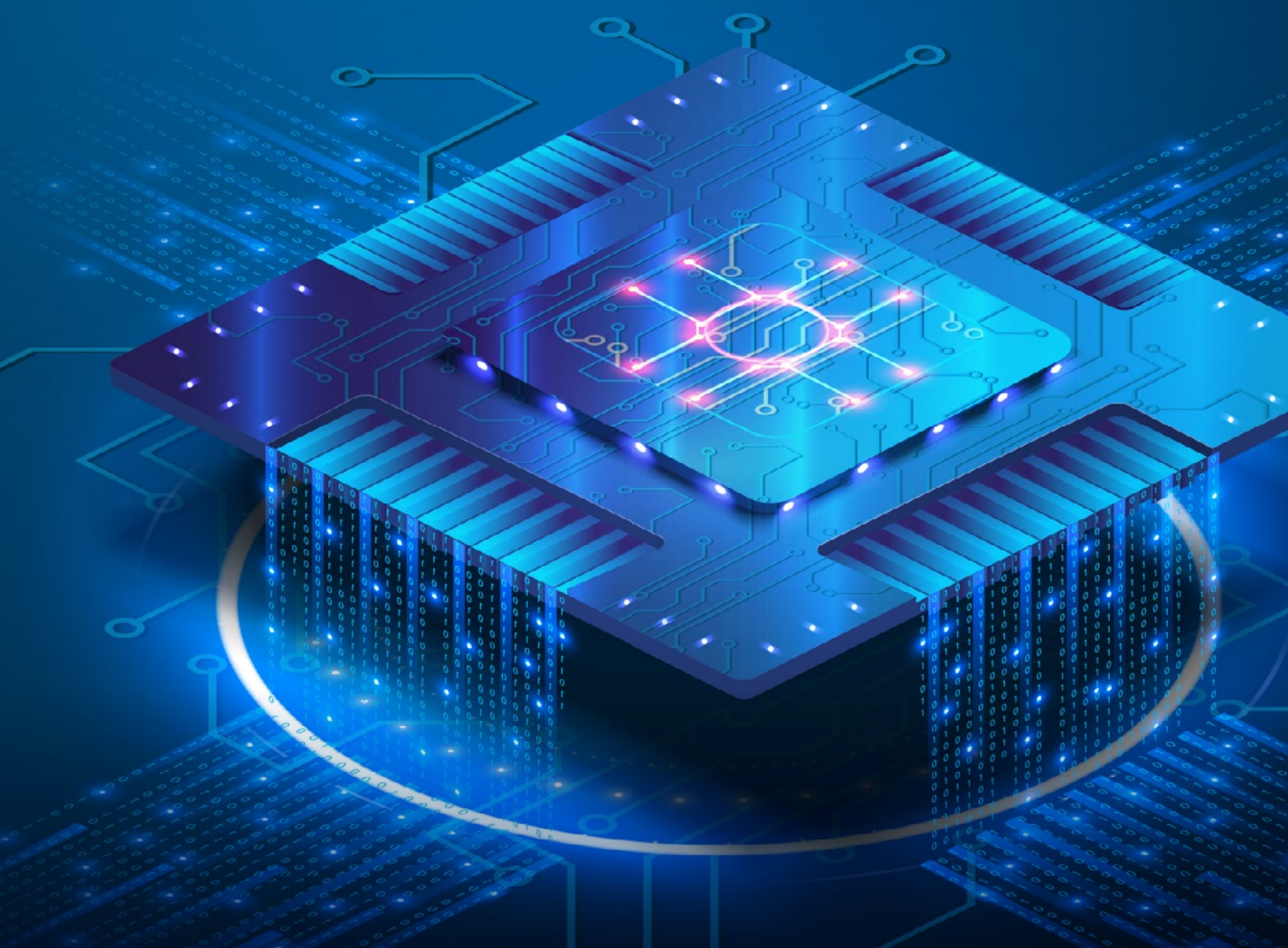


**DIGITAL POLICY,
STRATEGY AND
ADVISORY**



EMERGING TECHNOLOGIES

***DISRUPTING ECONOMIES, BUSINESS MODELS
AND OPENING AVENUES FOR ECONOMIC
GROWTH AND SUSTAINABILITY***

FOREWORD



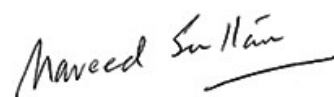
Naveed Sultan
Managing Director and
Chairman, Institutional
Clients Group, Citi

In a world of ever-increasing complexity, we believe that emerging technologies will help economic actors navigate fast and frequent changes in business and society. Such innovation will also help them seize the opportunities to generate the social and economic value that is being created by these changes.

