



NEXT GENERATION INFRASTRUCTURE

Clouded in Uncertainty

Research Reports



Executive summary	3
1 Big changes in demand call for a major rethink.	5
Everything online	6
Changing corporate structures	6
A new era of IT methods and strategic partnerships.	6
Taking a strategic view of demand patterns	6
2 Cloud becomes a key factor in infrastructure design	7
Factors that sustain an on-premises component	7
Cloud will begin to dominate by 2027.	8
Consequences for strategic partnering.	8
3 A new wave of technologies could further disrupt infrastructure planning	9
Front-end channel innovations	10
Artificial intelligence (AI) and machine learning (ML)	10
Blockchain and Web 3.0	10
4 Implications for current infrastructures	11
Changes in methods of connectivity	12
New approaches to network management	12
The future will present further challenges and opportunities	12
5 Likely changes to IT operating models.	15
Modernise the factory or create a new one?	16
Drive towards universal standards and governance.	16
Choice of strategic partners	16
Sourcing digital skills	17
Where might infrastructure fit within a digital future?	17
6 How might future infrastructures evolve	19
A realistic endpoint for next-generation infrastructures	20
Likely obstacles on the way to the endpoint.	20
Enabling a new era of microservices	21
7 Implications for the CIO and CTO	23
Assessing the magnitude and direction of change	24
Adopting a next-generation mindset	24
Conclusion: Next steps for CIO and CTOs.	25
About the author	27
About Hitachi Vantara	28

Executive summary

We are living through a period of unprecedented technology-enabled change. In this era of radical transformation, business cycles have been compressed from years or decades to weeks and days. The most visible example of this shift came in spring 2020, when the world's biggest companies transferred hundreds of thousands of workers from offices to homes. What might once have been an intractable challenge was completed quickly and successfully.

The pandemic has been the catalyst for many other innovations, from the adoption of hybrid working to the creation of new online channels to market. Across all these innovations, one technology above all others is the enabler: cloud computing. Ground-level developments in cloud technologies, such as Infrastructure as a Service (IaaS) and Platform as a Service (PaaS), have provided the foundations for businesses to shift their business models effectively. On top of this cloud-enabled base, companies have adopted Software as a Service (SaaS) applications to transform how employees and customers access services over the web.

CIOs and CTOs are at the centre of this seismic shift. Digital leaders who are charged with managing the cloud-enabled businesses of today face a very different landscape to the one they encountered in the past. In the traditional model of IT management, the IT chief's role was relatively straightforward – negotiate better deals with outsourcing partners for each of the primary towers: data centres, networks and end-user computing. This traditional model was tested first by the rise of the public cloud more than a decade ago (see case study, right) and has been further challenged by the rush to the cloud in response to the pandemic.

Today, the traditional model of IT management looks tired and stale. The transition to the cloud made during the past decade, such as the one detailed in our case study, is far from unusual. Now, most organisations are taking their first giant steps towards a hybrid mix of on-premises, private and public cloud. While some companies are further along their journey to on-demand IT than others, there is now clear evidence to suggest that there's no business strategy without a cloud strategy. The journey to a new form of technology management is well underway.

However, the destination is a long way in the distance. Yes, public cloud delivers the agility and flexibility to cope with periods of rapid change and uncertainty, but these services remain at a nascent stage of development. Estimates suggest the public cloud accounts for just 10% of spend in IT services. What's more, many barriers litter the pathway towards a comprehensive adoption of public cloud services, including a migration from legacy applications, an investment in ageing hardware, a lack of appropriate skills, and a range of restrictive outsourcing arrangements. For these reasons, we believe organisations will adopt hybrid solutions that blend on-premises, private and public provisions as they prepare for a full transition to public cloud during the next decade.

A further factor also needs to be considered. Businesses are undergoing full-scale transformations to become software-based entities that can fight off attacks from digital natives. New waves of technology such as Web 3.0 and blockchain promise decentralised economies and new business architectures. Taken together, these waves will facilitate the emergence of Industry 4.0, which in turn requires radical changes in business models and supporting infrastructures.

In this report, we examine the demand factors promoting change together with associated developments in infrastructure technologies, such as software-defined networks. We conclude that today's tower structures and private network technologies, such as virtual private networks and multiprotocol label switching, are no longer relevant within a digital economy. Instead, CIOs and CTOs must consider new approaches that merge their infrastructures into integrated IT architectures based on microservices and cloud platforms. This new approach calls for a rapid assessment of current assets and operating processes, and a roadmap towards fully integrated digital platforms based on public cloud services.

We thank the contributors to this research from many of the world's leading banks, insurance firms and telecommunication companies. We also thank the sponsors of the research, Hitachi Vantara, who are helping organisations around the globe to readjust to the new realities of next-generation infrastructure models.

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One of the world's leading CTOs commented that the pace of change has never been more pronounced in the infrastructure space. New waves of technology combined with unprecedented changes in demand require radical solutions and new partnerships.

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Case study: The rise of the cloud

Almost a decade ago, the group CIO of a major oil company was faced with a global infrastructure refresh. Outsourcing contracts with IBM, AT&T and HP had run their course and the organisation was faced with a competitive evaluation of these legacy operators. The CIO decided there might be a better way. He commissioned an evaluation of potential cloud vendors such as Amazon and Microsoft as possible alternatives to traditional outsourcing partners. The benefits of the cloud would be the flexibility and agility of a pay-as-you-go utility approach. Sadly, the hyper-scalers were not mature enough to take on such a vast, multi-billion-dollar infrastructure at that time. Ten years later, the situation has changed dramatically and more than 50% of the oil company's global infrastructure sits on public cloud platforms.

