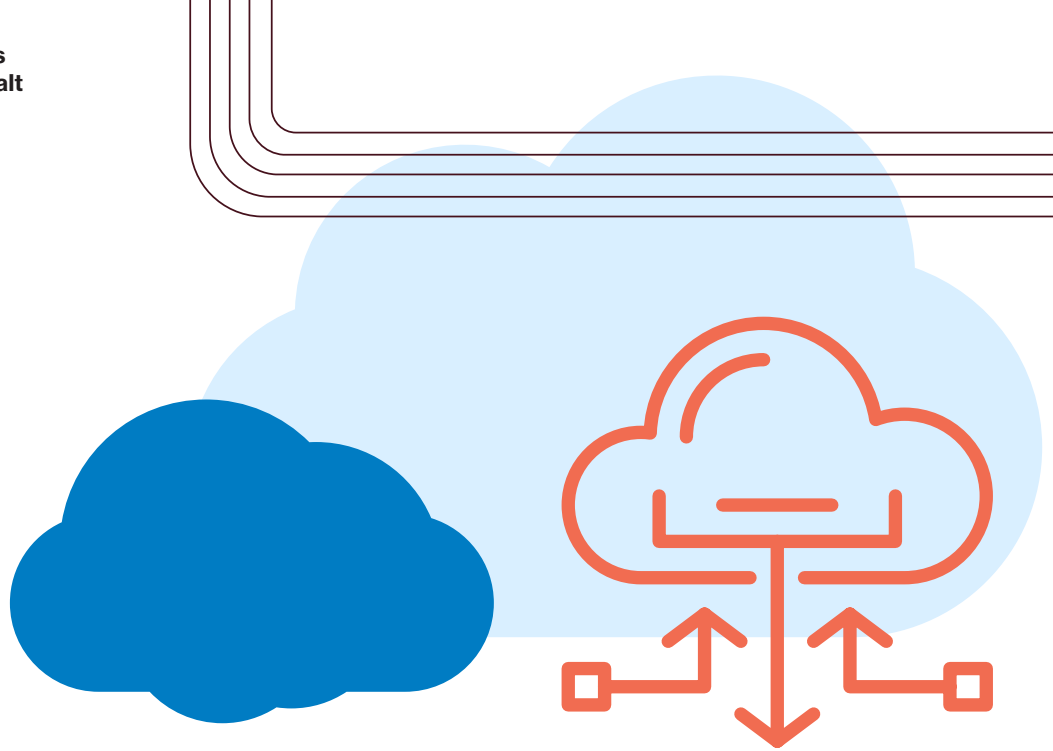# The Global Cloud Ecosystem Index 2022

How leading nations have marshaled cloud infrastructure, tools, and applications to accelerate and transform economic productivity.

Foreword

Over the past decade, there's been an evolution of cloud computing. What was once a business enabler is now core to many emerging business models. This evolution has transformed the global business landscape, especially as we all rebuild the economy. What's even more significant is that the cloud is enabling us to democratize leverage from technology by breaking the shackles of capital-intensive foundations, driving quicker deployment and bringing in ease of implementation. This is changing the game by enabling small and large enterprises along with established incumbents and emerging startups to access digital technologies on a level playing field, and to have equal opportunity to build, manage, secure, and deploy technology in a world where every business is a tech business. We now have a unique opportunity not merely to restore the past, but to create new equitable opportunities and dramatically advance broad-based prosperity for people throughout the world.

Along with its inherent capability to bring together a confluence of value from technology and tools like data analytics, artificial intelligence, blockchain, and 5G, the cloud's evolution can be better enabled with a combination of policymaker- and private-sector investments. There has been significant progress in several countries where this collaborative contribution is strong. Meeting that objective will depend on several factors, and we can learn valuable lessons from the experience of enterprises and countries that have been leaders and those that have been laggards.

The Global Cloud Ecosystem Index 2022, outlined in this report, showcases four themes and the role each has played in promoting the availability of cloud services. Countries are ranked based on their performance across each theme: infrastructure, ecosystem adoption, security and assurance, and talent and humanity affinity.

The Index charts out the path that cloud computing takes to help make economies more diversified and resilient, powering applications such as sustainable transportation and AI-enhanced scientific research and development, while also helping to future-proof skills and jobs.

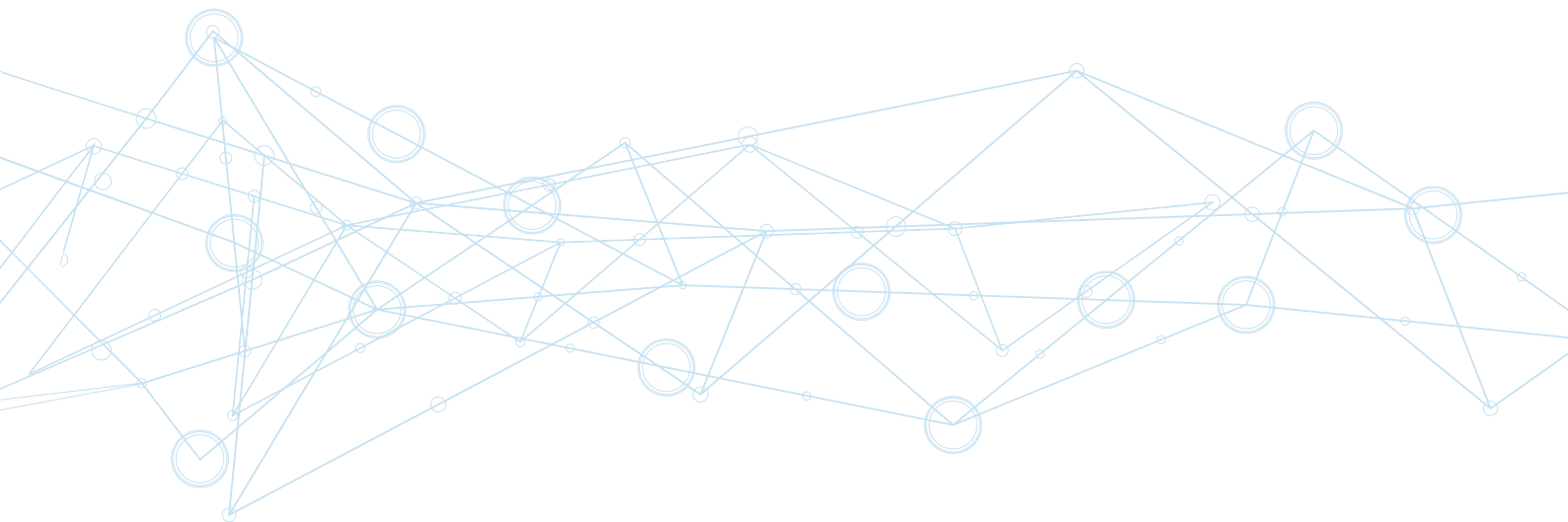One of the great benefits of the cloud's ongoing evolution and maturation will be its role in bringing more people into the modern, digital world. Connectivity is fundamental to prosperity, and the cloud is leveling the playing field for companies — particularly those that are small and those that are headquartered in developing countries. By providing the same suite of technologies and services, regardless of size and location, and doing so at reasonable price points, the cloud breaks down barriers to growth and helps stimulate those employment opportunities that can boost living standards.

Innovation, of course, underpins the growth of modern societies, and the cloud is fundamentally an enabler of innovation — creating a network effect across processes, data, content, and experience. The challenge ahead is for private and public sectors to continue implementing the measures that support not just continued but scaled innovation and help more institutions — and more individuals — to realize the cloud's full potential.

The Global Cloud Ecosystem Index 2022 provides a roadmap for maximizing that potential and creating a dynamic digital future that's defined by more opportunity — and more prosperity — for people no matter how different or how disparately spread in an unequal world. The promise of the cloud, when fully realized, is to uplift and equalize us all.

Ravi Kumar S
President, Infosys Limited

Preface

Contents

01 Executive summary

A decade or so ago, cloud computing was a burgeoning phenomenon, driving cost savings, flexibility, and innovation. Today, cloud *is* computing – a foundational resource for businesses and governments alike as they strive to harness emerging technologies such as 5G, artificial intelligence, and the internet of things.

Everywhere you look, cloud innovation is happening. Mobile internet powerhouse South Korea is turbocharging its cloud services development with split-second 5G broadband technology. India aims to put the power of digital tools in the hands of its people, to build the applications that undergird Indian social and economic life. And Belgium will invest more than a quarter of its EU-allocated covid recovery funds to bolster its data infrastructure.

