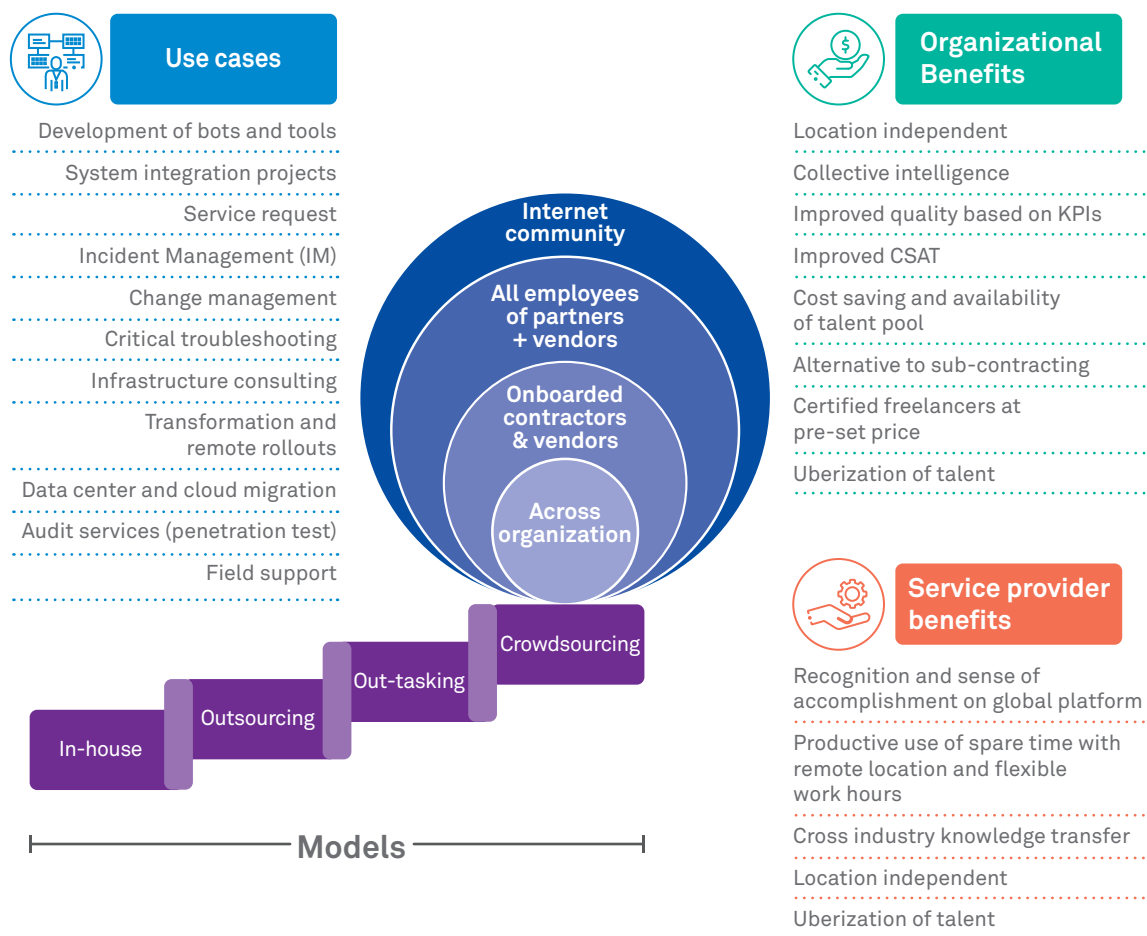
> Is there an innovative way to using crowdsourcing for IT operations? Organizations that find an answer to the question will be rewarded with several magnitudes of efficiencies.

To truly mainstream for infrastructure, crowdsourcing must address:

- Issues around the management of resources working on live systems

- Providing access to internal—and often proprietary—systems to external resources for bot development

- The availability of an on-demand collaboration platform for high-skill, high-paid resources to work together as a team for build type services while they are dispersed

- Security threats triggered by scripts that are a key part of automation and which are susceptible to malware injection

- Providing privilege access, surveillance, session recording, and remote access to resources without violating security and compliance requirements

Crowdsourcing has many dimensions that are of interest to organizations keen on fast-tracking IT infrastructure development and improving management while controlling costs (see Figure 80: Crowdsourcing for IT infrastructure: Use cases, benefits and challenges). The key to successful crowdsourcing is a platform which enables collaboration between internal and external resources, preserves privacy and allows experimentation with limited risk. The State of IT Infrastructure 2020 survey provided us with insights into how enterprises are approaching

Use cases

Development of bots and tools
System integration projects
Service request
Incident Management (IM)
Change management
Critical troubleshooting
Infrastructure consulting
Transformation and remote rollouts
Data center and cloud migration
Audit services (penetration test)
Field support

Internet community

All employees of partners + vendors

Onboarded contractors & vendors

Across organization

Crowdsourcing

Out-tasking

Outsourcing

In-house

⊢ **Models** ⊣

Organizational Benefits

Location independent
Collective intelligence
Improved quality based on KPIs
Improved CSAT
Cost saving and availability of talent pool
Alternative to sub-contracting
Certified freelancers at pre-set price
Uberization of talent

Service provider benefits

Recognition and sense of accomplishment on global platform
Productive use of spare time with remote location and flexible work hours
Cross industry knowledge transfer
Location independent
Uberization of talent

General challenges faced by enterprises while considering crowdsourcing

Security	Timeliness	Estimating costs
Uncontrolled access	Ownership	IP Infringement
Potential human error	Integration	One-sided communication
Quality of work	Cost control overrun	Unclean IP
Validation of work	Resource coordination	More ideas, less solutions

Figure 80: Crowdsourcing for IT infrastructure: Use cases, benefits and challenges

collaboration (see Figure 81: Where do you see your organization implementing crowdsourcing?). Despite the upsides of crowdsourcing, respondents said that crowdsourcing had been explored and not found relevant for IT operations (39%). Most said that crowdsourcing can be used

for infrastructure testing, system build and provisioning and design and planning (26% each). Is there an innovative way to using crowdsourcing for IT operations? Organizations that find an answer to the question will be rewarded with several magnitudes of efficiencies.

Q: Where do you see your organization implementing crowdsourcing?

- **Crowdsourcing has been explored and found not relevant for IT operations**
- **Crowdsourcing has been implemented**

- **Infrastructure testing need**
- **System build & provisioning**
- **Design and planning**
- **Operations & troubleshooting**
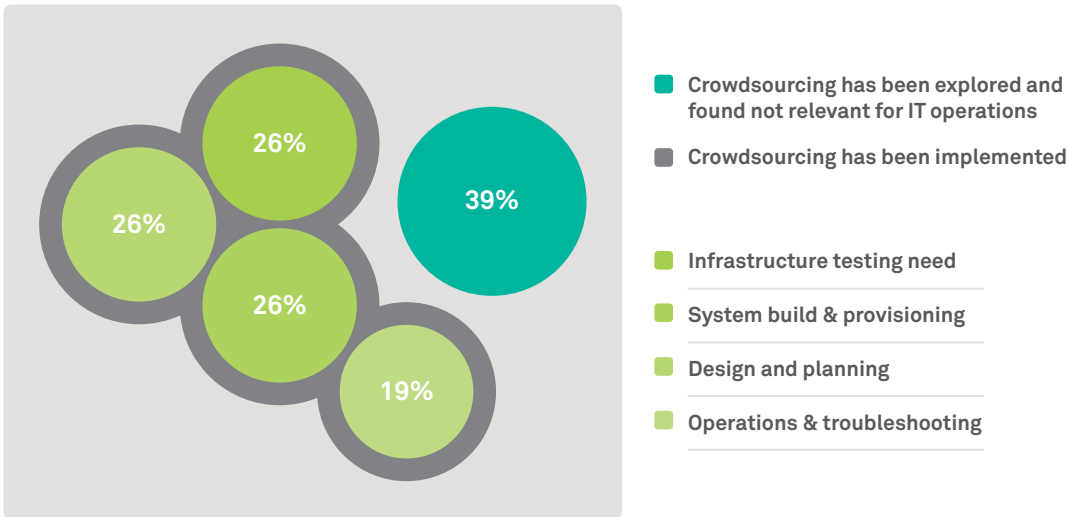
Respondents were asked to choose multiple response options

Figure 81

State of IT governance

#1 Priority: Understanding and aligning with business culture and goals

Delivering infrastructure services has many moving parts. It involves contracted services partners, building the back-office capability, selecting and implementing the technology, risk-assessment, integration, managing service levels, capacity, availability, continuity, budgets, compliance and talent management.

The last few years have shown that getting these right is not enough. Business can still have a negative perception about infrastructure services. IT organizations have to double down to manage this perception by developing an understanding of the business and building a culture that allows it to operate productively. In effect, this means putting a formal framework in place that aligns IT with business goals. Quality of governance determines how a business achieves its goals and how well it does this. Governance programs are therefore a potent component of modern IT infrastructure delivery.

Governance programs play a larger and more elevated role as well. Aside from making IT infrastructure delivery transparent and accountable, governance can create continuous value on top of meeting contracted service levels by going beyond agreed ROI. In essence, the nature of the governance program can determine

Quality of governance determines how a business achieves its business goals and how well it does this. Governance programs are therefore a potent component of modern IT infrastructure delivery.

what IT gives back to the business over and above providing dependable and trusted IT capabilities.

How does governance help IT delivery go beyond "accidental brilliance"? How does it raise the standards of practice so that IT delivery can be measured with empirical data on a continual basis? Most service providers, including Wipro, have developed service delivery platforms that address these questions. Enterprise infrastructure teams can develop similar capabilities by leveraging similar platforms that include best practices, standardization, quantified service delivery metrics, continuous improvement and innovation (see Figure 82: IT infrastructure operations: From standalone function to responsive advisor).
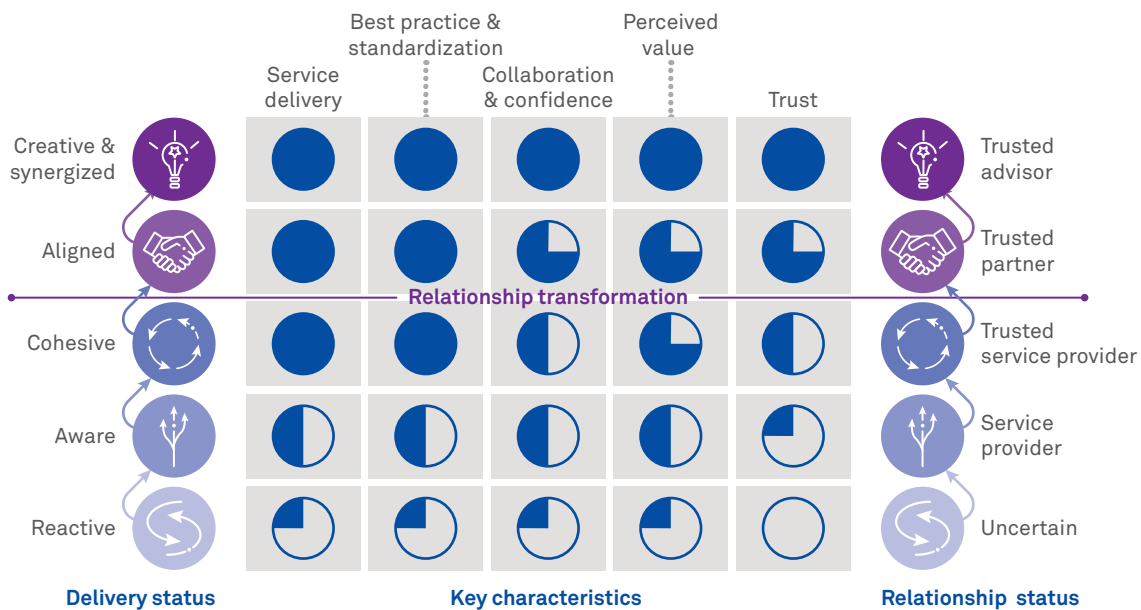
Figure 82: IT infrastructure operations: From standalone function to responsive advisor

A continuous value creation delivery framework requires a centralized approach to assimilate best practices and acquire new capabilities which include leveraging automation, digital knowledge management and reskilling resources. Infrastructure operations teams should assess their delivery efficiency for each business.

Enterprise can measure service delivery for maturity against a predetermined scale capturing:

- **Service delivery quality:** Ability to meet Service-Level Agreements. A full Harvey Ball score indicates complete achievement of service-level targets.

- **Best practices and standardization:** This measures the effectiveness of the centralized and standardized approach for best practices. A full Harvey Ball score indicates a complete standardization and best practices approach followed across the teams and client accounts.

- **Collaboration and confidence:** This measures the extent of how well infrastructure operations teams collaborate with clients for mutual benefit.

- **Perceived value:** This measures the perception of infrastructure operations by the business through service delivery. A full Harvey Ball score suggests the business can see significantly high value.

- **Trust:** This measures the ability of the infrastructure team to gain trust and work in an integrated fashion with the business. A full

Harvey Ball score indicates the highest level of trust with the business.

An important aspect of success is to ensure there is top-level sponsorship for all aspects of governance. As with other initiatives, communications related to governance between top leaders and the business must be kept continuous and vibrant. This is especially true for new initiatives and technologies being assimilated in IT infrastructure management and delivery. Finally, all initiatives should be monitored and measured with results shared— and in instances where failure appears imminent, governance itself should mandate that external assistance be sought to ensure success.

Budgets and spends

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With the rapid ingress of AI-driven automated operations, the considerations for creating accurate budgets and investments have changed. Study the following data points for 2020:

- 44% of global businesses are planning to raise their IT budget

- Every fourth IT enterprise is raising employee force

- Adoption of AI-powered technologies is expected to triple

- Almost all large enterprises are planning to deploy 5G technology

These are indicators that technology buyers are going to need major budgets to upgrade their infrastructure, software and services. As a consequence, the business technology market is expected to be $4 trillion in annual spend.

More than half of the $4 trillion[xv] is likely to be invested in:

- Security

- Collaboration and communications

- End-user hardware

- Server technologies (mostly cloud)

- Networking

- Storage and backup

Governance must cover all critical areas of IT infrastructure that impact business strategy and goals. This includes assessment, prioritization, investments/budgeting, vendor selection, delivery, SLA management, maintenance, compliance, refresh, improvement and retirement. However, your organization may benefit from bringing specific areas under the lens of governance for periodic re-examination and improvement. To understand the areas that may demand added attention, we asked respondents of our State of IT Infrastructure survey 2020 the areas they are most likely to invest in over the next three years. The findings tell us that attention is going to be drawn to DC and cloud (IaaS and PaaS), followed by software and tools used for operations and networks.