1 Big changes in demand call for a major rethink

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For a global investment bank, the pandemic has changed fundamentally its working habits, locations and interactions with key clients. This has opened the door for radical changes to organisational design with regional processing hubs and the potential to complement humans with digital workers operating 24/7.
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As we approach a post-pandemic era that continues to promote digital communications of all kinds over face-to-face interactions, demand factors that influence infrastructure design and operations are changing at an accelerating pace (see **Table 1**, below).

Table 1 – Changes in infrastructure demand factors

Demand factors	2022	2027
Market facing	Mobile and Online Real time transactions	Immersive experiences Always connected
Hybrid working	Office 365 Teams	Collaboration tools Augmented reality
Corporate structures	Regional processing hubs + SaaS services Office consolidations	Digital workforce (RPA) New business models
IT environments	DevOps and PaaS Hybrid cloud	Data centric Industry eco-systems

Everything online

During the past two years, most of our work and domestic activities have migrated to digital channels and devices, such as laptops, tablets and mobile phones. We have been forced to adopt online shopping, banking, healthcare, education, entertainment and much more. This shift from physical to virtual interactions has had a dramatic impact on corporate infrastructures, especially in businesses whose operations face end customers:

- Banks have closed 50% of their high-street branches in the UK and elsewhere in favour of mobile and online banking
- Doctors, teachers, and social workers have been forced to adopt telephone and video-conferencing technology as their primary means of communicating with the public
- Call centre and back-office staff have become accustomed to working from home due to successive waves of national lockdowns

These developments have accelerated the adoption of cloud services, such as Microsoft 365 and Teams. These services have supported remote working and promoted the adoption of mobile and online interfaces to help deal with an explosion in the volume of enquiries and transactions.

Changing corporate structures

The shift to hybrid working has led to a rethink of office layouts, with a move towards hot desking and collaborative workspaces. This transition has reduced office footprint in many organisations, including a consolidation of properties. Mobile and wireless connectivity, meanwhile, is better suited to hybrid working than traditional local area networks (LANs).

Corporations have also reviewed and modified their functional services to take advantage of SaaS offerings, such as Salesforce and Workday. These providers offer a single platform to serve global workforces. Their strengths mean monolithic ERP systems – such as SAP, that reside largely on-premises – have been progressively displaced by externally provided services. SaaS offerings use their own web-based infrastructures, which reduces the load on internal platforms.

A further corporate restructuring effort in global organisations includes the creation of regional hubs to improve the efficiency of business functions, including finance, HR and IT. This regionalisation has been accompanied by process automation and organisational simplification. Once again, this new approach to provision generates fresh demand patterns for corporate infrastructure.

A new era of IT methods and strategic partnerships

The exceptional pace of change during the past two years has accelerated the adoption of Agile methods and DevOps tools. CIOs now talk about delivering new applications in weeks rather than months or years. Cloud platforms provide the basis for much of the tooling that enables this rapid application development. In parallel, the explosion of data being drawn from external sources has demanded a rapid expansion of storage capacity that only public cloud can handle.

The adoption of public cloud has accelerated the erosion of traditional ‘tower’ structures, where data centres, networks and end-user computing services are provided by outsourcing partners, such as IBM, DXC, HCL and TCS. Instead, an emerging and hybrid mix of public cloud services and on-premises compute power has encouraged CIOs and CTOs to look for new strategic partners, including Microsoft Azure, Amazon AWS and Google Cloud Platform. Rather than the tight binds that characterised the outsourcing arrangements of the past, these new partnerships are based on flexible contracts that encourage a mix-and-match approach to infrastructure provisioning. The days of mega outsourcing contracts are finally coming to an end.

Taking a strategic view of demand patterns

Infrastructure refresh programmes were traditionally based on a 10-to-20-year life cycle, reflecting the relatively slow pace of change in demand patterns and supply options in outsourcing arrangements. Now, with the advent of cloud and new software services, life cycles have collapsed dramatically. Digital leaders are adopting two-to-five-year planning horizons for infrastructure upgrades. Our research suggests further changes in demand during the next decade:

- A digital workforce that combines human and machine-based talent
- Data-driven decision making that streamlines critical processes
- Immersive experiences that favour augmented and virtual realities
- Software-defined business models that are entirely data-centric

Taken together, these developments call for flexibility in the design and operation of next-generation infrastructures.

2 Cloud becomes a key factor in infrastructure design

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For a leading US retail bank, the journey to cloud has been fraught with challenges including the replatforming of core applications on a grand scale. This has encouraged the bank to adopt a hybrid cloud policy with 33% compute and storage remaining on premise, 33% private and 33% public cloud services.
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Public cloud services such as Azure and AWS might have been around for more than a decade, but adoption rates suggest the technology is still in its infancy. Total IT spend in 2022 will be around \$4.5 trillion but spend on cloud services will be just \$360 billion, according to analyst Gartner. Contributors to our research report similar trends – they suggest the average spend on public cloud is below 10%. Major banks, for example, show caution over the move to public cloud services due to regulatory barriers and concerns over business resilience and information security.

Table 2, to the right, illustrates the current segmentation between on-premises, private and public cloud. Most financial organisations believe there will be a move towards an equal balance between on-premises, private and public cloud within the next five years.