The Global Cloud Ecosystem Index 2022 is a snapshot of worldwide cloud development and innovation. It ranks 76 nations and territories on the technology, regulations, and talent they use to promote cloud computing services. The index consolidates scores given to each nation or territory across four themes, or pillars: infrastructure, ecosystem adoption, security and assurance, and talent and human affinity. The key findings are as follows.

- **Global Cloud Ecosystem Index 2022 leaders combine digital infrastructure and governance leadership**. Top scorers show significant efforts to propagate digital infrastructure and have digitally minded governments that use the cloud to deliver public services and safeguard personal data and digital transactions. Singapore leads the Index overall, thanks to a relentless "cloud-first" strategy that has benefited from a central government commitment and an ability to cultivate collaboration and cooperation across a nationwide digital transformation project. After Singapore, the rest of the Index's top 10 places are European countries that seek to preserve the rights of digital consumers (largely via the European Union's General Data Protection Regulation, GDPR) and to curb monopolistic tendencies of the internet services sector.

- **Fast-evolving digital infrastructure is foundational for a nation's cloud capabilities.** The top-ranked countries in the infrastructure pillar are largely Global Cloud Ecosystem Index 2022 leaders, relying on copious and reliable broadband and a reasonable density of secure servers and data centers to underpin overall cloud computing capabilities. Increasingly, 5G network investments are seen as a key cloud enabler, bringing computing resources, and the applications they enable, closer to consumers and businesses, and with greater speed and fidelity.

- **Enter the ecocycle.** There is a virtuous cycle — an "ecocycle" — emerging in many leading cloud economies, as the increased use of scalable and distributed computing resources by consumers and businesses in turn serves as a catalyst for developing greater and more efficient cloud resources, which accelerate further digital transformation across their economies. This has two profound implications for the future of the cloud: greater coordination of computing resources will drastically reduce "digital waste" (inefficient legacy infrastructure and unstructured data), and open architectures based on application programming interfaces, or APIs, will allow organizations to share insights and computing resources more efficiently and reciprocally.

- **Bridges, not fortresses.** Most cloud-minded governments work to build and promote a "trust infrastructure": the public policy and regulatory and social conventions that ensure a government's digital channels are efficient, effective, and secure. This is particularly noticeable in Europe's strict approach to data privacy and consumer privacy, which rather than create a regulatory fortress between it and the rest of the world has influenced global practices of compliance and regulatory action. Thus, there is hope that cloud technology ecosystems could, over time, provide the impetus for international bridge building, and in turn help strengthen global regulatory and cybersecurity infrastructure.

- **The cloud as a talent magnet.** A country's cloud-relevant talent assets have as much to do with its market dynamics and opportunities as its "raw materials" of engineering and computing skills. But this is nevertheless an important consideration for cloud-centric operations.

Methodology

The Global Cloud Ecosystem Index 2022 is based on the analysis of global macroeconomic, labor, trade, and technology data and primary research interviews with global technology developers, analysts, and policymakers. It quantifies the economies of 76 countries and territories along four separate pillars: infrastructure, ecosystem adoption, security and assurance, and talent and human affinity. Within each pillar, a series of indicators — lists of qualitative and quantitative factors — were then selected and populated. Through trend analysis and research, weighting assumptions were assigned to determine the relative importance with which each indicator and pillar influenced a country's cloud computing posture.

02 Introduction

The Global Cloud Ecosystem Index 2022 reveals a collection of countries top all its pillars. Their scores represent significant efforts to make digital infrastructure available to all constituents and are complemented by pro-cloud governments that use digital tools to deliver public services and create regulatory frameworks to safeguard personal data and digital transactions.

The cloudification of computing and digital application resources is not only essential for knowledge industries and digitally "native" businesses, but also for manufacturers, logistics companies, and other organizations keen to exploit the efficiencies and flexibility that the cloud provides. The cloud facilitates automation and AI, advances that help organizations manage network performance and generate the data that comprise much of the intrinsic value of increasingly intelligent factories and warehouses. The cloud has become an indelible and foundational part of nearly every national economy's journey toward enhanced productivity.

Cloud-enabled digital capabilities are becoming ever more pervasive, allowing governments, businesses, and citizens to conduct transactions efficiently and equitably. The cloud provides a resource pool of digital capabilities that accelerates a country's economic progress and increases equity and sustainability.

The Global Cloud Ecosystem Index 2022 rates and ranks each of the world's major economies according to how well technology, regulations, and talent promote the availability of cloud services. It also evaluates and compares the regulatory frameworks and digital practices that promote the use of cloud models in the public and private sector.

MIT Technology Review Insights evaluated each country using various data and indicator sets, organized into four driving themes: Infrastructure, Ecosystem Adoption, Security and Assurance, and Talent and Human Affinity.

- **Infrastructure:** This pillar consists of various data points that indicate how well each country is served by telecommunications networks and computing resources that enable cloud-centric production models. In addition to an overall indicator of telecoms capacity assessed by the UN, these metrics include the number of data centers, secure servers, and unique internet protocol addresses in each country, relative to its population. Indicators in this pillar also include the country's average broadband internet speed and its electricity grid coverage. The infrastructure pillar accounts for 15% of each country's overall Global Cloud Ecosystem Index 2022 score.

Figure 1: All Cloud Ecosystem Index rankings in order

Infrastructure

This pillar is based on data points that indicate how well a country is served by its telecommunications networks and computing resources that enable cloud-centric production models.

#	Country	Score	#	Country	Score	#	Country	Score
1	Singapore	8.48	8	France	8.07	15	Japan	7.76
2	Finland	8.46	9	Norway	8.07	16	Ireland	7.74
3	Sweden	8.43	10	Luxembourg	8.04	17	United States	7.71
4	Denmark	8.28	11	United Kingdom	8.00	18	Austria	7.71
5	Switzerland	8.28	12	Australia	7.91	19	South Korea	7.63
6	Germany	8.13	13	Netherlands	7.87	20	Canada	7.58
7	Iceland	8.13	14	New Zealand	7.78			

Ecosystem adoption

A half dozen indicators combine to determine the extent to which each country's constituents access the outputs of cloud application and services across public and private sectors. At 35%, this pillar contributes the largest portion to the Index's score.

#	Country	Score	#	Country	Score	#	Country	Score
21	Hong Kong, China	7.54	28	Poland	7.25	35	Malaysia	6.85
22	Portugal	7.44	29	Taiwan	7.14	36	Russia	6.78
23	Italy	7.40	30	Hungary	7.13	37	Chile	6.78
24	Czech Republic	7.37	31	Slovakia	7.02	38	Bulgaria	6.72
25	Spain	7.35	32	Israel	7.00	39	Uruguay	6.59
26	United Arab Emirates	7.33	33	Greece	6.90	40	China	6.51
27	Belgium	7.31	34	Romania	6.87			

Security and assurance

This pillar measures the maturity of regulatory environments that promote progressive, cloud-forward data security and sovereignty environments—and that enable trust in digital resources.

#	Country	Score	#	Country	Score	#	Country	Score
41	Turkey	6.38	48	Argentina	5.99	55	Saudi Arabia	5.78
42	Thailand	6.35	49	South Africa	5.97	56	Indonesia	5.75
43	Ukraine	6.14	50	Mexico	5.94	57	Colombia	5.63
44	Kazakhstan	6.10	51	India	5.93	58	Peru	5.46
45	Costa Rica	6.10	52	Brazil	5.92	59	Philippines	5.40
46	Kuwait	6.09	53	Vietnam	5.82	60	Morocco	5.20
47	Qatar	6.06	54	Iran	5.80			

Talent and human affinity

The indicators in this pillar examine each country's human capital assets that can contribute to a cloud-based digital economy.

#	Country	Score	#	Country	Score	#	Country	Score
61	Dominican Republic	5.14	68	Nigeria	4.05	75	Angola	3.12
62	Ecuador	5.01	69	Bangladesh	3.94	76	Ethiopia	2.68
63	Paraguay	4.95	70	Zambia	3.92			
64	Egypt	4.69	71	Uganda	3.83			
65	Kenya	4.45	72	Guatemala	3.71			
66	Ghana	4.39	73	Pakistan	3.57			
67	Algeria	4.15	74	Cameroon	3.39			

Source: MIT Technology Review Insights, 2022

Europe's cloud leaders have created a digital society that builds trust in its institutions, and in many cases, parlays that into competitive advantage: tiny Luxembourg (10th place) has layered data center hosting and cybersecurity services onto its traditional role as a finance and business services hub.