These technologies have varied implications for different economic actors. Governments should take the lead and implement a comprehensive digital policy to drive technology adoption and socioeconomic progress. In partnership with Financial Institutions, Governments can leverage emerging technologies to drive financial inclusion and democratize economic opportunities, for instance by providing small businesses with access to finance. Governments can also further develop their country's financial infrastructure to enable seamless commerce, underscoring how policymakers can help Corporates and Financial Institutions to realize the full potential of emerging technologies. Companies should seize this opportunity to commercialize innovations such as the Internet of Things (IoT), Robotics, 3D Printing, Artificial Intelligence etc., to improve their economic and social viability.

However, realizing these benefits will require collaboration between different economic actors, and significant investment in a combination of technologies. Together, technologies will yield greater benefits than they would alone. For example, smart cities that leverage IoT, 5G and Artificial Intelligence can reduce traffic, boost public safety, and protect the environment. Similarly, telemedicine, the electronic distribution of health services, also relies on multiple technologies. It has the potential to generate a significant impact on society in terms of providing patients with cheaper, faster access to care.

Citi is at the forefront of driving innovation and leveraging emerging technologies. We understand that various economic actors need to be aligned to operate effectively and drive economic progress. Citi's Digital Policy, Strategy and Advisory (DPSA) framework unites economic actors to operate within a "digital paradigm" to achieve economic and societal goals. Emerging technologies underpin Citi's DPSA framework. Our aim with this whitepaper is to help you understand the potential economic impact of emerging technologies, as well as their relevance to economic actors. We aim to help you devise a robust thought process for exploring the application of emerging technologies in your organization.



Naveed Sultan

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INTRODUCTION

Economies around the world are being transformed by four key trends:

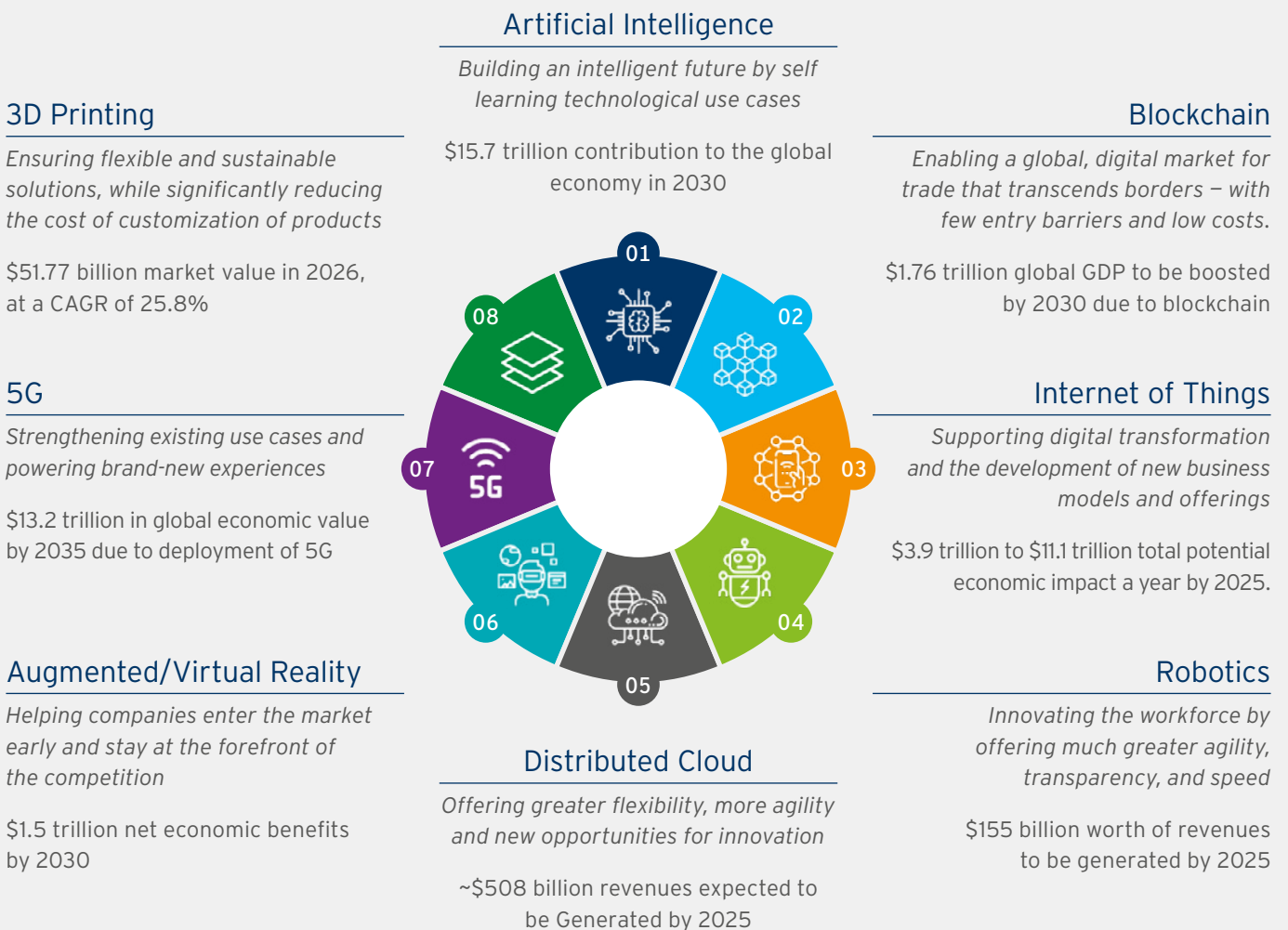
1. Shifts in pattern of demand driven by urbanization and the burgeoning gig economy;
2. Risks such as climate change, pandemics and cyber-attacks;
3. Digitization, driven by the advent of Industry 4.0 and ecosystem models that connect various companies, products and consumers;
4. A sharper focus on sustainability, sparked by both regulatory and consumer demands.