Factors that sustain an on-premises component

Financial services, government, manufacturing, telecommunications and retail organisations have invested billions of dollars in core systems from vendors such as IBM, SAP and Oracle during the past few decades. Many systems are highly customised and coded in heritage languages, including COBOL. As a former banking COO states, this reliance on legacy technology creates issues: “We don’t have the investment capital to redevelop our core systems to suit a cloud-native environment.”

Our research suggests global enterprises will begin to break their reliance on legacy systems once they develop standard, cloud-native applications to replace platforms

Table 2 – Take-up of public cloud solutions, 2022-2027

Segmentation	2022	2027
On-premise	Core systems Corporate apps	Legacy re-platformed Cloud native apps
Private Public	80-90% private	50-60% public
Public cloud	Selective IaaS SaaS and PaaS	Industry clouds High Performance Computing
Cloud vendor	Hyper-scalers Outsourcers	Heritage suppliers Service integrators

that are still used by national-level business units. However, making this break from the past is a massive undertaking that could take a decade or more to complete.

This slow progress towards public cloud comes in three flavours. First, the IT organisation is adopting IaaS for load balancing, data storage and cloud-native applications. IT also favours the public cloud for applications development and testing and relies on PaaS tooling that is provided by the three main cloud operators, Microsoft, Amazon, and Google. Finally, businesses are adopting SaaS to allow employees and customers to access services over the web.

Cloud will begin to dominate by 2027

We believe it is conceivable that between 50% and 60% of workloads could shift to flexible and agile public cloud platforms by 2027. Within three to five years, many of the legacy applications that populate on-premises systems will have been redeveloped to become cloud-native using Agile methods and DevOps techniques. Other developments that could contribute to this shift include:

- Growing demand for high-performance computing (HPC) to solve complex problems
- Consolidation of corporate data from separate applications to a single data lake
- Emergence of industry clouds that reflect the growing need to share data between partners

Consequences for strategic partnering

CIOs and CTOs report that Microsoft, Amazon and Google are their primary partners for IaaS and PaaS services, although some digital leaders expect IBM, Oracle, HP and Dell to expand their market shares. Regulators are already concerned that too many enterprises depend on too few cloud operators, especially in the financial services sector, and are likely to encourage new entrants. However, new providers will find it tough to enter the IaaS and PaaS market. Compute and storage are becoming global utilities, where the scale and geographic coverage boasted by the dominant players creates high barriers to newcomers.

In the SaaS market space, a growing number of players hold niche positions in the public cloud, such as Salesforce for CRM and Zscaler for security. We can expect an explosion of niche players over time that will make it more challenging to manage cloud services effectively. CIOs and CTOs will need to work with service integrators to find the best solutions for their compute environments.



3 A new wave of technologies could further disrupt infrastructure planning

The combined forces of cloud, mobile, data analytics and social media have dominated enterprise IT during the past two decades, but a new wave of technologies is emerging that could place further demands on modern infrastructures (see **Table 3**, to the right).

Table 3 – A second wave of disruptive technologies

Technology impact	Wave One 2010-2025	Wave Two 2025-2030
	Social Media	IoT
	Media Mobile	5G & 6G
	Cloud	Augmented and virtual reality
	Data Analytics	Machine learning
		Artificial Intelligence

Front-end channel innovations

5G rollout and rapid advances around the Internet of Things (IoT) will sponsor a proliferation of intelligent devices within home appliances, cars, buildings and other physical assets. The increased use of IoT will lead to a sharp rise in machine-to-machine traffic between suppliers and their customers over coming years. This trend will also be accompanied by advances in edge computing, where high levels of processing intelligence will be embedded in end devices.

Media attention is also focused on the metaverse, a virtual reality (VR) space focused on social connection. We should expect fresh developments outside traditional gaming applications during the next two to three years. One key trend will be the rapid adoption of VR interfaces, headsets and content as part of the consumer experience. Visits to shops, exhibitions and other public places will be enhanced by augmented and virtual imagery, which will help companies promote their products and services. VR and augmented reality might also be used to enhance remote meetings during the next few years. Any communication that takes place across the metaverse will add to current traffic levels across current mobile and online channels.

Artificial intelligence (AI) and machine learning (ML)

Contributors to our research anticipate a dramatic expansion of data flows that will place additional demands on internal infrastructures. The increase in data capture from front-line channels and supply chains will take place alongside rapid developments in data analytics. These advances in analytics will be enabled by AI and ML. The development of analytics will require access to additional storage and compute resources, which will usually be based in public clouds.

Such technologies will also find application within the workplace itself as robotic process automation (RPA) and low code/no code reach critical mass. RPA has the potential to displace 30% of all office jobs. Adding AI and ML could bring this proportion up to 50% by 2025. UiPath forecasts an equal split between human and digital workers by the end of the current decade. This trend will lead to a big increase in data traffic between humans and machines, requiring new platforms to provide interconnectivity and security.

Blockchain and Web 3.0

Blockchain has been the focus of media attention for the best part of a decade, but its commercial application until recently has been limited to niche areas, such as cryptocurrency. However, broader applications of blockchain can now be seen. Pharmaceutical, hospitality and consumer goods companies have been running experiments that track and assure provenance of their products across the supply chain from the extraction of raw materials to a product sale to an end consumer. Companies in other industries, such as construction and insurance, have been applying blockchain technologies to their own processes to expedite claims and accelerate cash flows.

More significant developments are likely to take place as organisations and industry ecosystems adopt decentralised architectures based on Web 3.0. Web 3.0 is a new iteration of the World Wide Web (WWW), which uses blockchain technologies and incorporates concepts such as decentralised and token-based economies. A decentralised web relies on a peer-to-peer network built upon a community of users. The shift to decentralisation could help overcome the problem of data centralisation, where Big Tech companies monopolise our personal data for their own advantage. In the age of Web 3.0, data could be devolved to smaller organisations and local communities and used for the purposes to which it is most relevant and socially desirable.