- **Ecosystem adoption:** A half dozen indicators combine to determine the extent to which each country's constituents access the outputs of cloud application and services across public and private sectors. These include measures of digital service adoption, participation in online services in the public sector, the growth in software-as-a-service (SaaS) revenues, innovation, and the price of broadband services relative to gross domestic product. At 35%, this pillar contributes the largest portion to the Index's score.

- **Security and assurance:** This pillar measures the maturity of regulatory environments that promote progressive, cloud-forward data security and sovereignty environments — and that enable trust in digital resources. This pillar has a weighting of 25% of the Index's score.

- **Talent and human affinity:** The indicators in this pillar, which account for 25% of a country's overall Index score, examine each country's human capital assets that can contribute to a cloud-based digital economy. They include assessments of the country's human capital productivity, depth of engineering and math skills, as well as the overall internet literacy in the society.

Leaders in cloud

The Global Cloud Ecosystem Index 2022 reveals a collection of countries top every pillar. Their scores represent significant efforts to make digital infrastructure available to all constituents and are complemented by pro-cloud governments that use digital tools to deliver public services and create regulatory frameworks to safeguard personal data and digital transactions. In first place is Singapore (see Figure 1), which has led a relentless "cloud-first" digital transformation effort begun in 2018 with a five-year national government project to migrate the majority of government information technology (IT) resources to public cloud infrastructure; by January 2022, Singapore had an estimated 600 government systems in the cloud.[1] The government's commitment to transform its digital economy has even engaged its public security bodies: Singapore's "Home Team" — the collection of seven departments and three statutory boards that collectively oversees the country's public safety and defense — has recently engaged Microsoft to develop a sovereign cloud to accelerate its innovation and training and production of digital resources.[2]

Singapore's growing cloud expertise is a function of its central government commitment and its ability to manage and coordinate a multi-stakeholder digital transformation project, according to Lim May-Ann, the emeritus director at the Asia Cloud Computing Association and the director of the Fair Tech Institute at Access Partnership. She describes the country's Government Technology Agency, known as GovTech, as pivotal in connecting government agencies to one another and to private sector companies through application programming interfaces (APIs). "Uniquely, GovTech is a government agency with a culture that allows for innovation and cross-sectoral collaboration," she says.

After Singapore, the rest of the Global Cloud Ecosystem Index 2022's top 10 places are held by European (and primarily European Union) countries, including all five Scandinavian countries. EU regulators often have a combative relationship with "big tech" companies, including global cloud leaders, but this contentious stance,

at first glance, seems at odd with their cloud leadership. These tendencies are perhaps better viewed as part of a policy posture that seeks to preserve the rights of digital consumers – largely established through the General Data Protection Regulation (GDPR), a landmark data protection framework put into effect in 2018 – and to curb monopolistic tendencies of the internet services sector. As such, Europe's cloud leaders have created a digital society that builds trust in its institutions, and in many cases, parlays that into competitive advantage: tiny Luxembourg (10th place) has layered data center hosting and cybersecurity services onto its traditional role as a finance and business services hub.

Index scores across the top 10 leaders average 8.2. That number eases down slightly in the next cohort of 20 countries, to 7.5. These are still largely European countries, although it includes Asian and North American nations that include innovative technology markets (the

United States, Japan, South Korea, and Taiwan) and countries with cloud-progressive governments (Australia, New Zealand, and the United Arab Emirates). Scores accelerate downward after that, largely because of lowered ecosystem adoption scores and weaker policy frameworks in Asia, Latin America, and Africa. Toward the bottom of the Index, score challenges are compounded by poor digital infrastructure; countries in the lowest-scoring cohort – cloud laggards – have a median score of 3.6.

When looking at the scores through geographic lenses, largely similar patterns emerge – leading countries are ones that foster digital service adoption through a holistic focus on physical infrastructure and regulatory clarity (see Figure 2). After Singapore, Australia and New Zealand rank second and third among East Asia & Pacific nations; both digitally centric economies have seen cloud adoption rise among the fastest in the world, according to Infosys' 2021 Cloud Radar report.[3]
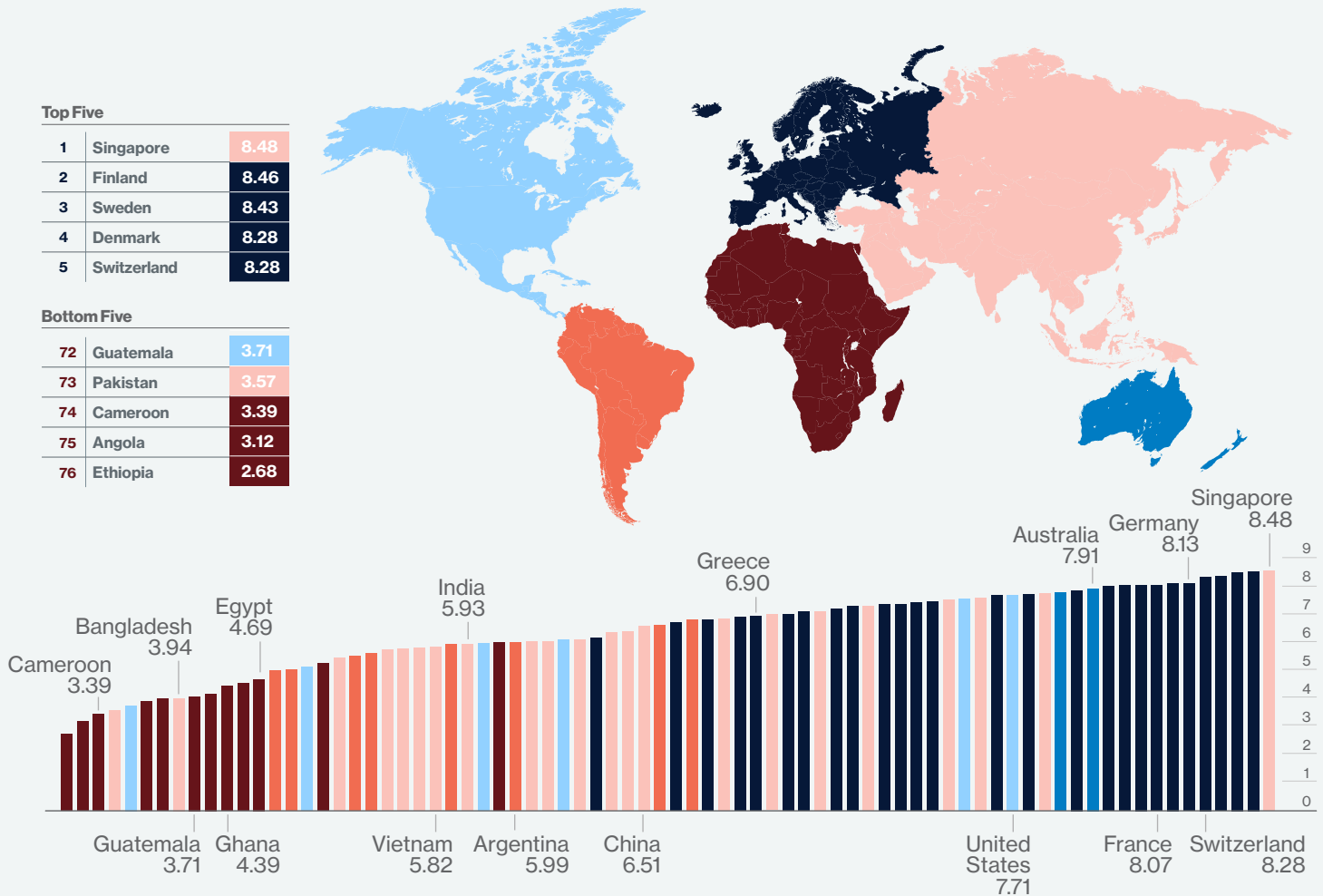
Figure 2: Top 10 Cloud Ecosystem Index ranks by geography (region)