The findings also reflect the fact that organizations may have begun to believe that Service Desk

investments can go down with the increasing amount of automation, AI and self-healing processes that are being injected into IT infrastructure, or will be in the next three years. This could be why as many as 49% said they plan to maintain investments in Service Desk at the same level as in the past while 36% said they would decrease it.

Operational metrics

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Operational metrics are the vectors by which the delivery of services is constantly improved. Data is used to optimize service delivery as well as to monitor, measure and meet service delivery levels negotiated between the service provider and the customer.

These metrics have benefits for:

- The customer, who has an awareness of precisely what, and what not, to expect from services

- The service providers who know what their responsibilities are in terms of delivering each service to the customer

In both cases, precise expectation management leads to more satisfied groups.

In the overall ITSM framework, these metrics play a critical role. Once the system is deployed, success and failure are measured based on the delivery of the agreed-upon service levels in an effective, efficient and economical manner (see Figure 83: Operational metrics that matter).
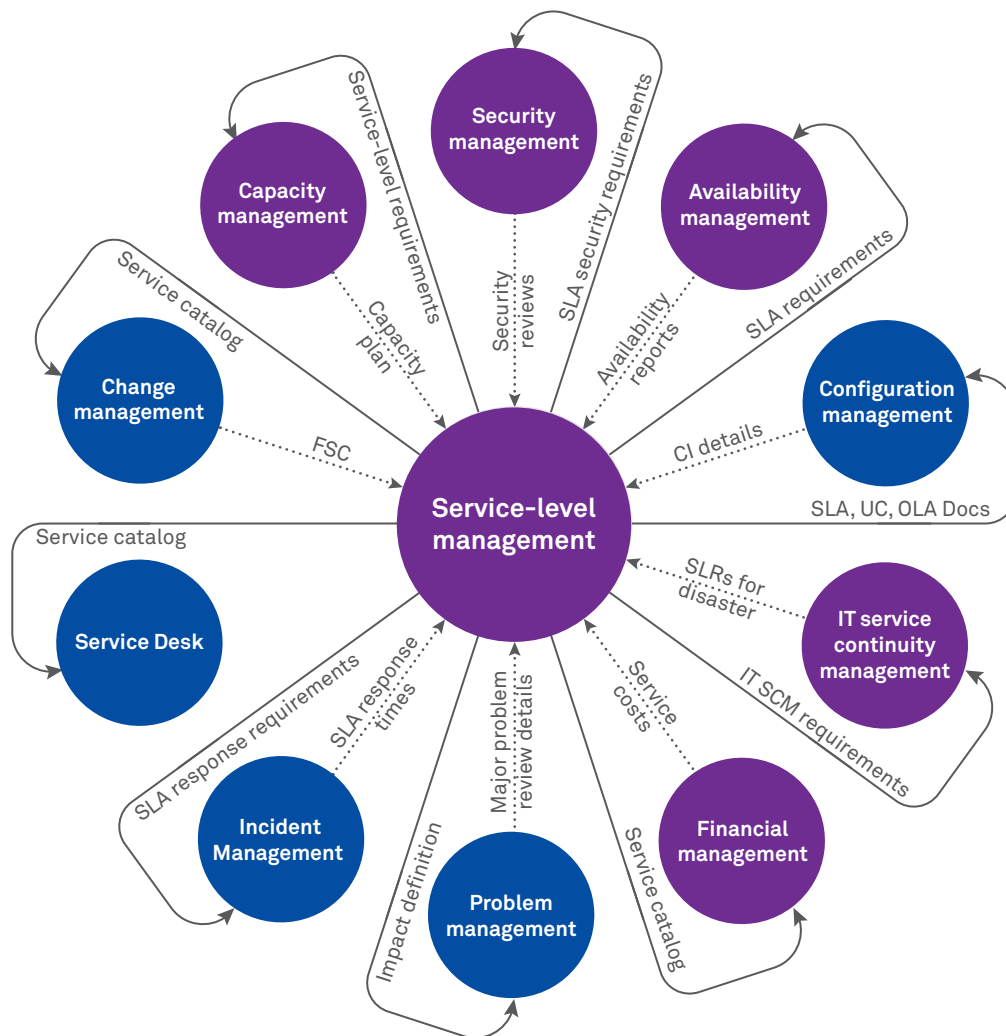
Figure 83: Operational metrics that matter

Digital operations
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Digital operations relates to all businesses enabled by IT. It also drives decentralization, putting more power into the hands of the end user. Digital operations reduce execution to almost real-time using next generation technologies. As an increasing amount of cognitive AI finds its way into digital operations and IT infrastructure, the experience of end users will improve by several magnitudes.

Effective integration of digital operation can be achieved by bringing equal focus on three components: People, technology and process.

A contributing factor for the success of digitizing and integrating processes across all areas of business, and the delivery of value to customers, depends on the roles and responsibilities of the team. Our survey showed that 58% businesses had independent teams to handle infrastructure, applications and business process. This can impact speed of decision-making as different teams need to collaborate with each other. Some organizations have strong collaborative cultures but most would need to be like the 31% that said one unified team handles infrastructure, applications and business processes (see Figure 84: What best describes the roles and responsibilities of the IT operations team in your organization?).

It is interesting to note that 42% of organizations in our survey said that applications operations are directly handled by the infrastructure operations team. This trend needs to be adopted by all organizations to ensure agility and responsiveness.

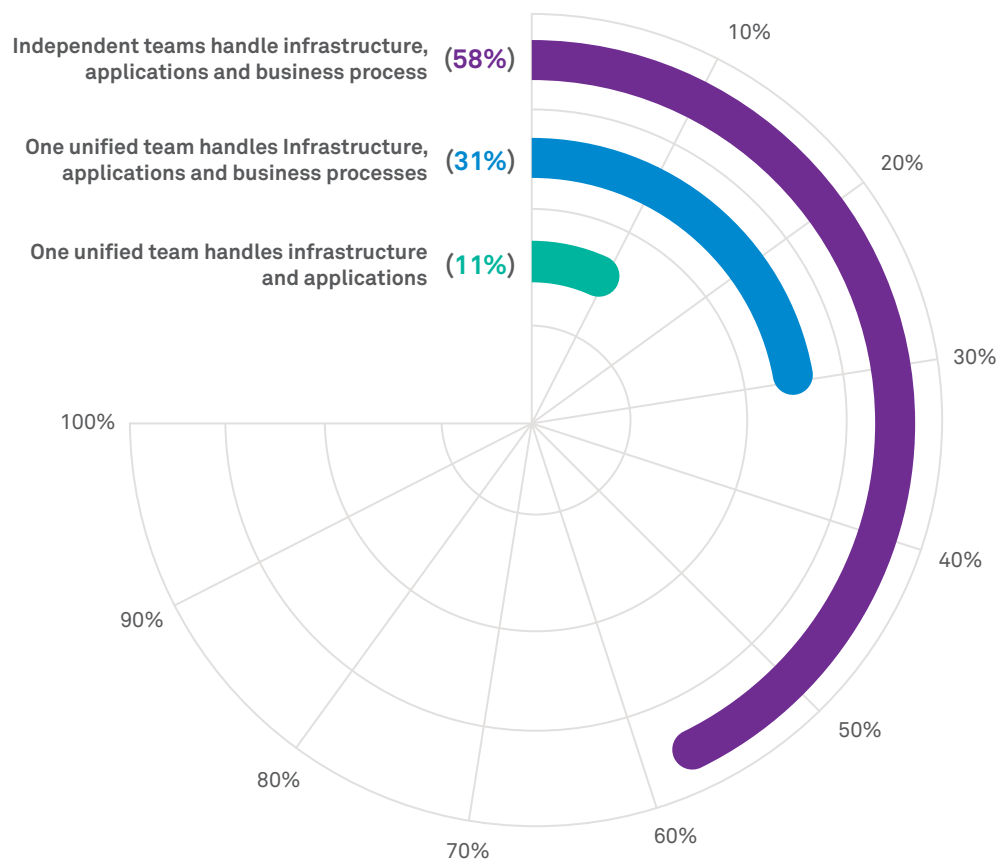Q: What best describes the roles and responsibilities of the IT operations team in your organization?

Independent teams handle infrastructure, applications and business process **(58%)**

One unified team handles Infrastructure, applications and business processes **(31%)**

One unified team handles infrastructure and applications **(11%)**

Figure 84

ITIL 4.0

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ITSM is now a proven framework for transforming IT service delivery. It has become—and will continue to remain—a powerful way to ensure consistent and effective management of IT service delivery. This is because ITSM standardizes and simplifies tasks for the IT team while enabling them to use data-driven insights to provide differentiated user experience. An equally important factor behind ITSM's continued adoption is the fact that it remains easy to implement. ITIL (Information Technology Infrastructure Library) is the compass that guides organizations in addressing service management issues and requirements. In effect, ITIL pushes ITSM to deliver more value. The latest version, ITIL 4.0, is also designed to reflect Lean,

agile and DevOps. This means businesses can use it to adopt new technology with ease.

ITIL 4.0 focuses on the service value system operating across four key areas—organization and people, information and technology, partners and suppliers, and value stream and processes, which represent the way various components and service value chain activities work together to facilitate creation of value through IT enabled services.

The new framework will allow organizations to adapt their IT operating model to the requirements of digital and continually improve their services. Modern ITSM and ITIL 4.0 are more inseparable than ever before: complementary twins that organizations cannot do without.

Human dimension

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IT infrastructure is being forced to adopt a variety of new technologies and processes while keeping its sights narrowed on collaboration, user experience and innovation. These technologies and processes range from mobile, to automation, cloud, SDx, full stack applications, AI, analytics, DevOps, agile, lean and user experience. Other technologies are also showing up, such as edge devices, Augmented Reality and Machine Learning. What this means is that skills, which have been prized for decades, are no longer adequate. Note: Those skills are still prized and are not obsolete. But IT infrastructure/ITSM specialists need more firepower today.

We asked respondents in our survey what affects their resource planning in the light of new technologies and priorities (see Figure 85: What are the factors affecting your resource planning that focuses on the human dimension to deliver better, faster and smarter?). The number one factor they pointed to was automation and AI (77%). This is not surprising. Automation and AI are seeping into every part of business, transforming it in radical ways. This has two implications: One, it will be another year or two before we fully understand the areas in which automation and AI will impact ITSM. This means resource planning can be fine-tuned with certainty only after these

outcomes of AI and automation become relatively clear. The second implication needs immediate thought and action. If billions of dollars are being sunk into AI and automation it can do no harm to retrain resources in being able to assess use cases and tools, develop strategies and processes that help induct these technologies faster.

Our survey also showed that cloud computing (74%) continued to pose a challenge to resource planning despite the widespread acceptance of cloud as an irrevocable part of infrastructure. This is cause for concern. There is no shortage of cloud certified specialists. The trouble could be that tech cycles and developments are shortening and organizations are unable to keep pace. By the time an adequate number of freshly trained resources get into their seats, there is another level of learning required.

We also believe that this particular problem could be related to the lack of clear job descriptions. Many organizations put out "digital transformation" as the role because that appears to resonate with the job market instead of asking for cloud skills (multi-cloud management, cloud security, cloud migration, etc.). The solution to such problems, at least for the short term, is to depend on technology partners to provide resources while the organization gets an accurate pulse on change.

Q: What are the factors affecting your resource planning that focuses on the human dimension to deliver better, faster and smarter?
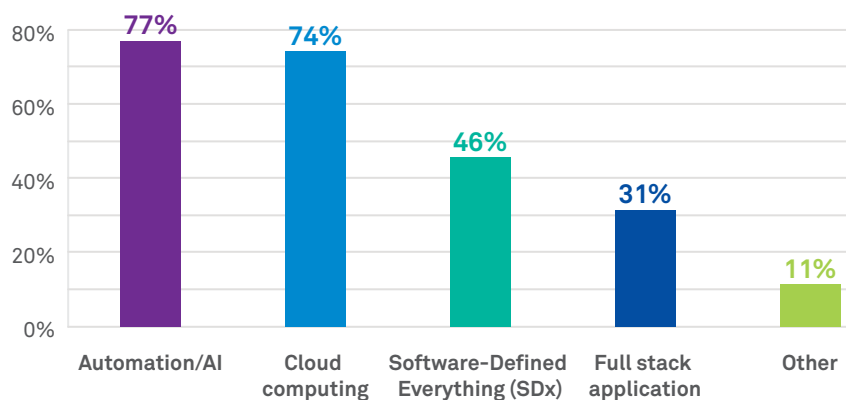
In an organization, multiple factors can affect resource planning

Figure 85

Service brokerage and federation

●●●●●

Cloud services have two clearly defined goals—to improve business agility and reduce operational costs. In addition, cloud services come bundled with management by the provider, taking away the overheads of supervision and administration. The critical question that remains for businesses to answer is: "Which cloud service is best to meet the quality and functionality that my operations demand?".

Cloud Brokers (CBs) play an important role in selecting suitable cloud services that also fulfill Quality-of-Service (QoS) requirements. Service selection should be part of the integrated framework for SLA management, service provisioning, and SLA compliance monitoring.