From IoT to AI and onto Web 3.0, we believe the emerging wave of technologies will help to change organisational design fundamentally. One significant consequence of this transformation could be the requirement for new supporting IT platforms and infrastructures.

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For a European mobile network operator, the prospect of Wave Two technologies such as 5G, IoT, the Metaverse and AI has created a unique opportunity to merge network operations with IT to create a fully integrated architecture capable of accommodating innovation at speed.
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4 Implications for current infrastructures

The advent of global compute and storage facilities, such as Microsoft’s Azure and Amazon’s AWS, has encouraged IT organisations to supplement private infrastructures with public cloud, as we described in the previous section. The coronavirus pandemic has accelerated this trend further by necessitating web-based communications to home based and mobile workers. In the wake of this transformation, CIOs and CTOs are now re-examining their infrastructures. We can expect a dramatic shift in network architectures during the next few years (see **Table 4**, below).

Table 4 – The shift in network architectures, 2022-2027

Components	2022	2027
Connectivity	VPNs, MPLS	Web-based
	Private networks	Software defined
Data processing	On-premise	HPC, Edge
	Co-location	Public cloud
Applications	Heritage	Cloud native
	Data segmentation	Data lakes
Security	Perimeter protected	Zero Trust environments

Changes in methods of connectivity

Traditional infrastructures were designed to accommodate data traffic between primary nodes such as data centres and local servers. The decades-long assumption is that this kind of traffic is best carried over private circuits to ensure adequate security and bandwidth capacity. Two main techniques have prevailed:

- Multiprotocol label switching (MPLS) – A routing technique that directs data from one node to the next based on labels rather than network addresses. Whereas network addresses identify endpoints, the labels identify established paths between endpoints
- Virtual private network (VPN) – This technology extends a private network across a public network and enables users to send and receive data across shared or public networks as if their computing devices are directly connected to the private network

With the advent of public cloud and a move to hybrid working, these traditional techniques are being superseded by software-defined, wide area network (SD-WAN) architectures. This approach relies heavily on communications over the internet between an organisation’s multiple locations and those of its suppliers and customers.

If standard setup and configuration messages are supported by all network hardware vendors, SD-WAN simplifies the management and operation of a WAN by decoupling the networking hardware from its control mechanism. This concept is similar in approach to virtualisation technologies, such as VMware, that aim to improve data centre management and operations. These new network management methods can deliver lower cost solutions with inherent flexibility and agility.

New approaches to network management

As SD-WAN traffic is carried over the internet, there are no end-to-end performance guarantees. Operational challenges include:

- Encryption of all traffic to deliver equivalent levels of security that exist in private networks based on MPLS and VPN architectures
- Adequate network latency and resilience that can meet the needs of the organisation and its suppliers and customers
- Full visibility of costs and end-to-end connectivity in a hybrid public/private environment that enables tight control over both commercial and operational performance

New tools and vendor partnerships are being enacted to overcome these challenges. For example, companies are introducing ‘Zero Trust’ procedures to ensure end-to-end security across perimeter-less boundaries. Zero Trust security models are based on never trusting and always verifying any transaction that takes place over the network. Companies such as Zscaler offer a cloud-based security solution that uses this Zero Trust policy. Dynatrace offers tools to improve network diagnostics, while CloudHealth helps customers monitor and optimise network costs.

Despite these developments, few large organisations feel comfortable today about network management in a hybrid cloud environment. Many CIOs have introduced automation techniques to simplify operations and tighten control over costs and security. Other CIOs have established centralised relationships with cloud vendors to obtain price caps across multiple business units and national organisations.

The future will present further challenges and opportunities

Participants in our research suggest that the pace of change will accelerate further in the next five years. We can expect the consolidation of information into massive data lakes placed within public clouds, a growing dependency on high-performance and edge computing, and the proliferation of SaaS services that replace in-house applications. IT architectures, meanwhile, will evolve towards microservices, which are loosely coupled services that are best suited to web environments.

Although the accelerating pace of change is now a certainty, the extent and direction of change are by no means obvious. Architects of next-generation infrastructures would be well advised to adopt flexible and agile solutions such as SD-WANs that can respond on-demand to multiple scenarios.

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For a global insurance company, the move to cloud has required a complete transformation in underlying network technologies, including the move away from VPN and MPLS to entirely software-defined facilities. Built into this new design is provision for edge computing and giant data lakes.
 ”



“ A tidal wave of new technologies combined with emerging digital business architectures will require a fundamental rethink of infrastructure architectures and associated strategic partnerships. ”



5
Likely changes to IT operating models

Infrastructure refresh is just one of many initiatives that IT organisations must undertake to help their businesses transform and operate effectively in a digital economy. Other key initiatives are likely to include re-platforming applications to suit a cloud-native environment, consolidating and cleansing data so that all staff can have easy access to services, and introducing automation techniques into the workplace, such as RPA and AI. IT policies and operations will need to adjust to the new digital realities (see **Table 5**, below).

Table 5 – IT operating models will reflect digital realities

	2022	2027
IT Policy and governance	Modernise the Factory	Support new digital business models
Innovation	Sustainability focus	Platform innovations
Automation	Task-focused	End to end processes
Skills and talent	Out tasked	Insourced
Vendors	Tower-based	Eco-systems

Modernise the factory or create a new one?