Overall top 10

RANK	COUNTRY	SCORE	REGIONS
1	Singapore	8.48	East Asia & Pacific
2	Finland	8.46	Europe & Central Asia
3	Sweden	8.43	Europe & Central Asia
4	Denmark	8.28	Europe & Central Asia
5	Switzerland	8.28	Europe & Central Asia
6	Germany	8.13	Europe & Central Asia
7	Iceland	8.13	Europe & Central Asia
8	France	8.07	Europe & Central Asia
9	Norway	8.07	Europe & Central Asia
10	Luxembourg	8.04	Europe & Central Asia

Source: MIT Technology Review Insights, 2022

The Global Cloud Ecosystem Index 2022 rankings world map

Top Five

1	Singapore	8.48
2	Finland	8.46
3	Sweden	8.43
4	Denmark	8.28
5	Switzerland	8.28

Bottom Five

72	Guatemala	3.71
73	Pakistan	3.57
74	Cameroon	3.39
75	Angola	3.12
76	Ethiopia	2.68

Cameroon 3.39 · Bangladesh 3.94 · Egypt 4.69 · India 5.93 · Greece 6.90 · Australia 7.91 · Germany 8.13 · Singapore 8.48 · Guatemala 3.71 · Ghana 4.39 · Vietnam 5.82 · Argentina 5.99 · China 6.51 · United States 7.71 · France 8.07 · Switzerland 8.28

Source: MIT Technology Review Insights, 2022

In Europe, the global leaders from Scandinavia take most of the top slots, led by Finland, which has parlayed a largely mobile data innovation technology cluster into a leading position in edge computing. Finland has also emerged as a regional hub for the European Open Science Cloud, leveraging cloud computing resources to host initiatives, such as an inter-Nordic effort on climate modeling using a supercomputer hosted in the Finland IT Center for Science's data center in Kajaani.[4]

In Latin America, Chile leads the region with a score of 6.8. The country has been steadily cultivating a technology ecosystem comprised of several sectors, including biotech and human resources technology. A collection of data centers and hyperscale facilities — mission-critical facilities that support scalable applications — has been growing around Santiago to accommodate computing needs; Microsoft is among the most recent, having filed applications to develop a $317 million, 6-hectare facility over the next two years.[5]

03 "High-capillary" networks

Fast-evolving digital infrastructure is increasingly enabling access to cloud capabilities. It's helping bring computing resources, and the applications they enable, closer to consumers and enterprises, and with greater speed and fidelity. The top-ranked countries in the infrastructure pillar are largely indistinguishable from Global Cloud Ecosystem Index 2022 leaders overall (see Figure 3), as copious and reliable broadband and a reasonable density of secure servers and data centers serve to underpin overall cloud computing capabilities.

There has been a significant shift in the building of data centers globally over the last quarter century. Data center

Figure 3: Infrastructure pillar leaders (top 10) and laggards (bottom 10)

Overall top 10

RANK	COUNTRY	SCORE
1	Iceland	9.52
2	Denmark	9.37
3	Switzerland	9.28
4	Luxembourg	9.17
5	Sweden	9.09
6	United States	9.05
7	Singapore	8.93
8	Norway	8.90
9	Finland	8.81
10	New Zealand	8.78

Overall bottom 10

RANK	COUNTRY	SCORE
67	Kenya	4.06
68	Ghana	3.95
69	Pakistan	3.25
70	Bangladesh	3.23
71	Nigeria	3.03
72	Zambia	2.94
73	Angola	2.89
74	Cameroon	2.68
75	Uganda	2.29
76	Ethiopia	1.05

Source: MIT Technology Review Insights, 2022

"The cloud is going to play a very important role in providing resilience, agility, and low latency for heavy workloads with millions of people accessing applications."

Ravi Kumar S
President at Infosys

5G

aggregator Turbidite. As a result, data center builders and hyperscale cloud providers have shifted to hub-and-spoke distribution models, with remote computing resources connected to growing numbers of smaller edge computing facilities. The hub-and-spoke model also neatly dovetails with the growing need for nations to reduce energy-intensive infrastructure to achieve growing carbon emissions reduction targets. Barney notes that even tech-forward Singapore has shifted away from putting "air conditioning-hungry data centers on the equator; it isn't a very climate-friendly move."
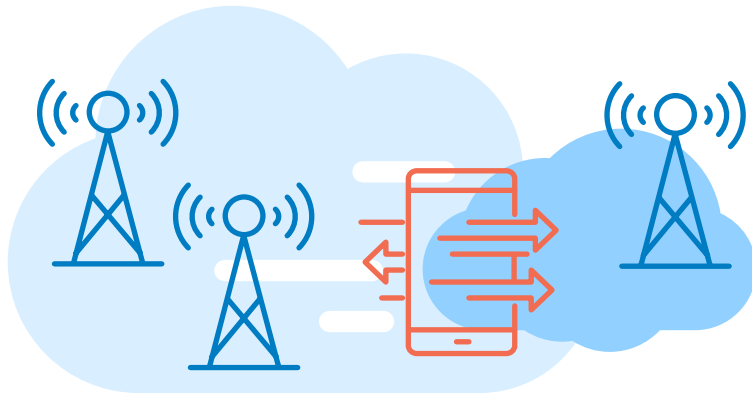
The need to build smaller facilities to engage edge computing resources, therefore, works against the earlier instinct to build vast clusters of data centers. It's also helping accelerate growth in broadband networks and 5G infrastructure, to create what Barney refers to as "high-capillary networks," which improve ubiquitous mobile data access in remote and poorer regions.

Ravi Kumar S, Infosys' president, notes that as digital development shifts to dispersed environments, "the cloud is going to play a very important role in providing resilience, agility, and low latency for heavy workloads with millions of people accessing applications."

As these environments shift toward hybrid cloud models, with workloads spread across on-premises and cloud environments, 5G is going to play an important role in distributing compute and storage resources.

This is because, cloud-forward policymakers hope, 5G networks will increasingly support multi-access edge computing (MEC) applications, automated systems, and managed networks of internet of things (IoT) and digital devices — all of which will allow enterprises and consumers to more effectively and productively access cloud computing resources. "5G networks enable the incorporation of the millions of devices that are defining the networks of the future," observes Professor Antonello Monti, who specializes in energy grid automation at Germany's RWTH Aachen University. In his view, cloud-based edge networks facilitated by 5G will allow enterprises and consumers to access computing resources and applications close to where their devices and facilities are.

clusters in densely populated urban business hubs reflected the industry's need to be close to corporations and talent in central business districts and to ensure access to stable sources of power. Over time, however, demands on computing resources have become more dispersed, and lower latency requirements have increased as smartphone-connected consumers require on-demand mobile connections to commerce apps and streaming video, and companies need to access fleets of sensors across their supply chains.

"Businesses need to get more customers and get closer to them," says Bill Barney, CEO of global data center

South Korea: Cloud on the go

South Korea scores near the top on telecom infrastructure, in large part because of a combination of robust competition in the country's communications services industry and a well-coordinated national information technology development policy. This has made Korea the world's most densely serviced broadband market for the better part of a decade; 86% of the country's fixed broadband subscribers have high-speed fiber-optic internet, twice the average recorded by the Organisation for Economic Co-operation and Development.[6]

Korea's need for speed has continued into the mobile internet. 5G has become an avenue for Korean carriers to promote cloud technology co-development through "sandbox" environments, as Korea Telecom has, using its KT Cloud platform to work with MEC application developers at the Yonsei Institute of Convergence Technology in Seoul and at the 5G Open Lab in Pangyo, a tech cluster outside the capital. SK Telecom has multiple partnerships with public cloud hyperscalers and a joint venture with Hewlett Packard Enterprise to develop an MEC platform to deliver to 5G carriers elsewhere in the Asia Pacific.

Cloud service development has been particularly intertwined with the rise of 5G in Korea, as Korean consumers continue to navigate their digital lives through smartphones and industries increase their reliance on robotics and other Industry 4.0 applications.

In December 2021, Naver Cloud, a cloud computing subsidiary of Korea's leading internet portal, Naver, launched a private 5G network for business clients seeking access to low-latency and high-capacity cloud resources.