The main component of the framework is a federation of CBs. These CBs are in charge of selecting suitable cloud services (see Figure 86: Cloud engineering and service management) and mediating between service consumers and cloud services to reach agreements that explicitly describe expected service delivery and QoS levels.
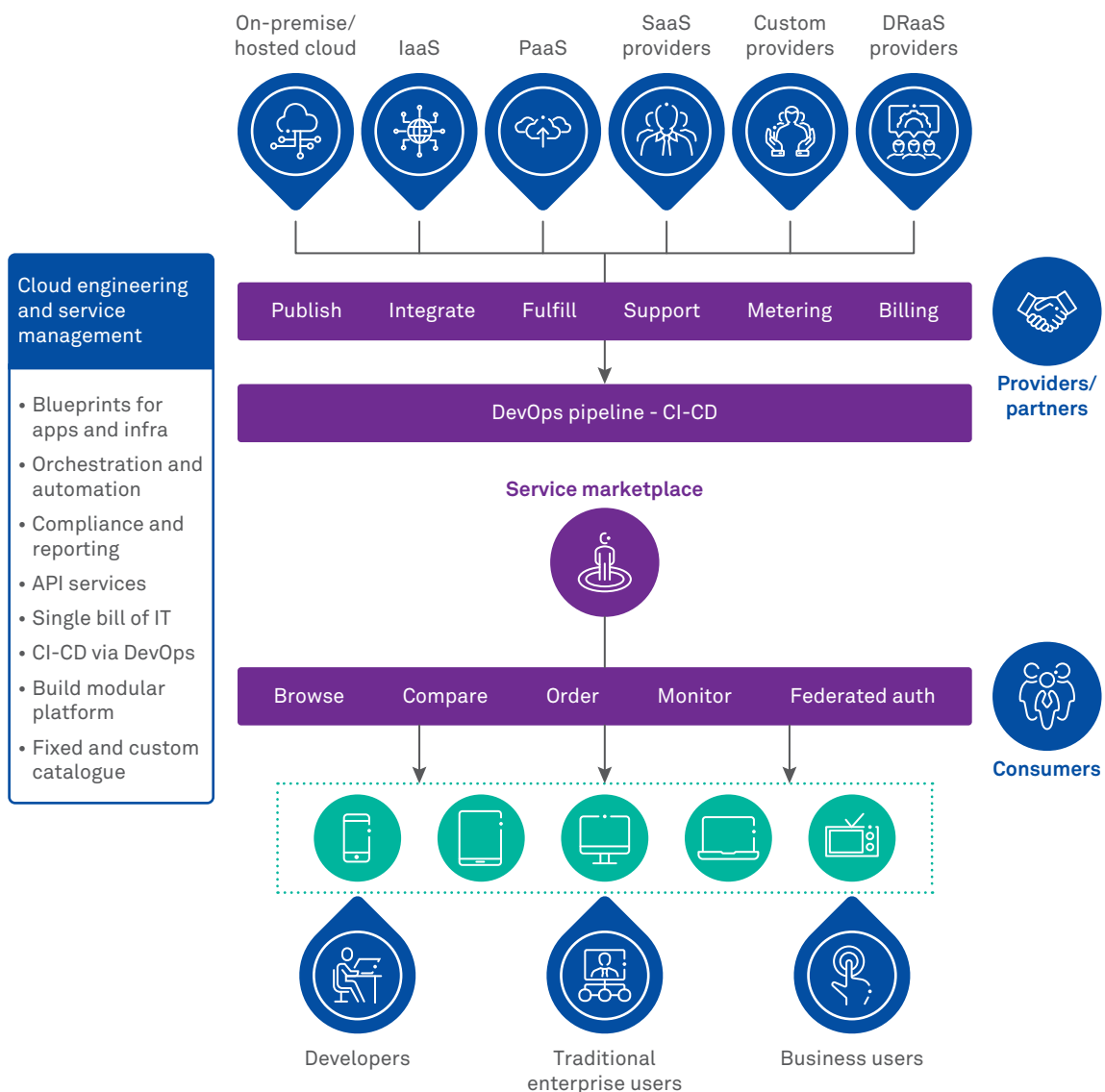

Figure 86: Cloud engineering and service management

Our survey showed that an extremely high 72% of businesses did not have a CB facility. This implies there is considerable room for improvement (see Figure 87: Do you have a Cloud Broker facility with a unified enterprise market place for self-service?). Businesses that quickly examine the role of CBs in cloud selection will avoid the pain of managing QoS.

Given the abundance of cloud service offerings, it is not easy for enterprises to select a service

that meets their functional and non-functional requirements and rank them based on quality requirements. Another challenge is the lack of heterogeneity in terms of quality indicators and SLA indicators used by Cloud Service Providers in their SLAs.

The CB is responsible for match making and bundling/provisioning services from multiple private cloud providers through volunteer and federated data centers, under varying load conditions.

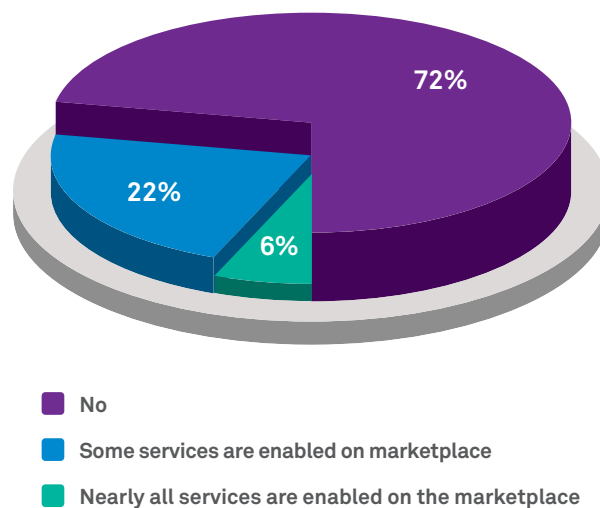**Q: Do you have a Cloud Broker facility with a unified enterprise market place for self-service?**

- ■ No
- ■ Some services are enabled on marketplace
- ■ Nearly all services are enabled on the marketplace

Figure 87

Sustainability
●●●●●

Data centers are power suckers. The hardware takes up space. They need extraordinary cooling power. Data center managers worry about redundancies. All this adds up. And the older the hardware, the more magnified these problems become, increasing operating costs and turning data centers environmentally unsustainable. A majority of the respondents in our State of IT Infrastructure survey 2020 (61%) said that they did not have environmental, social and economic sustainability-related KPIs (see Figure 88). This means the space they reserve for future needs is ad hoc and has no basis in data or business goals; they don't track energy

consumption/costs by site or applications in order to make decisions that lower their impact on the environment; and they don't have a plan to refresh ageing hardware.

Maintaining sustainability KPIs is becoming vital. For example, every data center manager should have a target Power Usage Effectiveness or a PUE metric. PUE measures how efficiently power is delivered to devices in the data center (it should be ‹1.2 for new data centers across seasons). If the PUE exceeds 1.8, which is the industry average, there is a need to bring in energy efficient practices and lower the impact of the data center on the environment. Today, the science of sustainability has advanced considerably and should be an area that data center managers keenly address.

**Q: Do you have environmental, social and economic sustainability-related KPIs
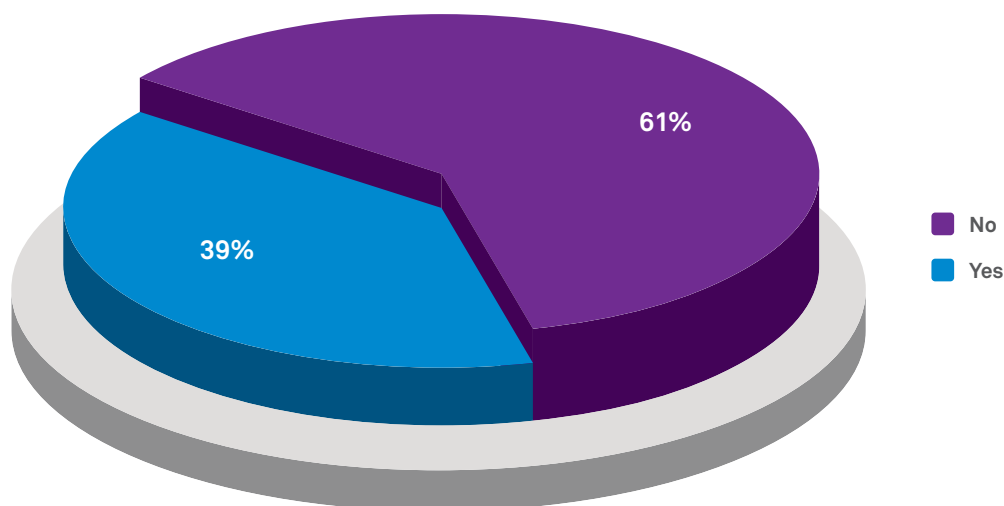vis-à-vis the data center?**

61%

39%

■ No
■ Yes

Figure 88

Balaji V. V,
Head-Business Technology Group, ICICI Bank

The 5000+ branches, 15000+ ATMs we operate is a small touchpoint for our customers in 17 odd countries that we operate in. We are continuously on the lookout for innovative delivery channels to take our banking and financial products closer to our customers. We got quite a positive response for WhatsApp banking, voice banking on Amazon Alexa and Google Assistant that we launched recently. Likewise, the ICICIStack stack we launched earlier is a comprehensive digital banking service where 500+ common banking service are made available through APIs for consumption. All this is a part of the broader digital business strategy we have set for ourselves. Data center and cloud strategy is an essential part of this strategy. It is important that we execute this and meet the stringent security controls we have and adhere to the functionality and performance criterion we have set, before we go live with any new service. Today, we use services from nearly all the prominent public cloud providers.

State of infrastructure security

Safety in going granular

For infrastructure planners, it is important to stay abreast of the trends in IT infrastructure security to keep business secure. With the growth in threats, the available expertise to manage security hasn't kept pace. However, new tools, AI and automation are becoming available.

IT infrastructure is extended beyond on-premise, with the increasing usage of public cloud, IaaS, PaaS and SaaS. The architecture has also become complex with connectivity models, authentication mechanisms and exchange of confidential data across different entities.

For businesses, the key is to secure networks, workloads and users. However, if businesses want to minimize breaches, the model to follow is Zero Trust Security (ZTS). Unfortunately, not too many businesses are able to effectively implement ZTS.

ZTS is defined as the process to verify everyone and every device/system inside and outside a network before granting it access to IT assets. For this, irrespective of zone, segment, application, users or devices, security has to be embedded at a very high level of granularity.

ZTS is not a solution or a product but an approach. It has a framework and associated elements to achieve maturity. A typical approach to achieve ZTS is based on existing maturity, business needs and context to the organization.

The cybersecurity industry has started adopting the ZTS model, which always verifies and provides access to organizational resources based on the context, time of access, level of compliance, the user and device from where the access is initiated.

When organizations begin to adopt new security technologies and tools, it leads to the accumulation of a large set of tools that add complexities in the environment. These tools typically pose challenges like lack of interoperability, lack of a coherent view of the security posture, increased redundancy and duplication, inconsistent ways of managing the tools that lead to operations overheads, process inconsistencies, vendor management overhead and competency challenges.

These disparate sets of security tools need to go through the process of categorization of threats covered by them and then get mapped to the respective control. This then determines the coverage and cost of the security posture. Post this, the business can decide the relevance of these being part of the enterprise infrastructure.

Traditionally, security infrastructure is managed using a hierarchical support model, with engineers and Service Desk teams performing a pre-defined set of activities. They are responsible for the upkeep of the infrastructure, managing the devices, handling service requests and reporting service status as part of the regular review with stakeholders.
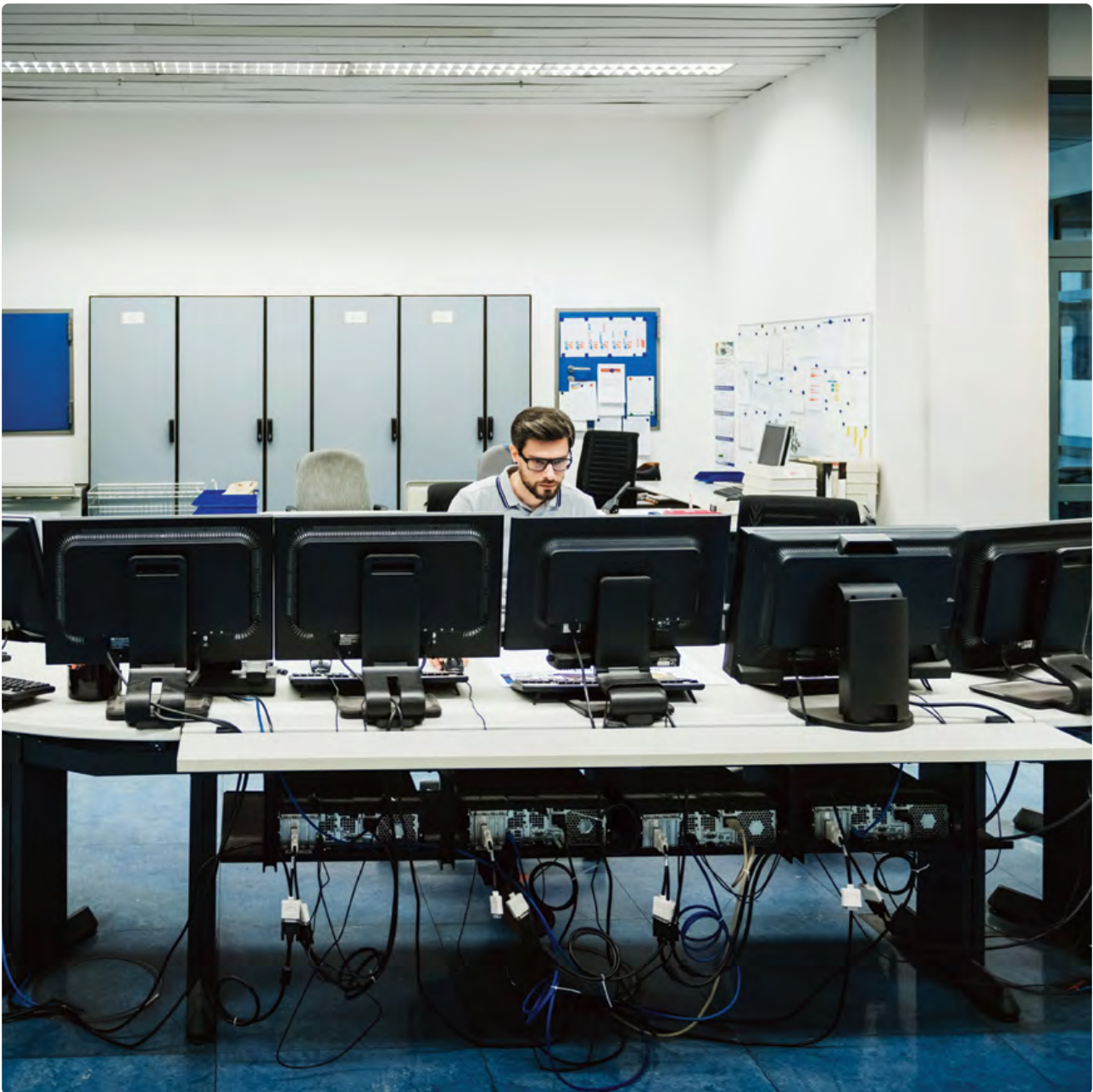
There are various commercial tools and platforms to monitor device availability or performance, scripts to automate generic tasks, along with service management platforms for ticket management and workflows in the operations process.

With the increase in number of security products and the associated complexity, enterprises and service providers have started using orchestrators and compliance management tools to reduce the effort of managing these products and to improve compliance of the infrastructure.

Organizations now need to focus on improving the "security hygiene" of the infrastructure and increase the visibility of infrastructure and associated service effectiveness.