Most incumbent organisations are focusing today on modernising their current business and IT operations using techniques such as process reengineering, workplace automation and data-driven decision making. There is a growing sense of urgency amongst these enterprises as digital natives encroach on their territories. Additional imperatives, including sustainability targets and cloud-first policies, have been introduced by senior management to help meet shareholder expectations.

However, there is a recognition from respondents to our research that incremental improvements will not be sufficient to survive growing competition from digital newcomers. For example, the advent of decentralised finance and crypto currencies might cause widespread disruption to financial services firms in the next five to ten years. As a result, businesses across all sectors are launching innovation initiatives:

- Building incubators to pilot new business models and ways of operating. Once proven, such entities need digital platforms to scale up to industrial strength
- Carrying out acquisitions of start-ups and scale-ups to expand digital footprint and bring new thinking into the organisation. Cloud becomes the enabling platform for such activities
- Divestment of non-core businesses, so that the organisation can focus on its core strengths. Cloud has simplified such transactions

To be successful innovators, IT must work closely with business units to achieve mutually desired outcomes. In this respect, the boundaries between IT and business are blurring rapidly. Many CIOs and CTOs see themselves today as business leaders with a broad remit rather than functional heads who are only responsible for technology operations.

Drive towards universal standards and governance

One effective way to achieve efficiencies within global organisations is to introduce standard ways of working across national boundaries and between business units. This approach is crucial in the financial services sector where organisations have often grown through acquisition. Such standardisation includes the regionalisation of back-office functions, migration to SaaS services, and the replatforming of core applications to achieve single-instance systems across the globe.

The IT department plays a critical role in the drive towards universal standards and governance as it retains control of core applications and associated processes, such as ERP. The group IT function coordinates developments by ensuring compliance with business and IT standards, while also building closer relationships with vendors. Many of the companies we interviewed have taken steps to strengthen their group IT units by adding senior enterprise architects and working closely with vendor partners to identify innovation opportunities. As we progress to cloud-based platforms and integrated business services, these centralised IT units will continue to expand in influence and authority.

Choice of strategic partners

The rise of hyper-scale behemoths such as Microsoft/Azure and Amazon/AWS is shifting the balance away from traditional tower operators such as IBM and Oracle. The recent move to hybrid working and the extensive use of Office 365 and Teams has helped to strengthen Microsoft's position. It is likely Microsoft will further cement its standing in coming years with additional collaboration and automation products. The continued rise of Microsoft and its rivals leaves large organisations with a dilemma. Should they take active steps to open source all applications or move closer to a hyper-scaler that can provide both infrastructure and a comprehensive range of development tools?

So far, the organisations we spoke to are adopting multi-cloud arrangements with no distinct loyalty to one hyper-scaler. However, these multi-cloud arrangements are complex to manage from a connectivity and security point of view. CIOs should reflect on this complexity and ask important questions about which external vendors have the necessary skills and resources to support internal IT units. Here, we include overall management of residual tower components such as data centres, as well as private and public clouds. Our belief is that a new breed of service integrator is needed to address this growing and complex market need.

Sourcing digital skills

Organisations in all sectors are evolving rapidly to become digital businesses, where technology underlies all operations. This evolution has important consequences for the type of skills that are needed to run and transform operations. In IT, expertise in Agile methods and DevOps techniques is essential to converting legacy systems into cloud-native applications. Within business units, staff must be better informed about digital capabilities that could transform their operations. They will also be required to develop their own applications in low code/no code environments.

We believe IT must first boost its own digital capability and then become the trusted enterprise-wide guide for the digitisation of the entire workforce. This shift places exceptional pressures on CIOs, CTOs and team members to train and recruit IT staff who are skilled in all-things digital. This pressure means many organisations are relying on expert help from external consultants.

Where might infrastructure fit within a digital future?

Historically, infrastructure has occupied a separate domain within the IT organisation. Infrastructure teams have been responsible for the operation of IT towers such as data centres, networks and end-user services. At the same time, most organisations relied on outsourcers to operate their facilities.

More recently, there has been a big shift in approach. With the advent of public and hybrid cloud policies, IT has taken many of the core skills needed to optimise and run infrastructures in-house. Enterprise architects, meanwhile, have begun to remove the historic distinction between infrastructure and other IT activities, such as applications development and management.

In the future, we believe managing a portfolio of IaaS and PaaS services to develop and run cloud-native applications and processes will lead to the gradual convergence of interests. This shift will lead to the creation of a unified IT structure, operating within a single enterprise architecture. We expect to see the CTO take responsibility for all IaaS and PaaS aspects, with the CIO focusing on broader business and strategic issues, reaching well beyond the boundaries of the IT organisation.

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For a European re-insurer, traditional IT infrastructures are being consolidated to create a single, integrated platform to support new digital business models. This has necessitated a change in existing partnerships to include hyper-scalers and leading security companies.
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6 How might future infrastructures evolve



By focusing on the forces that are acting on today's infrastructure, including changing demand patterns and network technologies, we can begin to visualise an end state for infrastructure within the current decade (see **Table 6**, below).