5G operators and hyperscale cloud providers are increasingly developing collaborative frameworks. In the U.S., AT&T and Microsoft are collaborating on a private 5G edge service combined with a public MEC to offer low-latency enterprise services. Korea Telecom has launched two sandbox innovation programs to leverage 5G connectivity and the cloud (see "Cloud on the go," page 15). Cross-border efforts are also evolving, such as the 5G Future Forum – a global 5G carrier alliance formed in 2020 by such carriers as Vodafone, Korea Telecom, Mexico's América Móvil, Canada's Rogers, Telstra, and Verizon to create global MEC standards that allow hyperscalers and service providers to collaborate on deploying international edge-computing resources. Government entities are also looking to boost 5G capabilities to enhance the reach and efficacy of cloud resources. For nearly a decade, the European Commission has been advancing 5G research-and-development efforts through a public-private partnership on 5G, which, among other things, aims to increase machine-to-machine and IoT network capabilities across the EU.

Enhancing a nation's cloud capabilities, therefore, increasingly requires pervasive – rather than just dense – computing resources. That said, many countries still cling to the notion that self-sufficiency in data center infrastructure is the key to enhancing their digital economies.

Ecosystem adoption: Toward a virtuous ecocycle

The extent to which consumers and companies effectively use the cloud is assessed in the Global Cloud Ecosystem Index 2022's second pillar, ecosystem adoption. Scores in this pillar represent an aggregation of several indicators that rate the usage of digital channels amongst a nation's constituents, the density of software-as-a-service (SaaS) organizations in the economy, and the relative affordability of broadband prices. Taken together, these indicators paint a picture of how much — and how well — people and businesses use cloud resources to enhance their productivity and economic progress. Here again, the top-ranked countries in this pillar are primarily overall Global Cloud Ecosystem Index 2022 leaders, with the exception of Japan, which performs better (6th) in the adoption pillar than it does (17th) overall, and Germany, which is sixth-ranked overall, but only 24th in its adoption (see Figure 4).

The variance largely has to do with the relative penetration of digital commerce and services in each country. Japan's e-commerce marketplace, estimated to be $217 billion in 2021, is the world's third largest, and more than half of its households routinely shop online.[7] The Fuji Chimera Institute estimates that Japanese enterprise use of SaaS services grew nearly 30% in 2020[8], and Allied Market Research forecasts that, as robotics and automation continue to expand in Japan's manufacturing sector, spending on edge AI technologies will grow from $7.8 billion in 2020 to $40.8 billion in 2030.[9] Japan's digital economy is also home to a number of innovative, globally

influential digital powerhouses, such as Softbank and Rakuten. Germany's digital adoption is, by contrast, moving at a slightly slower pace: at $107 billion,[10] Germany's e-commerce market is the world's fifth largest, but it remains smaller than that of the United Kingdom, an economy three-quarters of Germany's size. It grew 19% in 2021, while Europe's $17 trillion digital commerce market grew 30%.[11] Enterprise adoption also lags: a recent EuroCloud Deutschland survey of IT decision-makers found that fewer than a quarter were currently undertaking cloud-native approaches to their technology, and many are hampered by the lack of talent.[12]

But Germany's relatively slow adoption of digital channels belies a deeper transformation in its manufacturing and logistics sectors as it builds its fourth industrial revolution infrastructure and capabilities. Also referred to as Industry 4.0, the increased application of digital technologies in production processes — including the use of AI, automation, and the IoT — is widely held to be a critical factor in a country's future competitiveness.

Figure 4: Ecosystem adoption pillar leaders (top 10) and laggards (bottom 10)

Overall top 10

RANK	COUNTRY	SCORE
1	Singapore	8.07
2	France	7.82
3	Finland	7.58
4	Sweden	7.49
5	Iceland	7.44
6	Japan	7.43
7	Switzerland	7.39
8	Luxembourg	7.36
9	United Kingdom	7.19
10	Denmark	7.18

Overall bottom 10

RANK	COUNTRY	SCORE
67	Nigeria	4.19
68	Kenya	4.13
69	Uganda	3.89
70	Ghana	3.76
71	Ethiopia	3.60
72	Pakistan	3.23
73	Cameroon	3.05
74	Angola	3.01
75	Zambia	2.87
76	Algeria	2.33

Source: MIT Technology Review Insights, 2022

Mark Esposito, who lectures on technology and industry at Harvard University and is co-founder of the AI startup Nexus FrontierTech, observes that because "cloud is an integrated technology — a series of technologies or an architecture of technology which overarches around an economic system," it complements the Industry 4.0 aspirations of countries with experience creating industrial development policies and pushing economic infrastructure agendas, particularly in Asia. "South Korea has a clear national Industry 4.0 mandate, and you have interesting clusters in Malaysia and a very interesting hub emerging for Indonesian AI community," says Esposito. "These places came together with their infrastructure work that is gaining momentum, so the cloud technology community might sparkle into something more."

The increased use of scalable and distributed computing resources makes consumer markets and industry more efficient and governments more responsive. Fostering greater and more efficient usage of the cloud will accelerate further digital transformation across the

economy, creating a virtuous cycle for the entire cloud ecosystem — an "ecocycle." Critical to the ecocycle's development, according to Michael Pichler, vice president of customer transformation at Salesforce UK and Ireland, is the continuation of an evolution in the way organizations adopt cloud resources. "The initial beauty of the cloud was that, suddenly, computing layers became virtual: servers are not physical boxes anymore, and workloads can be easily shifted," Pichler says. "But the big shift is in the ability of enterprises to leverage the cloud as a series of platforms for business capabilities, so they can cluster their technology requirements around the best option: easily assigning customer-facing requirements to SaaS providers, say, or developing bespoke capabilities on the public cloud."

The resulting flexibility has led companies to focus sharply on outcomes, Pichler says. The companies that are doing well today are picking the right technologies to achieve their business outcomes. This has two profound implications for the future state of the ecocycle. The first

"Businesses need to get more customers and get closer to them," says Bill Barney, CEO of global data center aggregator Turbidite.

is that coordinated platforming of computing resources will drastically reduce what Esposito refers to as digital waste: a collection of inefficient legacy infrastructure and an accumulation of unstructured data, much of it gathered through duplicated or siloed data-gathering processes.

The second is that, as adoption of open, API-based architectures grows, organizations will be able to share data, insights, and computing resources with their partners more efficiently and reciprocally. Pichler sees this

as critical: "Now that the idea of APIs has become mainstream, it is enabling ecosystem partners to integrate their applications much better, and with it generate mutually transformative insight." Many cloud-aspirational governments are experimenting with frameworks to accelerate the dissemination of APIs and open development platforms, such as India Stack, an ambitious multi-stakeholder effort building on the strides the country has made in digital identity and payment infrastructure (see "Cloud innovation," page 18).

India: Cloud innovation
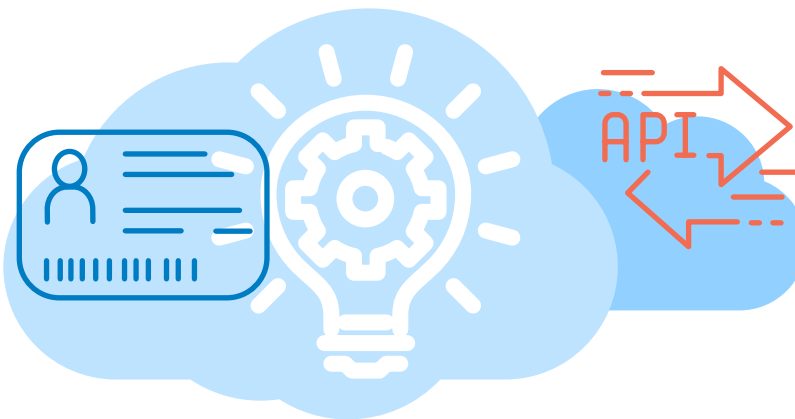
The India Stack project aims to provide its people with comprehensive and powerful cloud-based economic tools, building on an already impressive collection of digital assets, which include the world's single largest digital citizen identification project and one of the world's highest usages of online payments.

India Stack seeks to encourage API innovation and development in the

digital "public goods" that underpin India's social and economic life. These include authentication capabilities around Aadhaar, the biometric digital identification system managed by the Unique Identification Authority of India, which, as of June last year, was issued to over 99% of the 1.3 billion Indians over the age of 18. It also includes Unified Payments Interface, the National Payments Corporation of India's mobile

banking platform, which saw 38 billion transactions accounting for more than $1 trillion in value nationwide in 2021.[13]

Other assets are owned and managed by Indian ministries, including the Ministry of Communications and Information Technology; all participating government agencies work through India Stack to promulgate APIs and provide developers access to sandboxes in an effort to increase the digital capabilities of these core APIs. The penetration of digital identity and e-payment channels in India is reflected in its high e-participation indicator score, which helps lift the country's overall pillar score to 5.69 (45th overall).