The cybersecurity landscape and framework

With an increase in the infrastructure landscape, the threat can be from any layer—starting from the user end point to the network, the perimeter and can even be an internal threat. The cybersecurity scope has increased and starts from private cloud, public cloud or even the SaaS layer where mission-critical IT assets are located and extends to the data layer. Each layer has its own responsibility of protection. The scope of security varies from layer to layer (see Figure 89: Security layers: Scope of protection).

Figure 89: Security layers: Scope of protection

Mission-critical assets

Private cloud
openstack | Microsoft Azure | vmware

IT assets, workloads, applications, platforms

Public cloud
aws | Microsoft Azure | Google Cloud Platform

Workloads, applications, platforms

SaaS
app | box

SaaS applications, data

Enforce FW, vulnerability management, patch updates, automated policy, automated compliance, service visualization, virtual infrastructure, virtual appliances, virtual security, SaaS protection, storage services

Data security
Data classification, rights management, data integrity & monitoring, data/drive encryption, PKI, DLP, data wiping, data cleansing

Application security
DB Monitoring, application testing, code review, DLP, dynamic application testing, web application firewall, database secure shield

Endpoint security
Desktop firewall, host IDS, IPS, content security (AV, anti-malware), configuration compliance, patch management

Network security
Network IDS/IPS, DC FW, VoIP protection, virtual firewall, WebProxy, filtering, network access control, messaging security, wireless security, mobile security, enterprise remote access, DLP

Perimeter security
Advanced sensors, perimeter firewall, IDS, IPS, secure demilitarized zones, antivirus/anti-malware, application gateway firewall, physical security, DLP

WAN/internet | MPLS/private WAN | 3G/4G/LTE/5G | Wireless/broadband/Wi-Fi 6

WAN | SD-WAN | WAN | SD-WAN | WAN | SD-WAN

Branch offices | Plant locations | Headquarters & regional offices | Small offices | Remote offices | Roaming users

LAN | Users | Software-Defined LAN | LAN | Users | Software-Defined LAN | LAN | Users | Software-Defined LAN

Infrastructure and access layer

Policy management & governance layer

IT security governance, security architecture & design, configuration management, cyberthreat intelligence, security policies & compliance, technology roadmap & continuous improvement, vulnerability assessment, risk management, penetration testing, security awareness testing

Security operation and monitoring
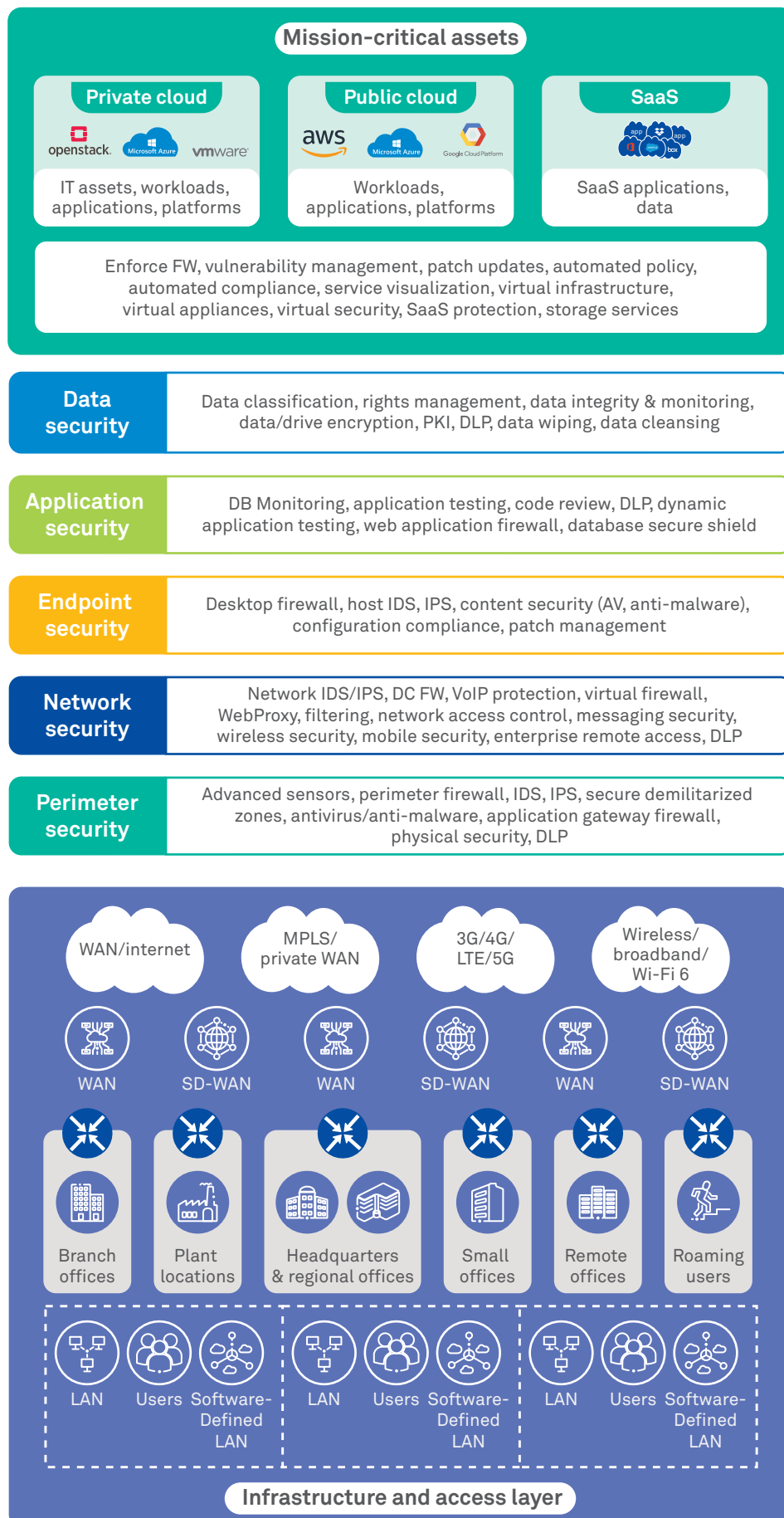
Incident detection & response, behavior anomaly analysis, escalation management, security dashboard, SIEM, situational awareness, continuous monitoring & assessment, security SLA & OLA reporting, forensic analysis

Security

●●●●○

With networks being transformed into software-defined security is tightly integrated with the network. Traditional methodologies of isolated, single-point security are changing to a distributed security model with ZTS becoming the norm.

Our State of IT Infrastructure survey 2020 showed that 10% of IT budgets were being allocated by responding organizations to the security of IT infrastructure (see Figure 90: What percentage of your organization's annual IT budget is allocated for the security of IT infrastructure?).

> **Q: What percentage of your organization's annual IT budget is allocated for the security of IT infrastructure (such as firewalls, load balancers, IDS, IPS, WLAN segmentation and Software-Defined Access)?**
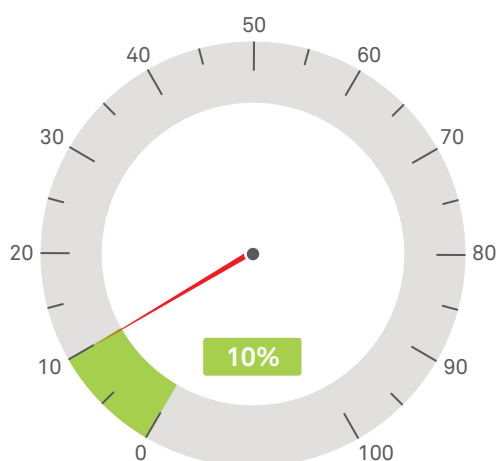
Figure 90

When security takes a large slice of the IT budget, it indicates the significant concerns businesses have around security. Our subsequent investigations also indicated many existing tools are being retired and replaced with new tools, even though this meant significant procurement cost.

Defense in depth

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There is a rise in sophisticated threats with new age malwares and ransomwares. These are bringing infrastructure and services to a halt, creating business impact.

There are several instances of cybercriminals being ahead of cybersecurity practitioners to identify vulnerabilities in a program or OS. This is because malwares are being enabled with ML and AI features to gauge the defense and ensure success of the attack. Malwares use AI to stay undetected, evade the defense mechanism and infect the end points.

Product vendors are innovating with methods and tools to protect infrastructure. Organizations have started deploying them, resulting in a stack of tools—probably with considerable duplication in what each tool does.

It is obvious that there is no silver bullet which can offer protection from all types of attacks. Thus, an in depth approach to defense is necessary, using security controls with specific purpose. This begins with identifying controls based on the sophistication and complexity of the threat.

Usually, businesses can be assessed for tools based on controls that can be added in order to enhance the maturity of existing tools. Here, the basic controls are simple and fast, designed to handle high volumes; the complex set of security controls need more maturity to be effective. The defense in depth consists of all these controls in a manner where each of them works in specific areas and forwards the issue to the next control.

In case a control fails to protect, the next set of controls with a different mechanism is engaged to mitigate the threat.

This approach provides complete visibility into infrastructure with multiple gateway points established to protect infrastructure from known and unknown threats, slowing down the movement of attackers or reducing the impact of the attack.

We asked respondents in our survey to pinpoint the areas in their infrastructure that were the most vulnerable to threats (see Figure 91: Which areas in your IT infrastructure have the highest vulnerability?). End points and edge devices/remote sites were the biggest concern. This is natural as security has traditionally focused itself on creating a perimeter around the organization, but today's digital organizations are extending beyond the traditional boundaries.

Q: Which areas in your IT infrastructure have the highest vulnerability?

End points | Edge/remote sites | Public cloud (IaaS and PaaS) | Private cloud | IoT and similar devices | New ecosystem partners
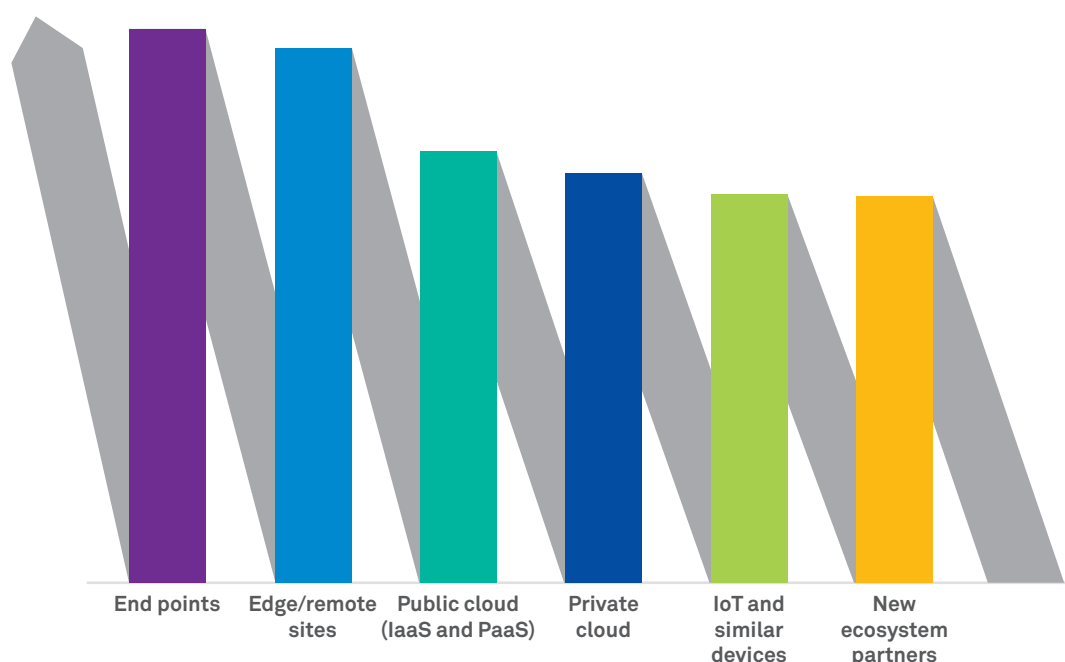
Figure 91

This brings us to discussing the importance of Security Operations Center (SOC). A SOC has the function of monitoring, enforcing and maintaining security across IT infrastructure. The high-level scope of a typical SOC should include:

• Security monitoring

• Vulnerability management

• Information protection

• Compliance and isolation (including segmentation and microsegmentation)

• Identity and Access Management

• Security lifecycle management

• Security patch management

Regulation and compliance
●●●●●

Planners of global business are required to keep track of regulations, enable efficient regulatory change management, and better data governance and regulatory reporting. Businesses have also become more demanding on IT infrastructure teams on SLAs and controls. It is a complex balancing act to manage the explosive data growth in this scenario and address questions such as "where is the data maintained, where is it processed, how is it encrypted, what is its durability and who has access to it?"

To understand the considerations that go into addressing those questions, we asked the

respondents in our survey what regulatory compliance affects them the most in undertaking transformation (see Figure 92). We learnt that the

GDPR initiated by EU and other similar laws in China, Thailand, Brazil, New Zealand, Japan, and India are keeping planners busy today.

Q: What regulatory compliance affects you most in undertaking transformation to realize full digital capability?

Geo specific statutory regulations **(75%)**
Organizational policies **(64%)**
Industry-specific compliance **(58%)**
Contracts and agreements **(53%)**
Standard adherence requirements **(44%)**
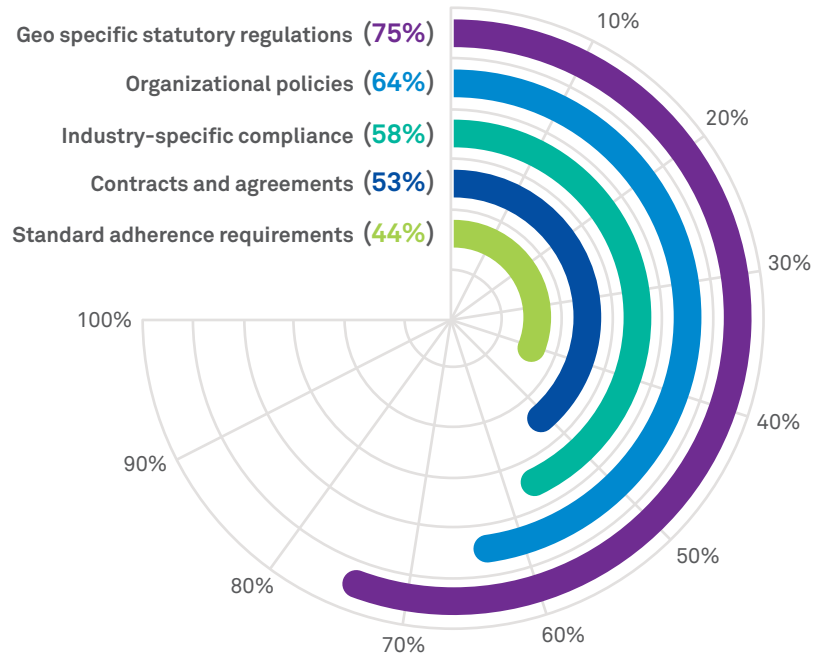
Respondents were asked to choose multiple response options

Figure 92

Change and transformation

Setting the stage for digital

A transparent infrastructure means frictionless operations for the application developers who consume the infrastructure. In turn, this makes it possible for businesses to respond quickly to changing conditions and trends. Due to the inherent inter-dependencies, many believe IT infrastructure is laden with rigid technologies and inflexible operating models—which pose a handicap to the digital capability goals of the business.