Table 6 – Visualising an end-state for IT infrastructures

Evolution Path	2022 -2027
Hardware	Consolidation of data centre footprint as compute and storage move to cloud
Software	Software defined infrastructure supported by artificial intelligence PaaS for agile developments
Data	Data Lakes and Data Master Files housed in the cloud
Security	From perimeter to Zero Trust

A realistic endpoint for next-generation infrastructures

Contributors to the research indicate that a cloud-first strategy should embrace all aspects of today's IT infrastructure across the next five to ten years. The salient aspects of such a strategy include:

- Transfer of hardware ownership (CAPEX) to a pay-as-you-go (OPEX) model. This merits a move to public cloud for all infrastructure services (IaaS). Cloud will provide the necessary agility and flexibility to cope with uncertain demand patterns
- Adoption of software-defined network (SD-WAN) architectures that enable companies to dispense with MPLS and VPN formats. Automation, including AI and RPA, will take a front seat in optimising and managing such facilities
- Migration of corporate applications to a cloud-native environment. This will rely heavily on Agile methods and DevOps techniques to speed up the re-platforming process. Companies will choose to exploit PaaS to take advantage of embedded tools
- Consolidation of data assets. This will require embedded databases to be transported into virtual data lakes within public clouds. RPA and AI will help to accelerate this migration by locating, cleansing, and standardising data
- Securing a multi-cloud infrastructure. Having transported corporate data and applications to public clouds, organisations will need to operate boundary-less perimeters. This is already the case with many external services, such as SaaS. New security regimes such as Zero Trust will be required

Likely obstacles on the way to the endpoint

Despite hype about organisations adopting a cloud-first strategy, it's important to recognise that there have been many obstacles on the journey to this destination. First and foremost, boards of major corporations have been reluctant to embrace cloud due to security and business continuity issues. However, many of these fears have been largely overcome during the past two years as the public cloud proved its value during the pandemic. Hyper-scalers, such as Microsoft, have been able to demonstrate that the public cloud offers high levels of security and resilience.

Cost has also been a challenge. Private facilities offered predictable control over infrastructure costs, such as data centres and networks. Public cloud has no such constraints. This lack of restraint is especially important in application development, where software engineers may leave tasks open outside work hours, absorbing costly storage and processing power. Data lakes and AI applications also generate new cost sources. Some companies have begun to negotiate price caps with hyper-scalers, although this can be challenging in a digital world characterised by demand uncertainties.

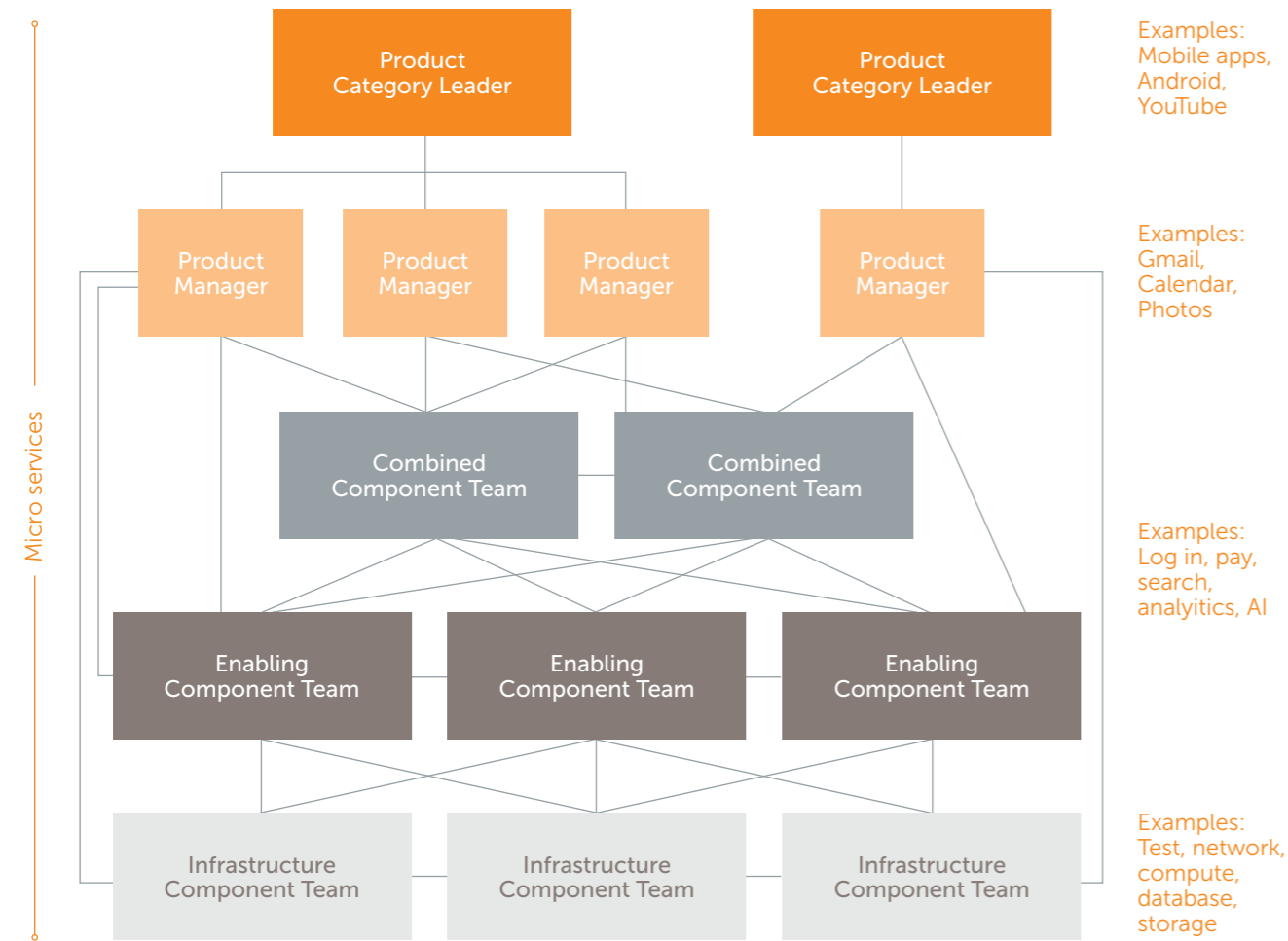
A further obstacle is the availability of human resources and associated tooling. Traditional outsourcing contracts included sufficient external resources to monitor and optimise infrastructures. As we progress to a hybrid cloud environment and dispense with outsourcing services, organisations find themselves suffering a major gap in resources. Some contributors to the research mentioned that they lean on external agencies, such as Accenture and TCS, to help manage application migration. Others have retrained internal staff to be cloud-savvy. However, the complexity of a hybrid infrastructure and the likely speed of change will only make matters worse in coming years.