05

Bridges, not fortresses: Security and assurance

The overarching goal of most governments as they work to nurture their cloud-centric digital economies is to build and promote a "trust infrastructure": the public policy and regulatory and social conventions that assure the digital channels used by an economy's consumers and businesses are efficient, effective, and secure.

The security and assurance pillar rates each country on a collection of indicators that include the quality of its cybersecurity regime, the effectiveness of its regulatory framework, and (another important facet of how well trust is maintained in a digital society) press freedom. Finland and the Netherlands are at the top of this pillar, with nearly spotless scores across all these dimensions (see Figure 5). Dutch national cybersecurity resources have transformed the country into a digital security service platform for regional governments and enterprises. The Hague alone hosts a European cybersecurity innovation cluster, the Global Forum for Cyber Expertise (a multinational cybersecurity training and capacity-building) and the cybersecurity operational headquarters for both Europol and NATO.[14] Yet even among cybersecurity leaders, constant vigilance is required; Belgium (10th-ranked in the pillar) is seeking to further boost its cybersecurity capabilities following a recent high-profile attack (see "Ramping up cybersecurity," page 21).

Given the globally interconnected nature of the cloud, it's clear that public policymakers and regulatory environments must support cross-border flows of secure data and the access of application and computing resources.

Nearly all the laggards in this pillar are relatively poor performers across the Index. They are largely emerging economies with low scores in government effectiveness, press freedom, and strength of regulatory institutions, which prevent them from being regarded as secure and trustworthy digital destinations. As a result, these laggards largely deter international investment in digital infrastructure or other cloud-friendly assets, although a few security laggards, such as Saudi Arabia or Iran, have bootstrapped their own digital infrastructure, technology, and talent resources to maintain capable, if somewhat geopolitically isolated, domestic cloud ecosystems.

Figure 5: Security and assurance pillar leaders (top 10) and laggards (bottom 10)

Overall top 10

RANK	COUNTRY	SCORE
1	Finland	9.73
2	Netherlands	9.63
3	Denmark	9.57
4	Sweden	9.56
5	Luxembourg	9.47
6	Norway	9.47
7	Switzerland	9.36
8	Germany	9.28
9	Austria	9.23
10	Belgium	9.19

Overall bottom 10

RANK	COUNTRY	SCORE
67	Saudi Arabia	5.25
68	Ecuador	4.76
69	Pakistan	4.21
70	Algeria	4.21
71	Iran	4.08
72	Angola	3.87
73	Bangladesh	3.87
74	Cameroon	3.11
75	Ethiopia	2.94
76	Guatemala	2.84

Source: MIT Technology Review Insights, 2022

Given the globally interconnected nature of the cloud, it's clear that public policymakers and regulatory environments must support cross-border flows of secure data and the access of application and computing resources. To facilitate, national governments must, in a sense, engage in a delicate balance, attempting to boost their own unique digital assets to attract investment and increase their own international competitiveness while simultaneously promoting an open, global, and frictionless digital connectivity.

When Europe's GDPR came into full effect in 2018, there was a concern that Europe was going to turn into a very different policy and e-commerce environment from the rest of the world. It was assumed that this would create friction, given the gulf between Europe's strict approach to data privacy and consumer privacy and most of the rest of the world's. In fact, it seems the opposite is true: global practices of compliance and regulatory action seemed to be cleaving toward GDPR and its goals.

Giusella Finocchiaro is a professor of internet law at the University of Bologna, Italy, and chairperson of the

Electronic Commerce working group at the United Nations Commission on International Trade Law (UNCITRAL). She believes that GDPR's chief merit is that it "drives attention to the value of personal data, and this could create a potentially global standard."

Moreover, Finocchiaro sees GDPR as a catalyst for further innovation of data regulation: "this isn't the conclusion of the story; it's the beginning," with at least two more chapters to be written. The first should center on non-personal data, which European legislation doesn't address. Finocchiaro notes that some regulatory environments, particularly China's, do include non-personal data. "The second is finding a way, at an international level, to build bridges between different data protection systems — not regulatory fortresses around each," as Finocchiaro believes Europe, China, and other regimes currently maintain.

There's hope that cloud technology ecosystems — which naturally engender innovation in such foundational components of trust technology as blockchain and AI — could in turn provide the impetus for this bridge

building. And these can then help strengthen regulatory and cybersecurity infrastructure. The Asia Cloud Computing Association's Lim believes that a nation's optimal data governance framework needs "a decent tolerance for risk, the capacity and capability to quickly design and write policies, and a pragmatic ability to implement them." Risk appetite, Lim believes, makes otherwise conservative policymakers think more innovatively: "Estonia has backed up all of its critical national data outside of its own borders, so it can rebuild its national infrastructure even if the whole country falls."

Lim also notes that speedy policy implementation must be complemented by a similar speed to review and revise cloud policies as circumstances change. She cites

Australia, which had a ground-breaking cloud-first policy, revised every three or four years to incorporate new security policies. This included a cloud accreditation program designed to "create an ecosystem where vendors that serve the government were trusted," but it was soon discovered that small and medium-sized Australian companies were left out of government procurement processes, as they struggled with the cost and complexity of the accreditation process.

The Australian government responded quickly, reworking their program into a simpler, more inclusive online marketplace. Lim points to other nimble, cloud-minded governments in the UK and Singapore as examples of those that focus attention on responsive "policy cycling and policy iteration."

Belgium: Ramping up cybersecurity
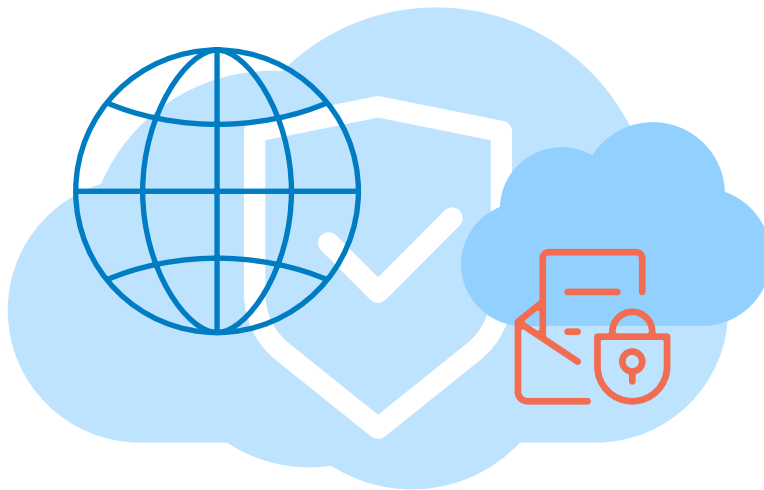
ike many European Union countries, Belgium had earmarked considerable funds from the EU's post-pandemic Recovery and Resilience Facility to invest in sustainability and digital transformation. The country will invest 27% of its €5 billion allocation to enhance data infrastructure and governance frameworks.[15]

A sizeable portion (€61 million) will be allocated for strengthening Belgium's cybersecurity facilities, which have come into renewed focus in the wake of a December

2021 cyberattack on the country's Defence Ministry, which left it unable to access part of its network, including email servers, for nearly a month.[16]

Belgium has placed considerable emphasis on digital security for years, although, like many advanced economies, it has seen a marked increase in attacks as the pandemic-driven shift to remote working has created new opportunities for cybercriminals; a study in early 2021 sponsored by a coalition of Belgian government and business organizations found that 43% of corporate respondents had been the victim of some sort of cyberattack.[17]

06

Human capacity and capabilities

The availability of talent and skills is a critically important consideration for cloud services companies, SaaS providers, and other ecosystem participants when determining where to set up service nodes and regional operations globally. The depth and quality of this talent is measured in the talent and human affinity pillar. A noteworthy entry into the ranks of the leaders in this pillar is Iran, in third place (see Figure 6 and "Talent in a vacuum," Page 23).

Just as more digital infrastructure helps reduce latency and increase performance for cloud users in a particular country, talent pools can also serve cloud service providers better when they're close to end users. Tracey Arnish, vice president of human resources for Google Cloud's platform engineering and technical infrastructure, says, "We select our cloud region locations based on customer demand to make services easier and faster for companies, and we also invest in those locations to make sure we have the right talent to serve our customers."