The ability to achieve transparent infrastructure is becoming an imminent priority. There is a growing realization among IT planners to achieve "invisible infrastructure" where everything, from bare metal to MPLS, and from desktops/laptops to Unified Communications (UC) move into the dimensions of cloud, SaaS, BYOD, SD-WAN and UCaaS, etc. A typical journey of transformation to an invisible infrastructure goes through multiple steps, leading to the destination of frictionless operations and a firm foundation of genuine digital capabilities (see Figure 93: Journey towards an invisible infrastructure).

As technology rapidly advances and disruptive trends emerge, the path to an invisible infrastructure is naturally eased out. The onus is now on the IT owners to leverage the new breed of technologies as they mature. Simultaneously, it becomes crucial to consolidate, standardize and rationalize existing infrastructures in order to achieve a state of invisible infrastructure. On

A typical journey of transformation to an invisible infrastructure goes through multiple steps, leading to the destination of frictionless operations and a firm foundation of genuine digital capabilities.

the other hand, many organizations that continue to follow a cost take-out initiative, want to push the boundaries of technology transformation – they feel that without transformation further cost reductions are difficult.

The key advantage of an invisible infrastructure is the ability to simplify and standardize, with reduced costs and risks a result of scalable architecture. Organizations can enjoy greater efficiency and focus resources on business innovation, delivering value-added services and enhancing end-user experiences.

With agility and improved functionality at its core, IT infrastructure transformation provides a boost

to performance, thus enabling organizations to sustain a competitive edge in a digital marketplace. It is therefore now imperative to recognize the significant role that IT plays as an ideal partner for facilitating and supporting business transformation and enabling business growth.
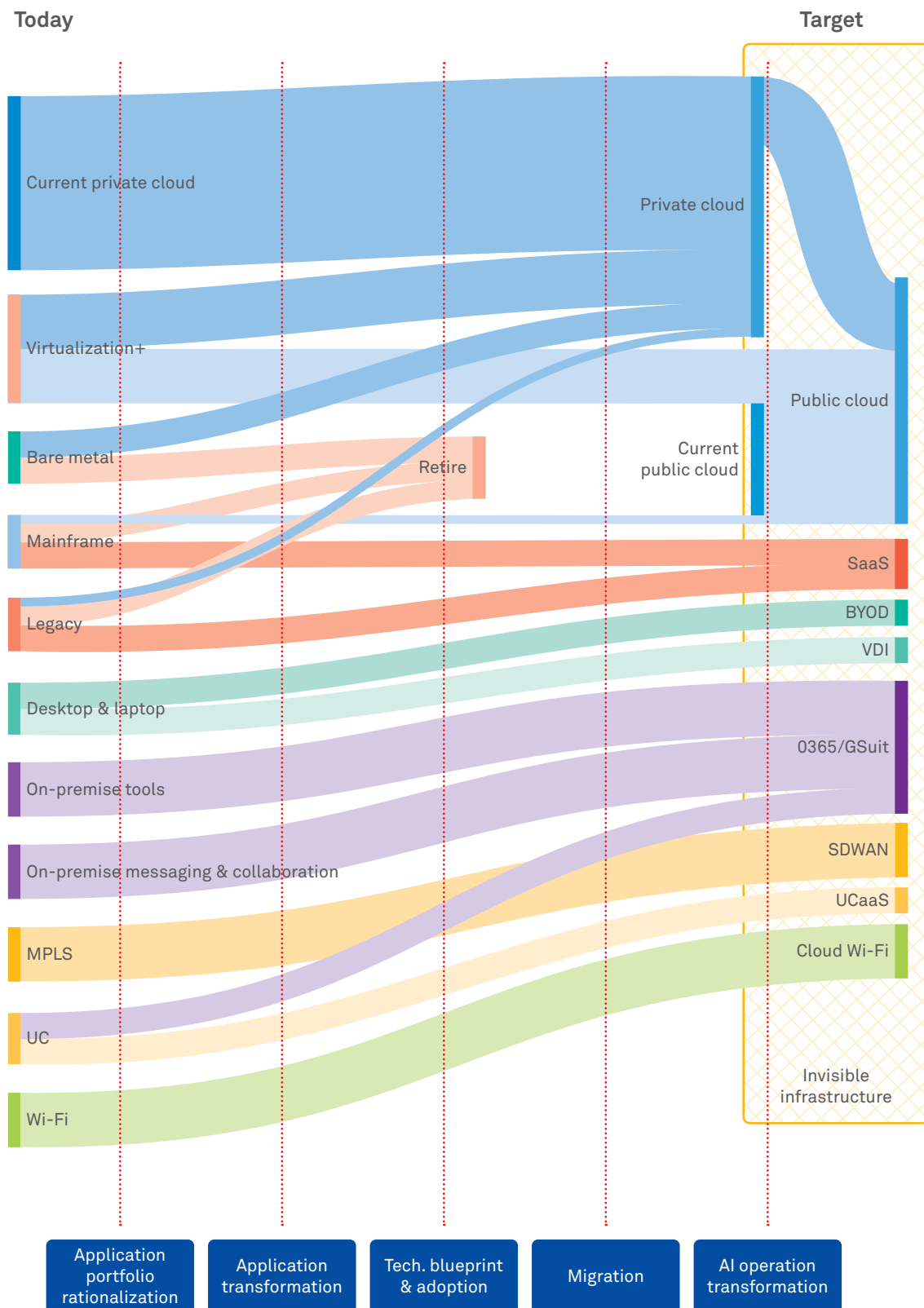

Figure 93: Journey towards an invisible infrastructure

Infrastructure Quality Assurance

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Testing is a practice to be undertaken when applications are provisioned or redeployed over a new system or when there is a significantly large change in the environment. Infrastructure testing provides an assurance for the underlying application runtime, providing the assurance for scalability, performance and availability with an integrated approach. Testing ensures a reliable and robust environment for business-critical applications and ultimately delivers the performance, speed and user experience expected from embracing digital transformation.

With digital services directly dependent on IT, testing is an essential part of transformation projects. However, testing applications alone will not weed out the deficiencies of the underlying architecture. The ever-increasing complexity of IT demands a holistic approach for end-to-end testing of the infrastructure coupled with an integrated process.

Infrastructure testing at an overall level guarantees the following:

- Improved quality of service

- Reduction in incidents caused by change

- Compliance to agreed SLAs and reduced operational risks

- Improved user experience

- Reduced cyber-attacks and increased compliance levels

- Reduction in downtime and rework cost

- Assurance that services function in a managed and controlled process

In order to understand the on-ground approach to testing, we asked respondents in our State of IT Infrastructure survey 2020 the scenarios that prompted testing in their businesses (see Figure 94: For which scenarios does your organization conduct infrastructure Quality Testing?). As expected, transformation and newly built systems were the #1 reason for testing (76%). Hardware migration,

Q: For which scenarios does your organization conduct infrastructure quality testing?

Scenario	Value
Transformation/newly built systems	76%
Hardware migration	71%
Patching	71%
New application roll outs	71%
Software migration	58%
Version upgrades	58%
None of the above	8%
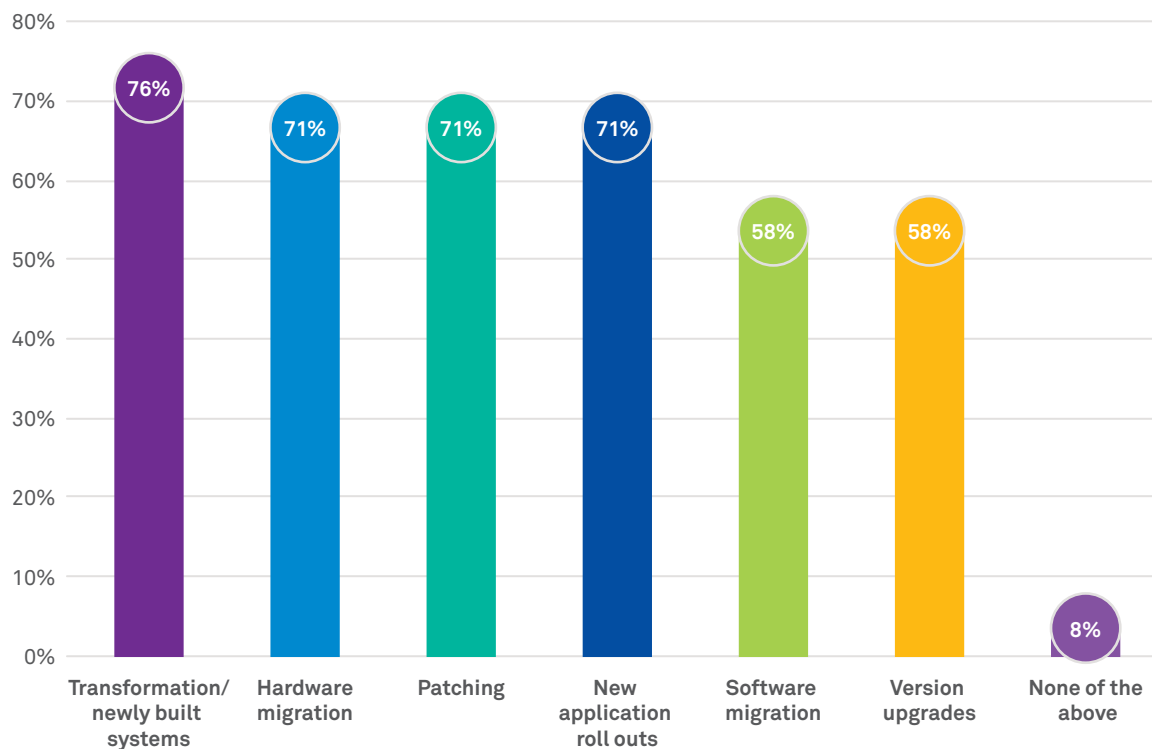
Respondents were asked to choose multiple response options

Figure 94

patching and new application rollouts came next (71% each). Hardware migration, required largely when systems either reach their end-of-life, when businesses require additional capacity or systems can't be upgraded for newer functionality, will become a focal point in the months to come as the new breed of always-on, real-time, AI-driven, IoT-dependent applications become more demanding.

Impediments to future state adoption

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The benefits of digital-ready IT infrastructure are well understood. And yet, there are businesses that are falling behind in their efforts to reach a future state of infrastructure. We wanted to know what impedes progress despite the availability of technology and the demands placed by a digital-native workforce. Our survey revealed that the lack of an overall digital strategy (64%) and the cost of transformation (64%) were the biggest barriers (see Figure 95: What are the challenges you face in transforming the infrastructure to a fully digital-ready infrastructure?). Organizational structures and legacy partners (58%) are also hindrances but we expect these will reduce rapidly as the promise of digitalization turns into visible reality across industry ecosystems.

Q: What are the challenges you face in transforming the infrastructure to a fully digital-ready infrastructure?

Challenges faced

Internal resistance
36%

Lack of an overall digitization strategy
64%

Lack of skills
44%

Organizational structure, legacy partners
58%

Cost of transformation
64%

Respondents were asked to choose multiple response options
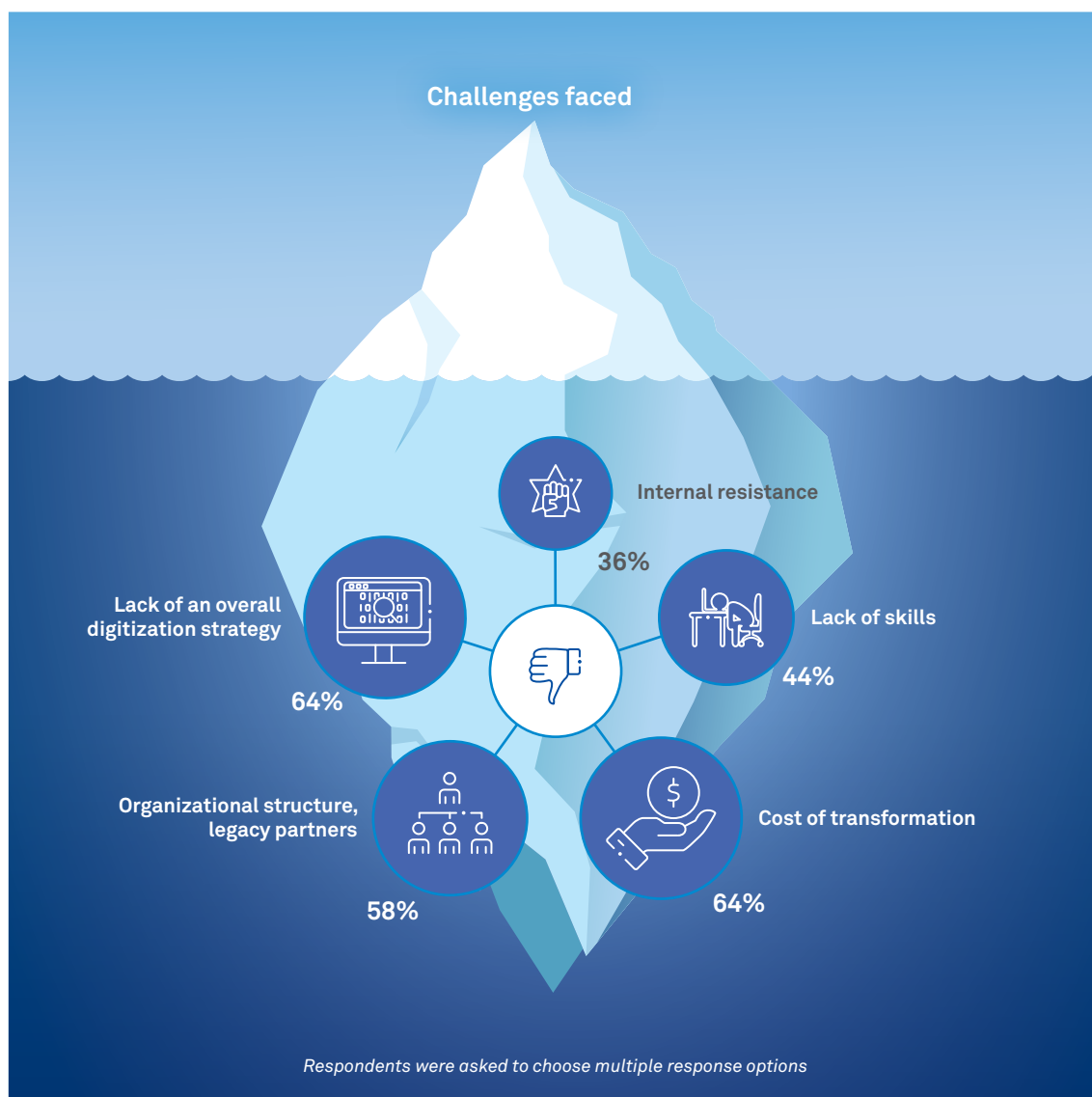
Figure 95