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For a global telecommunications operator, emphasis is being placed on automation of all critical processes that support the customer as well as back office. Process mining is helping to identify and analyse such processes. AI and robotic process automation are being applied to existing and new process designs to transform performance.
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Enabling a new era of microservices

So, how can organisations overcome these obstacles and create a successful cloud-first strategy? In the case of digital natives, the answer has been to adopt microservices as the optimal way of supporting changes to front-end commercial products and services (see **Figure 1**, below).

Figure 1 – Structure of a digital business (Google)



The success of this loosely coupled approach means many IT organisations, and not just digital natives, are now considering new architectures based on microservices. These loosely coupled services allow business units to emulate digital native structures and compete more effectively in key areas such as product and service innovation. In this new era of microservices, infrastructure becomes the foundation for software-defined businesses.

For some digital leaders at slow-moving corporates, this new organisation might appear a long way in the distance. However, there is no room for complacency. Just as Web 3.0, blockchain and decentralised architectures are approaching on the horizon, the adoption of microservices is an inevitable consequence of the fast-emerging digital economy.





7 Implications for the CIO and CTO

The transition from a traditional tower-based model that includes data centres, networks and end-user computing to a hybrid cloud structure that combines on-premises, private and public cloud in roughly equal proportions has important implications both for the CIO and CTO (see **Table 7**, below).

Table 7 – IT organisations will need to adopt new strategies

Policy	2022	2027
Planning	Baseline assessment	Scenario planning
	Sunset strategies	Innovation focus
Platforms	Single source (e.g., AZURE)	Multi-source (open standards)?
Partnering	Keeping the lights on	Eco-systems of specialist players
Positioning	Infrastructure as a separate unit	Merging with other IT functions

Assessing the magnitude and direction of change

The starting point in any major transition to a future position is an assessment of the current state. One contributor to the research has launched a global review of infrastructure facilities that includes hundreds of separate data centres and networks. Having created a baseline, it is feasible to start then plotting a roadmap to the envisaged end state and to develop a detailed design that is ready to be implemented. Across all organisations, the key factors to be considered are:

- Ownership and configuration of private networks and data centres. Most organisations, especially in financial services, will need to preserve a small number of strategic data centres to house mission-critical applications. These might require limited private network facilities
- Assessing legacy applications for cloud readiness. CIOs and CTOs will need to document and assess which of the many hundreds of on-premises applications can be migrated into the cloud, either by a 'lift and shift' or full conversion to cloud-native formats
- Choosing strategic partners and associated standards. With the decline of traditional outsourcing contracts, CTOs will need to consider who will be the most appropriate platform and service partners to support a hybrid structure, including IaaS, PaaS, and SaaS
- Reskilling the IT organisation. The adoption of Agile methods and DevOps will require a new generation of skilled programmers and business analysts. CIOs and CTOs will need to collaborate closely with the businesses to deliver value-based outcomes
- Meeting sustainability goals. CEOs have been vocal in declaring their commitment to Net Zero targets by 2030. IT needs to be a contributor to achieving such targets within its own domain. IT can also provide many of the tools to assist other parts of the organisation in this endeavour

These factors in combination require a comprehensive transformation of not only the infrastructure but the entire IT organisation itself.