Arnish regards location as a means to broaden its talent pool. "To keep our culture inclusive and innovative, we aren't looking for culture fit so much as we're looking for culture 'add' – bringing a more diverse set of perspectives, backgrounds, and experiences that can help us better understand our customers, build better technology, and drive better outcomes." Google's pursuit of culture is putting a sharper focus on such places as Atlanta and

A country's cloud-relevant talent assets have as much to do with its market dynamics and opportunities as its "raw materials" of engineering and computing skills.

Seattle in the United States, Mexico City, Warsaw, Poland, and various Indian cities. This co-location imperative is borne out in the performance of high scorers: half of the top 10 countries in the talent pillar are also in the top ranks of both the infrastructure and ecosystem adoption pillars, suggesting that the availability and capabilities of cloud talent are highly correlated with a market's density of digital infrastructure and service adoption.

When looked at this way, a country's cloud-relevant talent assets have as much to do with its market dynamics and opportunities as its "raw materials" of engineering and computing skills. "A computer science degree isn't required for most of our software engineering or product manager roles, and we have several learning journeys that enable candidates from different backgrounds to explore roles in technology," says Arnish. She adds that cloud-based tools and learning resources help Google augment and transition roles more effectively.

Figure 6: Talent and human affinity pillar leaders (top 10) and laggards (bottom 10)

Overall top 10

RANK	COUNTRY	SCORE
1	Germany	8.86
2	Singapore	8.51
3	Iran	8.42
4	South Korea	8.31
5	Finland	8.21
6	Sweden	8.20
7	United Kingdom	8.17
8	Russia	8.02
9	Denmark	7.86
10	Switzerland	7.82

Overall bottom 10

RANK	COUNTRY	SCORE
67	Egypt	4.23
68	Bangladesh	3.73
69	Pakistan	3.60
70	Guatemala	3.43
71	Kenya	3.36
72	Ghana	3.20
73	Nigeria	3.16
74	Uganda	2.84
75	Angola	2.66
76	Ethiopia	2.11

Source: MIT Technology Review Insights, 2022

Iran: Talent in a vacuum

Iran maintains robust science and technology academic infrastructure and continues to produce nearly a quarter of a million engineering graduates annually, the world's fifth-largest pool after China, India, Russia, and the United States. Moreover, at 70%, according to UNESCO estimates, Iran awards the highest percentage of engineering degrees in the world to women.

A well-skilled talent pool has laid the groundwork for a burgeoning information economy; in a November 2021 report on Iran's innovation ecosystem,[18] the UNDP found that the number of workers in knowledge-based companies grew from 86,000 in 2016 to more than 227,000 in 2021. That said, Iran's ongoing geopolitical isolation creates barriers between its digital economy and that of the rest of the world. This in turn impedes its access to technology and bandwidth, and lowers its ranking in other dimensions.

Some of these restrictions are self-imposed; the UN Human Rights Commission recently expressed concerns that the Iranian Parliament's potential passage of a restrictive Online Services Bill will further limit its country's access to global internet resources.[19]

But the availability of a country's digital workers is still an important raw material consideration for cloud-centric operations in site location, and many cloud ecosystem leaders naturally attract and foster relevant pools of talent: technology and security analyst company Techshielder recently named Singapore the country with the highest availability of cybersecurity professionals.[20]

Abundance of skilled workers is also an important consideration for cloud companies looking to implement infrastructure- and process-intensive projects at scale. This makes India, Vietnam, and the Philippines, which are ranked second, third, and fourth in the Global Cloud Ecosystem Index 2022, among emerging economies (see Figure 7).

Turbidite's Barney singles out India and the Philippines as having large pools of what he calls "interoperable talent," English-speaking tech workers who are familiar with global technology operations environments. Nexus FrontierTech's Esposito explains that his company chose Vietnam as a key development hub for its operations, positing that the country's education system prepares workers to take on new skills within a short period of time, "so raw talent can be turned into data scientists with the least amount of 'transaction costs.'" One of the ancillary benefits of this system has been the high degree of inclusion in the digital workforce; Esposito points out that most of his company's data scientists are women.

Figure 7: Top 10 cloud rankings by economic development tier, lower middle income

Overall top 10

RANK	COUNTRY	SCORE
43	Ukraine	6.23
51	India	5.98
53	Viet nam	5.92
59	Philippines	5.47
60	Morocco	5.33
64	Egypt	4.87
65	Kenya	4.69
66	Ghana	4.53
67	Algeria	4.23
68	Nigeria	4.22

Source: MIT Technology Review Insights, 2022

07 Conclusion

The notion of the cloud powering a virtuous ecocyle is a compelling one: the way consumers and businesses use the cloud today can speed up a country's digital transformation, powering new applications such as sustainable transportation and AI-enhanced scientific research and development, and helping future-proof skills and jobs in an increasingly automated world. Cloud platforms and resources can help both business and government decision-makers generate operational efficiencies. They also can be used to measure the carbon footprint of economic activities and generate a broader view of the activities that create carbon. Germany's Federal Agency for Cartography and Geodesy is creating a cloud-based digital twin of Germany to engage in simulation and modeling efforts to assist in the optimal management of land and energy, mitigate the impact of extreme weather events, and plan out carbon capture strategies.[21]

To effectively maintain this ecocycle, leaders of governments in the Global Cloud Ecosystem Index 2022 must continue to be referees and players on the field: pro-cloud governments are those that promote digital channels by both creating strong regulatory environments and by being leading users of cloud resources themselves.

What the next phase of the ecocycle looks like in any given economy largely depends on how business and government respond to the opportunities created. "The future is extremely exciting, almost unimaginably so, when we consider the metaverse and the future of digital business — and the cloud is a very important enabler of both," says Vishal Salvi, senior vice president, chief information security officer, and head of Infosys' cybersecurity practice. He explains that, as most global computing resources and digital applications inexorably shift to the cloud, two challenges will emerge. "While I don't see a gloom-and-doom event emerging, privacy and data localization challenges may create some constraints before the industry finds its equilibrium." A second and more potentially challenging problem for cloud-dependent businesses, Salvi observes, is industry consolidation: "We continue to move from an extremely distributed compute ecosystem to one defined by extremely highly concentrated compute resources. Do we really want to consolidate the world's digital ecosystem into the hands of three or four companies?"

Market data suggest that this trend is already underway. Analysts at Canalys estimated that global cloud infrastructure spending in the fourth quarter of 2021 grew 34% year-on-year, to $53.5 billion, and that nearly two-thirds of that spend was captured by the world's top three hyperscale providers.[22] At the same time, increasingly cloud-dependent businesses are struggling to control spending: in its 2021 State of the Cloud report, Flexera noted survey results revealing that their average respondents went 24% over budget in public cloud spending, and were anticipating cloud investment in the next year would increase 39%.[23]

Maintaining leadership in the cloud ecosystem, therefore, will require vigilance to ensure that cloud resources are maintained in the environments in which they were first

"The future is extremely exciting, almost unimaginably so, when we consider the metaverse and the future of digital business — and the cloud is a very important enabler of both."

Vishal Salvi
Senior Vice President, Chief Information Security Officer, and Head of Infosys' Cybersecurity Practice

cultivated — that is, distributed, readily accessible, and fit for purpose. No simple task, it must be incorporated into an already sizable to-do list for cloud-minded governments and industry participants, which includes staying on top of evolving regulatory notions of data privacy (which soon may include, as UNCITRAL's Finocchiaro predicts, non-personal data as well as that of private citizens) and the need to maintain societal trust in digital channels in a world besieged by cyber-malfeasance.

But there is mounting evidence of policy vigilance to temper oligarchic tendencies in cloud markets, notably in EU countries: ever the champion of the digital consumer, the European Commission reportedly plans to mandate interoperability and forbid cloud and SaaS providers from charging fees when customers switch services when it introduces its new European Data Governance Act later in 2022.[24] Additionally, 28 European communications and cloud carriers in February agreed to make their cloud services compliant with Gaia-X, a European initiative to build a common software and governance framework to ensure regional interoperability for cloud and edge services.[25]

For cloud laggards, these challenges are no less daunting, and are compounded by the need to get foundational infrastructure and equitable (read: affordable) access to digital services in place to begin to boost consumer and business adoption. Fortunately, the potential opportunities in redressing this cloud capabilities gap are increasingly attracting investment.