Transformation areas

Gone are the days of having multi-year infrastructure transformation projects. Those projects evoked anxiety and apprehension as in most cases the demand of business changed by the time the solution was implemented. A strong project portfolio management practice combined with a tried and tested approach is the way forward to timely and successful transformation (see Figure 96: Top transformation projects impacting infrastructure).
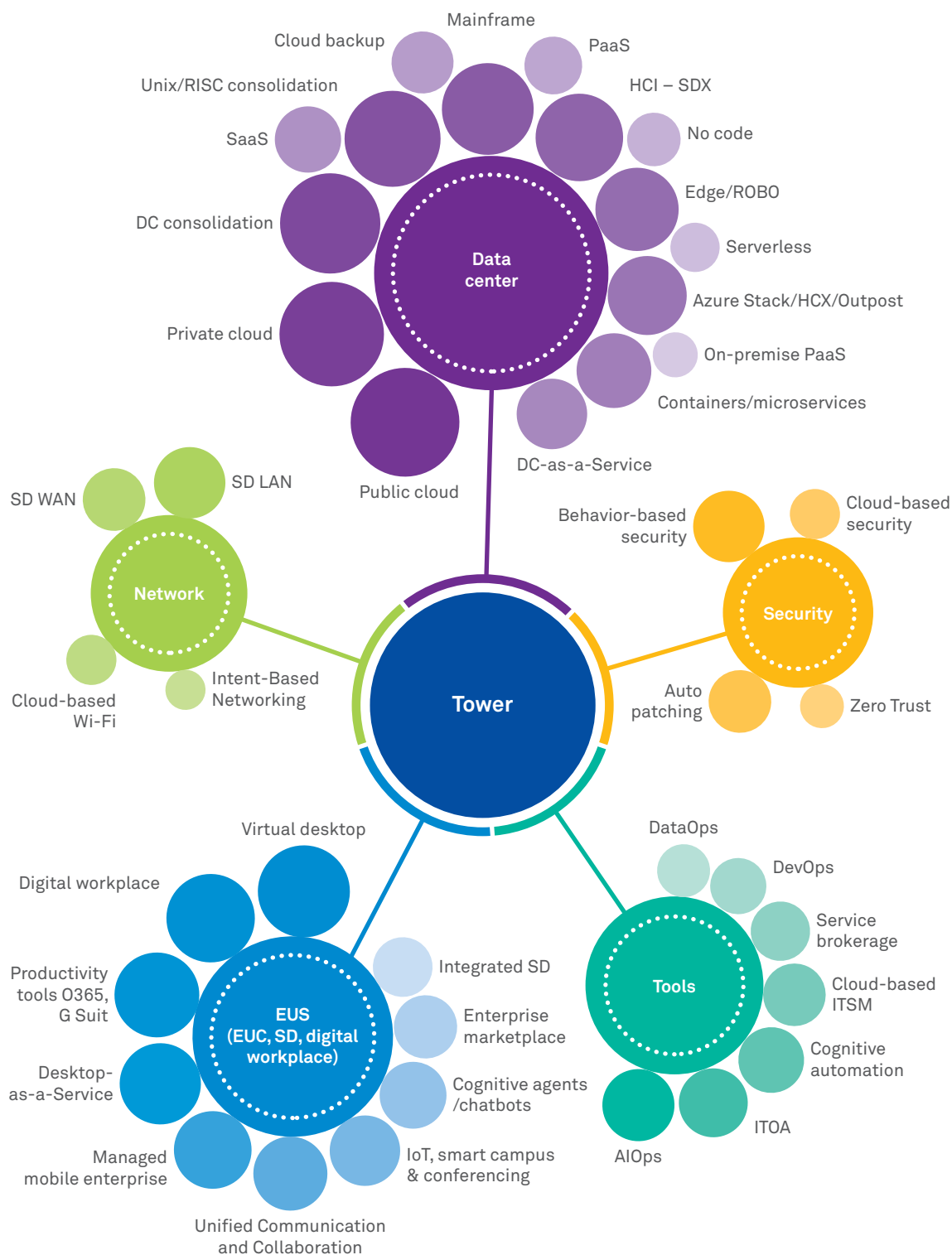

Figure 96: Top transformation projects impacting infrastructure

Transformation approach
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In essence, IT infrastructure transformation implies two types of transformation: the first is transformation of operational and productivity applications across functions such as email, messaging and collaboration; the second is domain-specific applications that require re-platforming and redevelopment or the adoption of a SaaS approach to take advantage of new technologies, data and processes. The

transformation involves an element of risk; it needs a flexible mindset; and demands a major buy-in from the workforce. This is perhaps why our survey results indicated that a majority of businesses prefer to completely drive the transformation in-house (43%). A slightly lower number said they had transformation embedded into their outsourcing contract (41%). These organizations, it would appear, are more confident of their outsourcing partners and the processes that govern the transformation (see Figure 97: What best describes your infrastructure transformation approach?).

Q: What best describes your infrastructure transformation approach?

- 43% Driven completely in-house
- 41% Transformation embedded into outsourcing contract
- 16% Engaged external consultant to drive transformations
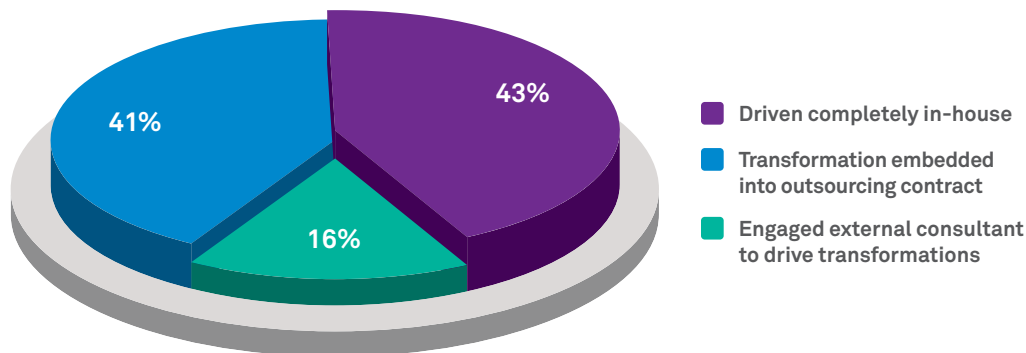
Figure 97

Continuous improvements
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There are several internal and external factors that affect the performance of IT systems and continuous proactive improvement has become imperative in today's IT world to ensure we avoid risk from hidden problems in the technical and non-technical aspects of an environment. A comprehensive evaluation through analysis of an IT environment is required before the environment is assured against risks. The fishbone diagram (see Figure 98: Proactive approach: Key parameters for evaluation) shows each component in IT infrastructure that needs an audit or self-assessment exercise.

- **Architecture** of the solution and its building blocks
  - » **Choice of technology:** Due to the volatile nature of the ecosystem a choice of technology at the time of a solution

deployment need not be right after a few years

  - » **Currency of components:** Over the years, a piece of technology can become obsolete exposing risk
  - » **Solution design:** A piece of solution can be integrated and deployed in many ways, there can be many boundary conditions in designs

- **Usage -** the requirement captured to build the solution
  - » **Application fitment:** Due to change in the application requirements the underlying infrastructure can be subjected to stress and performance strains
  - » **Service levels:** With changing criticality of applications, suitable alignment of infrastructure is required to meet the service-level obligation
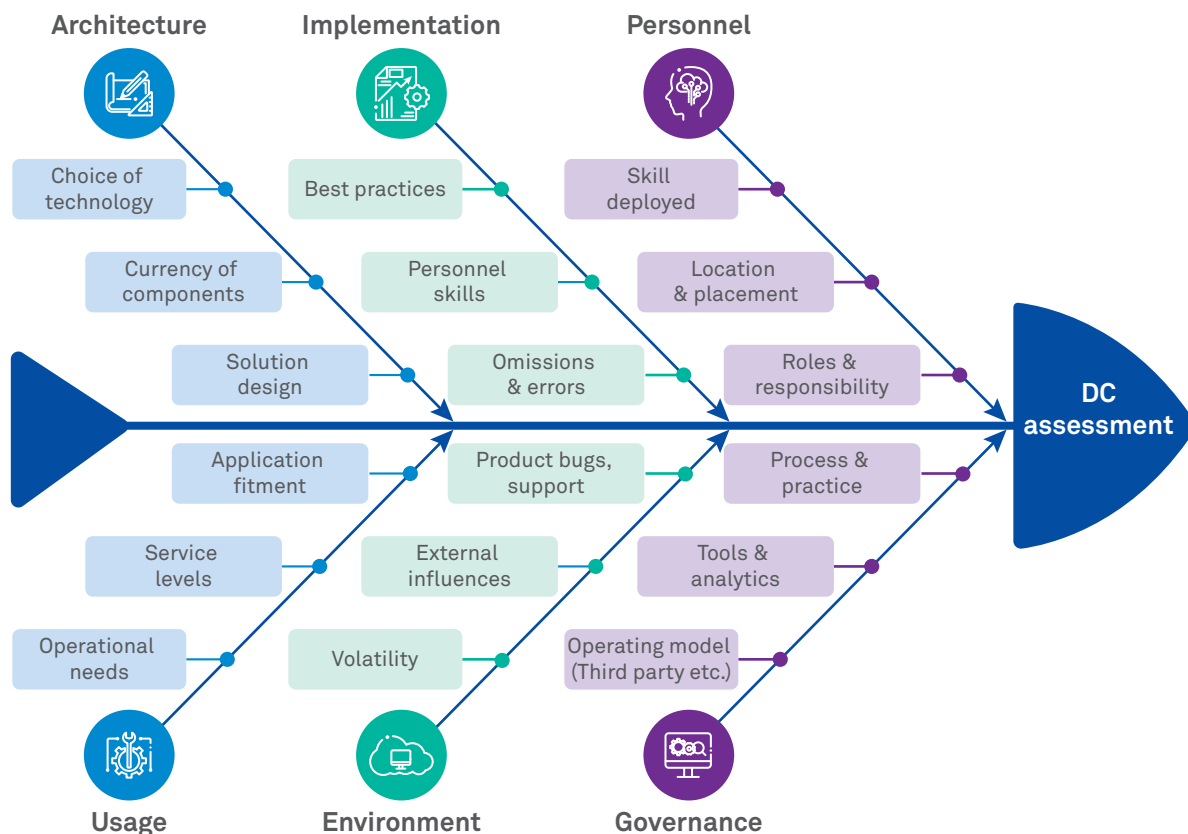
Figure 98: Proactive approach: Key parameters for evaluation

» **Operational needs:** Every piece of technology has operational needs like maintenance window, patching, etc. It's not unusual to find that this gets overlooked with time

• **Implementation** or how the team went about the solution build

» **Best practices:** The application of best practice in implementation including documentation, certification is crucial for long-term stability

» **Personnel skills:** Employing the right experts in implementation is the path to assured performance

» **Omissions and errors:** Possible omission in enabling critical features can impact critical operations when specific features are needed

• **Environment** in current production/operations

» **Product bugs, support:** Known errors and documented bug are not addressed

» **External influences:** Some dependent prerequisites that have an indirect impact on performance, like hosting environment

» **Volatility:** External situation is triggering operating conditions that the product is not designed for

• **Personnel** who manage the operations

» **Skills deployed:** Lack of adequate expertise for day-to-day operations

» **Location and placement:** The placement of resources due to techno commercial reason is not suitable for the operational requirements

» **Roles and responsibility:** Adequate roles and controls are in place for decision making and segregation of responsibilities

• **Governance** for hidden impact

» **Process and practice:** The process and practices are governed in a standardized process without islands of excellence

» **Tools and analytics:** There is adequate investment in tools for monitoring and management

» **Operating model (Third party etc.):** Suitable warranty or AMC at adequate SLA level exists

State of IT Infrastructure – an industry view

Industry outlook: The inside track of IT infrastructure

In several industries, IT infrastructure is still regarded as a commodity. While provisioning of servers and monitoring of applications has been largely commoditized, the smarter businesses are using their IT infrastructure to create value, raise the competitive bar, and ensure top notch customer and employee experience. It will herald the onset of deep transformation in the way IT infrastructure is managed.

Here, we provide snapshots into the strategies and focus that are allowing the Banking, Manufacturing, Consumer Services and Energy and Utilities industries build value through their IT infrastructure. These industries are addressing distinctive industry-specific challenges related to markets, products/services, customers, operational efficiencies and business models. But the snapshots go a little beyond narrating their industry-specific business stories and provide us with cues to the trends of interest within our own industries.

As an example, the need for workforce transformation is most urgent in the Consumer Services and the Energy & Utilities industries (100%) followed by Banking (93%). These three industries will provide us with answers to some of the deepest challenges that will crop up when workforce transformation acquires urgency in industries such as Travel and Transport, Retail, Engineering and Construction, etc.

IT infrastructure specialists will also be interested in the AIOps adoption in the Energy & Utilities industries—33% respondents in our survey said they had adopted AIOps in some areas and another 67% had pilots. Consumer Services were showing interest in AIOps (50% had pilots). Large enterprises, keen to use AIOps tools to combine data, AI and Machine Learning to enhance their IT operations, availability, monitoring and service management capabilities, will do well to see how Energy & Utilities and Consumer Services progress with their test cases. AIOps will, in the post COVID-19 period, quickly attract more

attention. Enterprises will want to leverage it to avoid outages, automate service assurance and become zero-incidence enterprises. Analysts are already bullish about AIOps (30% of enterprises are expected to use AIOps by 2023 compared to 5% in 2018[xvi]). Integrating AI and IT Ops will become a pivotal element in fusing IT and business more snugly to prevent outages, achieve business goals and deliver exceptional customer experience.