Adopting a next-generation mindset

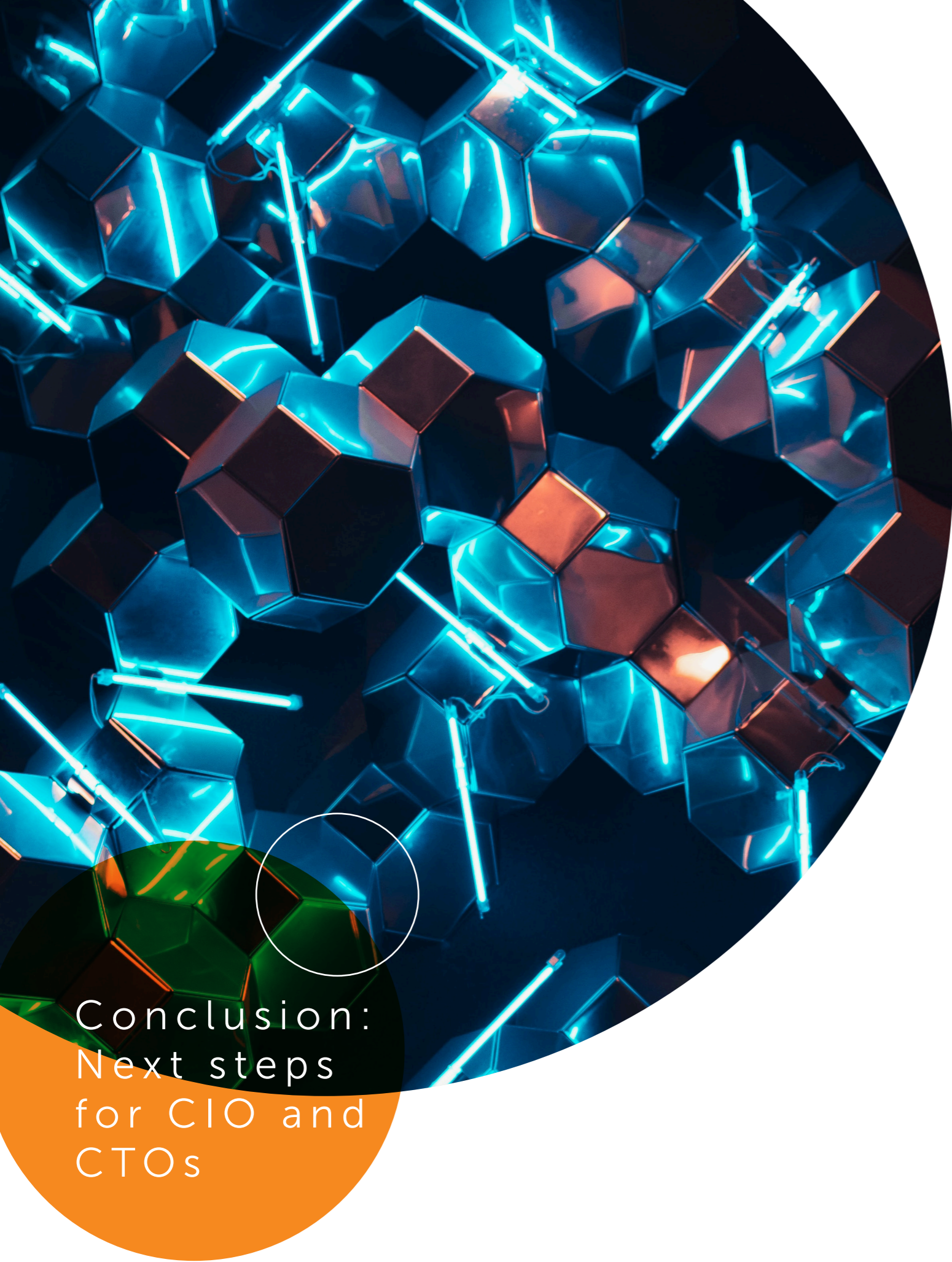
The global environment today presents levels of change and uncertainty that are unprecedented. According to research contributors, the pace of change has increased dramatically in recent years due partly to the pandemic but also the infusion of new waves of technology, including blockchain, 5G, IoT, AI and VR. The pace of change is only likely to accelerate during this decade.

Digital leaders will play a central role in helping their organisations adjust to this new velocity. Here are some ways in which CIOs and CTOs can help:

- Offer techniques that are appropriate to high levels of uncertainty, such as scenario planning. For example, consider how new waves of technology-led innovation will have a profound effect on future business landscapes
- Provide education and guidance on how digital technologies and processes can address business problems in a new and fundamental manner. This approach requires full participation by IT leadership in all aspects of business planning and operations
- Build and run cloud-based platforms that can support digital business models. Such platforms should encourage experimentation and hyper-scaling of new concepts (build the new), as well as the transformation of existing operations (modernise the factory)

Dealing with this level of change will be not straightforward, yet IT has several advantages over other functions. First, it is frequently the channel through which new, innovative ideas enter an organisation. Second, it reaches into every aspect of a business, both at the front and back end. By designing and implementing next-generation digital infrastructures, IT can provide the foundations on which organisations evolve and flourish.

“
For an Asian bank, the Group CIO is conducting a baseline assessment of current assets to decide which of these need to be rebuilt and which will remain as legacy systems. The path of travel is to sunset most current systems and invest in cloud native application that will smooth the transition to public cloud.
”



Conclusion: Next steps for CIO and CTOs

Let us be clear – all CIOs and CTOs must focus on next-generation infrastructures now. Decade-long arrangements, characterised by rigid outsourcing contracts, are being replaced by flexible public cloud relationships that create the modern platforms to support radical changes in business demand and new IT architectures. By mid-decade, it is likely that large organisations will achieve a balance for their provision: one-third each for on-premises, private, and public cloud.

This transition to a next-generation infrastructure can be seen as a genuine business transformation. It will require a different range of skills, tools and partnerships to previous generations. Rapid developments in the demand for network services – combined with fundamental changes in network technologies, such as software-defined architectures – demand action around infrastructure planning and refresh. The organisations we spoke to are instituting these actions:

- Assessment of current infrastructures, such as asset inventories, external contracts, and traffic-pattern analysis
- Design of an endpoint vision for next-generation infrastructures that embraces the need for flexibility and agility
- Development of a practical route map for the implementation of new designs, including strategic partnerships, skills and tooling
- Construction of a business case that aligns infrastructure refresh with broader commercial goals. Here, infrastructure must be seen as a value-enabler rather than merely a cost

About the author



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A pioneer of today's Internet as an ARPA research fellow at MIT in the seventies, Roger has spent over forty five years helping corporations harness the power of new technologies such as cloud, mobile communications, e-commerce, voice recognition and satellite. He was a partner at EY responsible for e-commerce during the dot.com boom. He is a graduate of Cambridge University and MIT, and a visiting professor at the University of Surrey.

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