African nations make up seven of the 10 lowest ranks in the Global Cloud Ecosystem Index 2022, in large part because of the continent's sparse broadband and data center resources: analysts at Xalam Analytics estimate that to serve its needs, Africa must develop 700 data centers,[26] yet there are currently only 80 in service, and 70% of that capacity sits in a single country — South Africa.[27] Yet in the last year, several commitments to build potentially dozens of data centers have reportedly topped $2 billion, many of these commitments coming from local African technology firms, such as Africa Data Centres,[28] a subsidiary of Zimbabwe's Econet.

Although far from inevitable, there are clear signs that growth in global cloud capabilities is inexorable. And both leaders and laggards in the Cloud Ecosystem Index 2022 should see steady progress. With this progress, observes Infosys' Salvi, "comes a huge amount of opportunity for every organization in every country. It is going to be efficient, it is going to be more secure, and it will help all businesses move fast. The cloud is how global business will be conducted, and how digital technology will be adopted."

About MIT Technology Review Insights

MIT Technology Review Insights is the custom publishing division of *MIT Technology Review,* the world's longest-running technology magazine, backed by the world's foremost technology institution – producing live events and research on the leading technology and business challenges of the day. Insights conducts qualitative and quantitative research and analysis in the US and abroad and publishes a wide variety of content, including articles, reports, infographics, videos, and podcasts. And through its growing MIT Technology Review Global Insights Panel has unparalleled access to senior-level executives, innovators, and thought leaders worldwide for surveys and in-depth interviews.

From the partner

Infosys Cobalt is a set of services, solutions, and platforms that acts as a force multiplier for cloud-powered enterprise transformation. It offers 35,000 cloud assets and over 300 industry cloud solution blueprints. Infosys Cobalt helps businesses redesign the enterprise, from the core, and also build new cloud-first capabilities to create seamless experiences in public, private and hybrid cloud, across PaaS, SaaS, and IaaS landscapes. With Infosys Cobalt's community leverage, enterprises can rapidly launch solutions and create business models to meet changing market needs while complying with the most stringent global, regional and industry regulatory and security standards.

For more details on Infosys Cobalt, visit us at infy.com/infosyscobalt

GCE Index 2022 Footnotes

1. Singapore Government Developer Portal's "Government on Commercial Cloud," Singapore Government, https://www.developer.tech.gov.sg/technologies/ infrastructure-and-hosting/government-on-commercial-cloud.

2. Dan Swinhoe, "Microsoft to develop sovereign cloud in Singapore," DCD, Feb. 11, 2022, https://www.datacenterdynamics.com/en/news/ microsoft-to-develop-sovereign-cloud-in-singapore/.

3. Shannon Williams, "Australia and New Zealand lead cloud adoption, but more progress to be made," ChannelLife New Zealand, May 27, 2021, https://channellife.co.nz/ story/australia-and-new-zealand-lead-cloud-adoption-but-more-progress-to-be-made.

4. Cecilie Maagaard Winther, "LUMI Supercomputer Aids in Nordic Climate Modeling, HPCwire, Feb. 11, 2022, https://www.hpcwire.com/off-the-wire/ lumi-supercomputer-aids-in-nordic-climate-modeling/.

5. Dan Swinhoe, "Microsoft files plans for Chilean data center region," DCD, Jan. 24, 2022, https://www.datacenterdynamics.com/en/news/ microsoft-files-plans-for-chilean-data-center-region/.

6. OECD-Paris, "OECD broadband statistics update," OECD, Feb. 10, 2022, https://www.oecd.org/sti/broadband/broadband-statistics-update.htm.

7.   "Japan e-commerce market to grow by 10.5% in 2021, says GlobalData," GlobalData, Sept. 23, 2021, https://www.globaldata.com/japan-e-commerce-market-grow-10-5-2021-says-globaldata/.

8.   "Cloud Computing: Overview," International Trade Administration, July 1, 2022, https://www.trade.gov/country-commercial-guides/japan-cloud-computing.

9.   "Japan Edge AI Market," Allied Market Research, December 2021, https://www.alliedmarketresearch.com/japan-edge-ai-market-A14986.

10. Pleuni, "2021: Ecommerce in Germany worth €99 billion," Ecommerce News, Jan. 28, 2022, https://ecommercenews.eu/2021-ecommerce-in-germany-worth-e99-billion/.

11. "European eCommerce revenues jump 30% to US$465bn in 2021," Internet Retailing, https://internetretailing.net/rxgeu/rxgeu/european-ecommerce-revenues-jump-30-to-us465bn-in-2021.

12. "Survey: German Cloud-Native Market Picking Up Speed," Business Wire, Oct. 28, 2021, https://www.businesswire.com/news/home/20211028005311/en/Survey-German-Cloud-Native-Market-Picking-Up-Speed.

13. Tushar Deep Singh, ETech, "UPI transactions scale new peak in December 2021," The Economic Times, Jan. 4, 2022, https://economictimes.indiatimes.com/tech/tech-bytes/upi-transactions-scale-new-peak-in-december-2021/articleshow/88689479.cms?from=mdr.

14. "Cyber Security: Overview," International Trade Administration, Nov. 9, 2021, https://www.trade.gov/country-commercial-guides/netherlands-cyber-security.

15. "Belgium's recovery and resilience plan," European Commission, https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility/belgiums-recovery-and-resilience-plan_en.

16. "Cyber attack on Belgian Defence network halted mail traffic for almost four weeks," The Brussels Times, Jan. 12, 2022 (subscription required), https://www.brusselstimes.com/201203/cyber-attack-on-defence-network-halted-mail-traffic-for-almost-four-weeks.

17. Orlando Whitehead, "Almost half of Belgian companies victims of cybercrime," The Brussels Times, Sept. 3, 2021, https://www.brusselstimes.com/news/belgium-all-news/183529/almost-half-of-belgian-companies-victims-of-cybercrime.

18. "Mapping of the Existing Innovation Ecosystem in the I.R. of Iran," United Nations Development Programme, Jan. 19, 2022, https://www.undp.org/publications/mapping-existing-innovation-ecosystem-ir-iran#modal-publication-download.

19. https://www.ohchr.org/EN/NewsEvents/Pages/DisplayNews.aspx?NewsID=28176&LangID=E

20. Lasse Walstad, "The Best Cities For A Cybersecurity Job," TechShielder, Dec. 9, 2021, https://techshielder.com/the-best-cities-for-a-cybersecurity-job.

21. Anja Hopfstock, Michael Hovenbitzer, Florian Lindl, and Patrick Knofel, "Building a Digital Twin for Germany," GIM International, March 10, 2022, https://www.gim-international.com/content/article/building-a-digital-twin-for-germany.

22. "Global cloud services spend exceeds US$50 billion in Q4 2021," Canalys, Feb. 3, 2022, https://www.canalys.com/newsroom/global-cloud-services-Q4-2021.

23. "Flexera 2022 State of the Cloud Report," https://info.flexera.com/CM-REPORT-State-of-the-Cloud.

24. Matthew Gooding, "The EU wants to make it easier to switch cloud provider," Tech Monitor, Feb. 4, 2022, https://techmonitor.ai/technology/cloud/eu-data-act-cloud-providers-schrems-ii.

25. Saf Malik, "Deutsche Telekom and TIM among companies joining cloud programme," Capacity, Feb. 18, 2022, https://www.capacitymedia.com/articles/3830798/deutsche-telekom-and-tim-among-companies-joining-cloud-programme.

26. Abigail Opiah, "Africa's 700 data centre target," Capacity, April 12, 2021, https://www.capacitymedia.com/articles/3828248/africas-700-data-centre-target.

27. Quentin Velluet, "Cloud technology in Africa: Who is doing what, where? Teraco, Raxio, Rack Centre…", The Africa Report, July 26, 2021, https://www.theafricareport.com/111593/cloud-technology-in-africa-who-is-doing-what-where-teraco-raxio-rack-centre/.

28. Balancing Act, "Africa: Fourth African Investment Wave in Digital Infrastructure Tops U.S.$2 Billion – the Changing Shape of Digital Transformation," AllAfrica, Dec. 10, 2021, https://allafrica.com/stories/202112120055.html.

MIT Technology Review Insights

🌐 www.technologyreview.com

🐦 @techreview @mit_insights

✉ insights@technologyreview.com

NAVIGATE YOUR ENTERPRISE FROM CLOUD CHAOS TO CLARITY

Learn how Infosys Cobalt can accelerate your business
with cloud services, solutions and platforms.

www.technologyreview.com/thecloudhub

Infosys
cobalt