Similarly, 75% of manufacturers have adopted SDx, infusing intelligence into their infrastructure. Banking and manufacturing are leading with investments in edge computing. Keep an eye out for developments in these industries if SDx or edge computing are going to appear on your IT infrastructure agenda (as they inevitably will).

On the other hand, it is interesting to see that 56% of the Manufacturing industry has explored crowdsourcing and hasn't found it relevant. In the Energy and Utilities industry, 100% plan to leverage crowdsourcing for testing (or design and planning), while 45% in Banking and Consumer Services say they will use crowdsourcing for infrastructure testing. What is manufacturing missing? Can it gain from the knowledge spill over from industries that are keen on crowdsourcing?

Knowledge always spills over. Models can be repurposed. Ideas can be redeployed. Uber presents us with a compelling case of how knowledge, technology and models from one industry can be adopted by another. There are many businesses—unrelated to hailing a ride— that have been "uberized". Farming communities are benefiting from the Uber model by gaining access to equipment on a pay-as-you-go basis along with agricultural specialists providing farm operations as a service. Even the baby-sitting business has been uberized![xvii]

IT infrastructure professionals have much to gain from observing trends and practices in other industries. They can use those ideas to innovate in their own business context. The next four pages provide you with a map to decide what you want to put on your IT infrastructure watch list!

Technology focus

Top 3 areas
› Digital business
› AI
› Application optimization and modernization

Edge computing

43%

Likely implementation in 6-12 months

Storage scenario

69%

respondents predict increase for

program data, configuration information

AIOps

15%

AIOps implemented

31%

Pilot
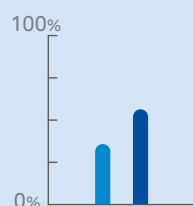
Crowdsourcing

45%

respondents see interest area in

infrastructure testing

Banking

IT delivery model

100%

0%

35%
Mainly in-house but with resources hired on T&M basis

53%
Mainly outsourced in managed service model

Spend forecast

78%
respondents predict increase

for data center and cloud

SDX adoption

58%

SD-WAN

Workload distribution

100%

0%
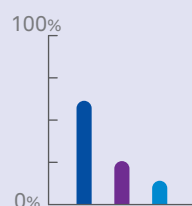
61%
Private cloud/ virtualization

25%
Physical hardware

14%
Public cloud (IaaS and PaaS)

Security breaches

More than

90%

reported less than 5 incidents in last 3 years

Addressing workforce transformation

93%

Re-skilling existing workforce

BCP/DR

57%
Meets current RPO/RTO

43%
Partially meets current RPO/RTO

Technology focus

Top 3 areas
› Application optimization and modernization
› Digital business
› Business-driven, agile solutions

Edge computing

40%

Likely implementation in 6-12 months

Storage scenario

30%
respondents predict increase for

RDBMS, unstructured data, logs

AIOps

60%
No AIOps implemented

40%
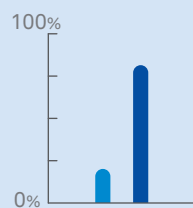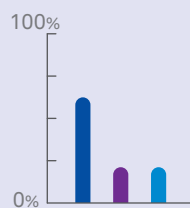Pilot

Crowdsourcing

56%
respondents

explored and found not relevant for IT operations

Manufacturing

IT delivery model

100%

0%

20%
Mainly in-house but with resources hired on T&M basis

80%
Mainly outsourced in managed service model

Spend forecast

80%
respondents predict increase

for data center and cloud

SDX adoption

75%

SD-WAN

Workload distribution

100%

0%

62%
Private cloud/ virtualization

19%
Physical hardware

19%
Public cloud (IaaS and PaaS)

Security breaches

80%

reported less than 5 incidents in last 3 years

Addressing workforce transformation

80%

Increase outsourcing with existing and new partners

BCP/DR

40%
Meets current RPO/RTO

60%
Partially meets current RPO/RTO

Technology focus

Top 3 areas
› Business-driven, agile solutions
› Application optimization and modernization
› Digital business

Edge computing

17%

Likely implementation in next 6 months

Storage scenario

59%
respondents predict increase for

RDBMS, logs, unstructured, miscellaneous

AIOps

50%
No AIOps implemented

50%
Pilot
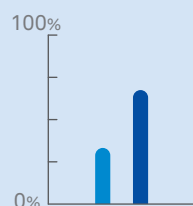
Crowdsourcing

40%
respondents see interest area in

infrastructure testing need

Consumer Services

IT delivery model

100%

0%

33%
All services are owned in-house but with resources hired on T&M basis

················

67%
Mainly outsourced in managed service model

Spend forecast

86%
respondents predict increase

for data center and cloud

SDX adoption

60%

SD-WAN

Workload distribution

100%

0%
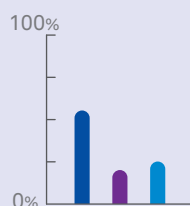
55%
Private cloud/ virtualization

··················

20%
Physical hardware

··················

25%
Public cloud (IaaS and PaaS)

Security breaches

17%

reported 0 incidents in last 3 years

Addressing workforce transformation

100%

Re-skilling existing workforce

BCP/DR

33%
Meets current RPO/RTO

··················

33%
Partially meets current RPO/RTO

··················

34%
Infrastructure deployed does not meet RPO/RTO

Technology focus

Top 3 areas
› Business-driven, agile solutions
› Application optimization and modernization
› AI

Edge computing

33%

Likely implementation in 6-12 months

Storage scenario

67%
respondents predict increase for

RDBMS, logs, miscellaneous

AIOps

33%
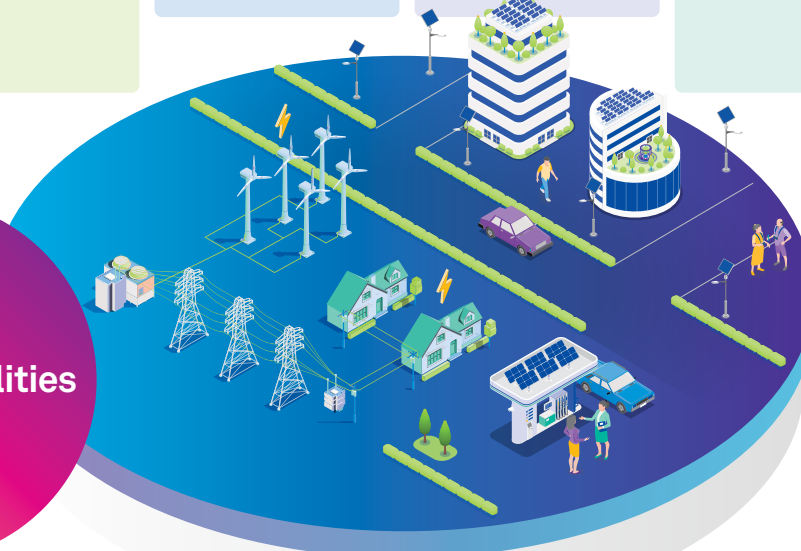AIOps in some areas

67%
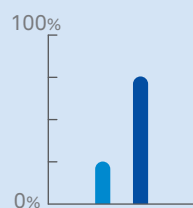Pilot

Crowdsourcing

100%
respondents see interest area in

infrastructure testing, design and planning needs

Energy and Utilities

IT delivery model

100%

0%

25%
Outsourced as outcome sourced model

75%
Mainly outsourced in managed service model

Spend forecast

75%
respondents predict increase

for data center and cloud & software and tools

SDX adoption

50%

Block storage network-LAN security

Workload distribution

100%

0%
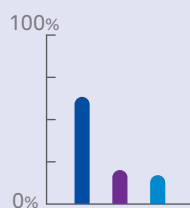
63%
Private cloud/ virtualization

20%
Physical hardware

17%
Public cloud (IaaS and PaaS)

Security breaches

33%

reported 0 incidents in last 3 years

Addressing workforce transformation

100%

Re-skilling existing workforce

BCP/DR

33%
Meets current RPO/RTO

67%
Partially meets current RPO/RTO

Appendix

Remote working during pandemics - Note from Wipro CIO

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How a virus is changing the responsibilities of the IT infrastructure team

The outbreak of the global COVID-19 (novel coronavirus) pandemic will promote remote working more than anything else ever has in the past.

The need to ensure employee safety against the COVID-19 virus is forcing businesses across the world to down shutters and close their doors. Now, the only way to ensure business continuity is by supporting employees with the training, hardware, tools, connectivity, compliance/security, and support necessary to work from home (WFH).

Practically every organization already has a well-defined and established remote working policy, thanks to the proliferation of smartphones and reliable networks. The challenge today is to scale this up to where a distributed workforce practically becomes the default operating model, keeping the workforce safe, lowering costs, and improving employee productivity. The challenge emanates from having invested decades in fine-tuning Disaster Recovery and Business Continuity Planning, and not enough in WFH.

Every industry cannot hope to implement 100% WFH for every role. The mix of WFH and on-site will vary from industry to industry. However, if there is at least one certain outcome of COVID-19, it is the permanent shift it will bring in work arrangements.

Change indicators

Businesses that implement effective WFH measures will experience two distinct shifts. One, employees will not want to return to office once the threat levels from COVID-19 are reduced and restrictions are lifted; and, two, businesses will have witnessed higher levels of efficiency enabled by WFH.

Organizations are already putting their plans for mobility, collaboration tools, and security controls to enable WFH in accelerated mode. One clear indication of the trend is the rise in stocks of

collaboration products. In March 2020, barely a few weeks after COVID-19 placed the world in a state of complete lockdown, Zoom Video Communication stocks grew 275% while the Dow Jones went into a tailspin, falling 33% from the previous month's high.* Zoom is one of several providers of online meeting and collaboration tools.

The transition to enable and manage remote working at scale is as urgent as it is daunting. However, the right processes, technology and infrastructure can make it simpler. Staying on top of WFH requirements at scale is a relatively new skill that IT infrastructure teams will need to master.

Six key aspects of WFH that need attention

- **Providing hardware/devices and reliable connectivity:** Employees must be provided laptops, desktops, tablets, etc., along with data cards/modems/routers and other devices to enable work. Based on user roles and profiles, these devices must provide access (if necessary, via VPN or virtualized desktops) to enterprise, Line of Business and partner applications, data, collaboration and communication tools over a reliable and always-on network.

- **User Identity and Access Management:** To ensure complete security, every remote user must be verified and authenticated. To access enterprise systems, users must be synced with Active Directory, a device manager should check device credentials, authorized IPs, and initiate two-step multi-factor authentication, where necessary. Where security is of paramount importance, biometric authentication (voice, fingerprint, face scan) is also recommended.

- **Device management:** The IT infrastructure team must be able to manage all end-point devices remotely. A vast number of end-point management solutions are available that ensure user software and virtual enterprise desktop image is updated, patches are installed and compliance objectives are met. Managing devices can become complex when employees must use

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* https://www.investors.com/research/breakout-stocks-technical-analysis/zoom-stock-ipo-leads-coronavirus-stock-market/

the same hardware to access enterprise systems and partner/customer systems. The two may often have differing and overlapping identity management, access, security and compliance processes. Device management solutions may also come bundled with vulnerability management and governance tools.

- **Productivity and collaboration applications:** WFH presents unique challenges to employees who need secure storage and backup solutions, calendars, collaboration tools that allow online voice/video meetings, sharing of content and presentations, communication tools/ Instant Messaging and workflow management applications. Most users are already familiar with tools like Dropbox, Slack, Twitter, Zoom, Skype, WeTransfer, and WhatsApp. Integrating with these makes adoption faster and simpler. One of the bigger challenges before IT infrastructure teams is to customize the tools for WFH employees. For example, can the online meeting application have ice breakers that can be used by teams? Can it reflect the enterprise environment and ethos using business logos and colors? Can the virtual rooms be customized for an immersive experience? Can engagement be measured? At the moment, there are very few such tools available but more will become available as the importance of customization becomes evident in a growing WFH culture.

- **Service monitoring and support:** With a vast number of employees accessing systems remotely, loads on networks will grow. It will, therefore, become important to set up new service monitoring and support systems that use AI and real-time analytics to flag events before they occur and impact users. To ensure that users can quickly restore services, self-help, self-healing, and intelligent voice-based assistants need to be used to supplement human assistance.

- **Sensitizing employees and preparing their families:** WFH will be welcomed by most of the workforce. However, they and their families must be sensitized towards the need for discipline and an extraordinary attention must be brought to mental wellbeing. Working without colleagues to lean on and talk to for support can make employees feel disconnected and lost. A full-fledged program designed to provide tips and tricks to work from home is essential.

This should include topics such as maintaining a work schedule, structuring the work day, committing to deliver and staying accountable, online meeting etiquette, being available online to colleagues, maintaining the tools required for effective WFH (microphone, camera, monitor, desk/chair, ambient lighting, managing noise levels, etc.) and taking regular breaks and following exercise routines.

Quick-fix solution

Since most businesses are not designed to respond to such extreme events such as COVID-19, it may help to use simple processes to set up WFH environments that leverage existing investments. Setting up robust Virtual Desktop Infrastructure—acquiring hardware, installing VDI software, creating and deploying virtual desktop images—often requires weeks of planning and implementation. This is not a practical time frame for emergencies triggered by events like COVID-19 and the scale on which businesses need to respond. In such instances, the solution is to set up a connection server and use something like VMware Unified Access Gateway (UAG). The connection server allows the IT team to list which users may connect to physical PC/system within the office premises. The UAG provides security from outside the firewall to the PC and other resources within the business.

A better future for WFH

In the coming months, private 5G networks will resolve many issues that hinder WFH programs. While the fact remains that private 5G networks are expensive, new models are emerging across the world, offering cloud-based services combined with secure high-speed networks. As new partnerships spring up between technology companies like Amazon and Verizon, Microsoft and AT&T[**], we will see joint offerings that allow businesses to lease 5G networks with compute, storage, hosted applications and security starting from WFH devices to across the network and the hosted infrastructure. These partnerships will provide committed SLAs, management, support, dashboards, and a ready-to-use catalog of services mimicking an IaaS model.

[**] https://www.bloomberg.com/news/articles/2019-12-03/amazon-verizon-partner-to-push-computing-to-millions-of-devices

An enterprise checklist for effective WFH

Businesses must decide how the burden of WFH is shared between the business and the employee, remembering that WFH results in considerably lowering real-estate costs, utility expenses, management overheads, and sundry responsibilities.

#	Requirement	Implications, justifications, and benefits
1.	Stable, uninterrupted power supply	Many homes do not have reliable power supply; provisioning a UPS circumvents disruptions
2.	An always-on wired/wireless network	Essential for seamless operations and collaboration
3.	Trusted connectivity and access to enterprise networks, applications, data, systems, and services	Essential for customer trust, business security, and compliance objectives
4.	Noise-free environment	Critical to stress-free productivity
5.	Ergonomic furniture	Central to employee wellbeing and productivity
6.	Hardened desktop/device	DRM solutions must be implemented
7.	Self-service and provisioning automation	Enabling services include one-click hardening, software installation, etc., to reduce the need for IT support
8.	Digital collaboration, time management, communication, and productivity tools	Employees must be trained in using new tools and managing processes that record work and interactions
9.	Shoulder tap and break fix support	Adopting best-in-class approaches such as automation, self-service, self-healing, bots, and voice-based support to ensure productivity and employee satisfaction
10.	Printer and photocopy facilities	Some roles may require provisioning printer, photocopy and consumables; in all other instances, the business must go completely paperless
11.	Office access and time tracking	Existing norms must be relaxed and policies modified
12.	Service classification and user personas	To create the ability to map needs, determine capacity and availability of systems and services
13.	Capacity planning and infrastructure	Business should be able to scale capacity and infrastructure based on changing requirements
14.	Access to trusted crowdsourcing ecosystem	This would help improve the ROI for WFH programs as employees will become more productive and innovative
15.	Re-assessment of DR and BCP policies	The new policies should be pre-approved by the CISO/CXO and could be based on user persona or service classification
16.	Driving cultural change and expectations	WFH could cause a sub-set of employees reducing focus on work, missing delivery timelines, and avoiding commitments; this could be for a variety of reasons that need to be explained to employees, monitored and followed up with corrective action

Table I

Methodology and demographics

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The "State of IT Infrastructure 2020" report is based on primary and secondary research conducted by Wipro. It also uses the accumulated expertise of over three decades acquired from delivering IT infrastructure services and innovations to global business leaders. This report is meant to serve as guidance for those mandated to provide IT infrastructure in a fast-changing business and technological environment.

We conducted a survey to understand how industries across the world were adjusting their approach to IT Infrastructure and the practices they were adopting for a world where digital technologies are pervasive. The survey gives

stakeholders and geos unbiased representation and uncovers strategies and insights using analysis to provide the reader with a neutral point of view.

The online survey was conducted in December 2019–January 2020 for a period of one month using a detailed questionnaire. The results of the survey were analyzed and the insights have been interpreted, explained and contextualized by our team of domain experts.

Respondents to the online survey included IT Managers (46%), IT Directors (33%), Senior VPs, Vice Presidents, Assistant Vice Presidents (6%) and CEOs, CIOs, CTOs and COOs (3%), and others(12%).

Role of respondents

46%
Manager IT

33%
Director IT

3%
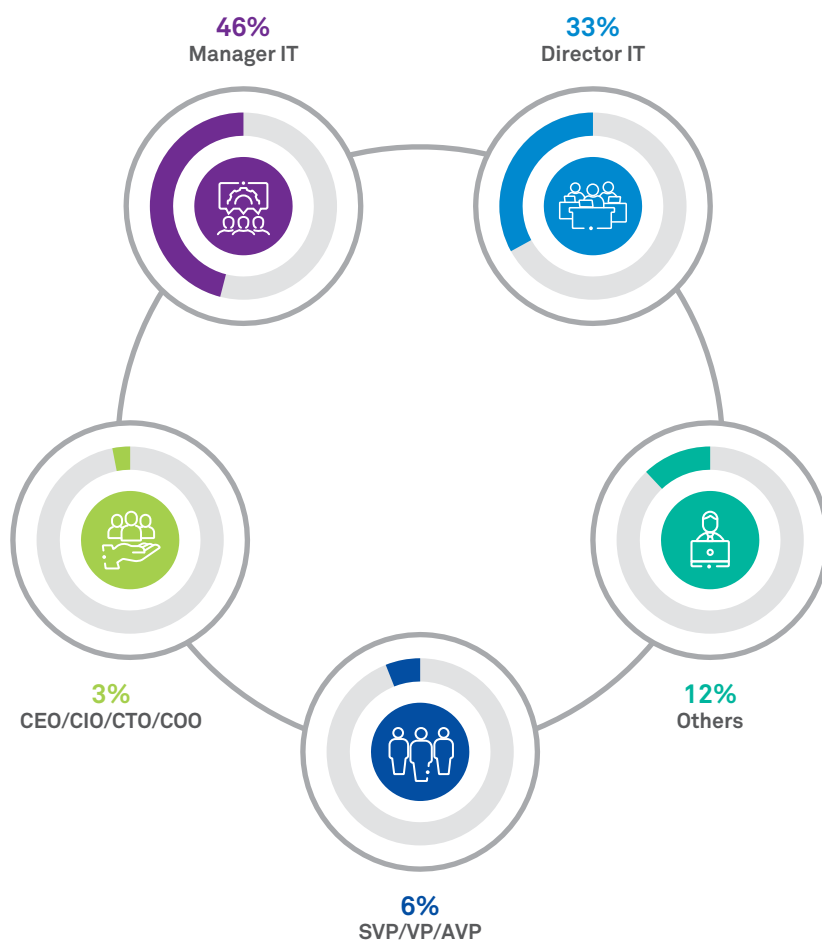CEO/CIO/CTO/COO

12%
Others

6%
SVP/VP/AVP

Figure 99

These respondents belonged to businesses in Banking (20%), IT Services (18%), Insurance (11%), Industrial and Process Manufacturing (9%), Utilities (6%), Oil & Gas (6%), Communications (5%), Securities and Capital Markets (4%), Automotive (4%), Consumer Packaged Goods (4%), and other (13%) industries.

Respondents - Industry
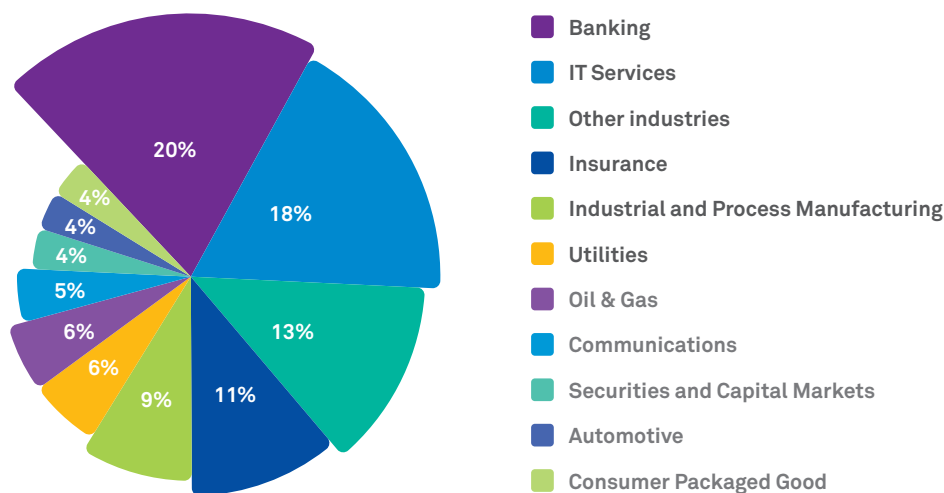

Legend:
- Banking
- IT Services
- Other industries
- Insurance
- Industrial and Process Manufacturing
- Utilities
- Oil & Gas
- Communications
- Securities and Capital Markets
- Automotive
- Consumer Packaged Good

Figure 100

The respondents' businesses/organizations operated in the UK (12%), North America (25%), the Asia Pacific Region (22%), in Continental Europe (17%), in the Middle East (15%), and in Latin America (9%).

Respondents - Geography

12% UK
17% Continental Europe
25% North America
22% Asia Pacific
9% Latin America
15% Middle East
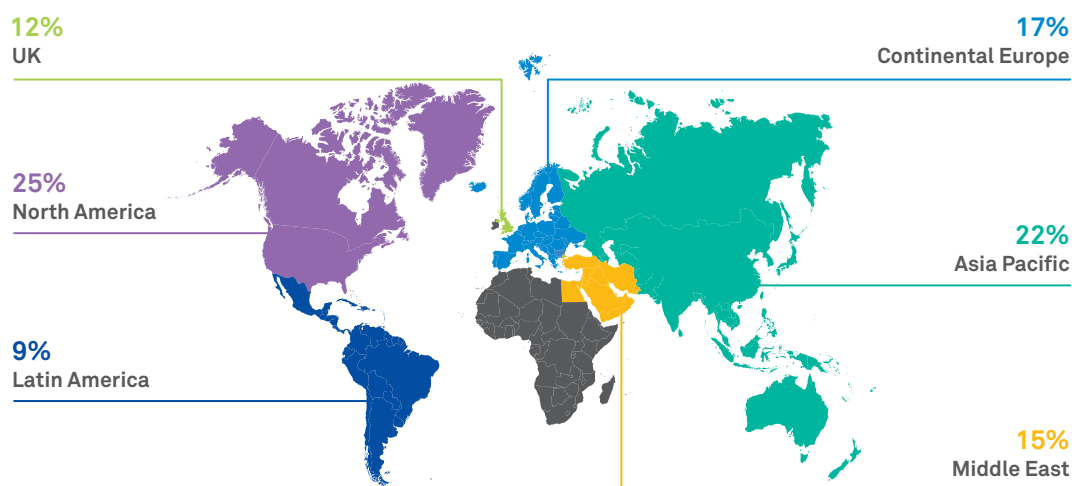
Figure 101

Credits & key contributors

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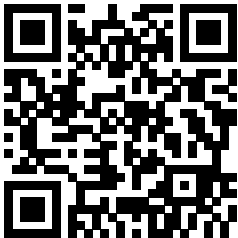
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Abbreviations

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APT	Advanced Persistent Threats	**DDoS**	Distributed denial-of-service
Agile ALM	Agile Application Lifecycle Management	**DTP**	Dynamic Trunking Protocol
AFAs	All Flash Arrays	**ENIAC**	Electronic Numerical Integrator and Computer
APM	Application Performance Management	**EUS**	End-User Services
AI	Artificial Intelligence	**EUC**	End-User Computing
AIOps	Artificial Intelligence for IT Operations	**EAN**	Enterprise Access Network
AR	Augmented Reality	**EA**	Enterprise Architecture
BYOD	Bring Your Own Device	**EMS**	Enterprise Monitoring Services
BCP	Business Continuity Planning	**ESM**	Enterprise Service Management
BSM	Business Service Management	**FC**	Fiber Channel
CMMI	Capability Maturity Model Integration	**FTE**	Full-Time Equivalent
CASB	Cloud Access Security Broker	**FaaS**	Function-as-a-Service
CB	Cloud Broker	**GLP**	Good laboratory practice
CSP	Cloud Service Provider	**HAM**	Hardware Asset Management
COTS	Commercial-off-the-shelf	**HAMR**	Heat Assisted Magnetic Recording
CMDB	Configuration Management Database	**HMI**	Human-Machine Interface
CRI	Container Runtime Interface	**HCI**	Hyper-Converged Infrastructure
CaaS	Containers-as-a-Service	**IDaaM**	Identity and Access Management
CI/CD	Continuous Integration/Continuous Deployment	**IDaaS**	Identity-as-a-Service
CLM	Customer Lifecycle Management	**IM**	Incident Management
CPE	Customer Premises Equipment	**IIoT**	Industrial Internet of Things
DLP	Data Loss Prevention	**ITIL**	Information Technology Infrastructure Library
DataOps	Data Operations	**iQA**	Infrastructure Quality Assurance
DL	Deep Learning	**I&O**	Infrastructure & Operations
DMZ	Demilitarized Zone	**IaaS**	Infrastructure-as-a-Service
DevOps	Development and Operations	**IaaC**	Infrastructure-as-a-Code
DevSecOps	Development, Security and Operations	**IOPS**	Input/Output Operations per Second
DR	Disaster Recovery	**IM**	Instant Messaging
DRaaS	DR-as-a-Service	**IPaaS**	Integration Platform-as-a-Service
		IBN	Intent-Based Networking

IoT	Internet of Things	**ROBO**	Remote Office/Branch Office
ITAM	IT Asset Management	**RPA**	Robotic Process Automation
ITOA	IT Operations Analytics	**SAFe**	Scaled Agile Framework
ITSM	IT Service Management	**SIEM**	Security Information and Event Management
JML	Java Modeling Language		
JBOD	Just a Bunch Of Disks	**SOC**	Security Operations Centre
ML	Machine Learning	**SAS**	Serial Attached SCSI
MAMR	Microwave Assisted Magnetic Recording	**SLA**	Service-Level Agreement
		SOA	Service-Oriented Architecture
MR	Mixed Reality	**SRE**	Site Reliability Engineering
MDO	Multi-Domain Orchestrator	**SCSI**	Small Computer System Interface
MPLS	Multiprotocol Label Switching	**SAM**	Software Asset Management
NBIoT	Narrowband Internet of Things	**SDK**	Software Development Kit
NLP	Natural Language Processing	**SaaS**	Software-as-a-Service
NAS	Network Attached Storage	**SDA**	Software-Defined Access
NFV	Network Function Virtualization	**SDx**	Software-Defined Everything
NFVI	Network Function Virtualization Infrastructure	**SDI**	Software-Defined Infrastructure
		SD-LAN	Software-Defined LAN
NVMe	Non-Volatile Memory Express	**SDN**	Software-Defined Networking
OCI	Open Container Initiative	**SDS**	Software-Defined Storage
OSI	Open Systems Interconnection	**SD-WAN**	Software-Defined Wide Area Network
OF	OpenFlow	**SAN**	Storage Area Networking
PCIe	Peripheral Component Interconnect Express	**SNA**	Systems Network Architecture
		TAC	Transport Accident Commission
PCF	Pivotal Cloud Foundry	**UC&C**	Unified Communication and Collaboration
PaaS	Platform-as-a-Service		
PoD	Point of delivery	**UC**	Unified Communications
PUE	Power Usage Effectiveness	**UCaaS**	Unified Communications-as-a-Service
QA&T	Quality Assurance and Testing	**UAN**	User Access Network
QoS	Quality-of-Service	**VDI**	Virtual Desktop Infrastructure
RPO	Recovery Point Objective	**VNF**	Virtual Network Functions
RTO	Recovery Time Objective	**VR**	Virtual Reality
RISC	Reduced instruction set computer	**XLA**	Experience Level Agreement
RDBMS	Relational Database Management System	**ZTS**	Zero Trust Security

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