Consequently, the business environment is increasing in complexity because of fragmented digital infrastructure, evolving regulatory policies, and lack of knowledge to solve complexities across Governments, Corporates and Financial

Institutions. Emerging technologies are poised to play a major role in simplifying this increasingly complex environment. Historically, technologies have been a driving force in the transformation of businesses and economies. Technological breakthroughs in the last decade – the move from 3G to 4G and now 5G networks, the emergence of platform models and rise of big data – have enabled new business models, positively impacting revenues. As per McKinsey, among incumbent companies that are diversifying beyond their sector, digital revenue is 25 percent higher than the average of their peers.¹

Among the many technologies that are fundamentally transforming the global economy, there are eight that we believe will have the greatest impact for Governments, Corporates, Financial Institutions and Households. These key emerging technologies have shown the potential to generate substantial economic value (refer to Figure 1).

Figure 1: Eight Key Emerging Technologies are Reshaping the Future of Economies



1) Artificial Intelligence (AI) – AI is expected to contribute \$15.7 trillion to the global economy by 2030, more than the combined output of China and India, through labor productivity improvements and product enhancements.² Governments, Corporates, Financial Institutions and Households are deploying AI. The need to do so is increasing as the volume of data being generated rises and connected devices and mobile technologies are more widely adopted.

2) Blockchain – Blockchain is one of the most exciting technologies to have emerged in the last decade. Provenance, payments, supply chain tracking and digital identity are emerging as key use cases of blockchain. Blockchain has the potential to add \$1.76 trillion to the global economy by 2030 and create about 40 million jobs in the same period, as per PwC.³ It will do this through reducing costs, speeding up transactions and improving financial inclusion.

3) Internet of Things (IoT) – IoT is expected to generate up to \$11.1 trillion in economic value a year by 2025.⁴ IoT will play a vital role in smart infrastructure, smart mobility and smart homes, and provide opportunities for partnerships between the public and private sector.

4) Robotics – To date, most robot adoption has occurred in manufacturing, where advanced automation has the potential to boost productivity and flexibility in the factory and the supply chain, so that producers can quickly adapt to changing consumer needs. As per BCG, advanced robotics can generate savings of up to 40% when combined with other technologies and process changes.⁵ However, as robots get cheaper, more flexible and autonomous – by incorporating self-learning capabilities – they will gain further adoption. Use of robotics is already spreading across different sectors, from agriculture to logistics and financial services.

5) Distributed Cloud – The demand for distributed cloud computing and edge computing, which localizes data storage to improve response times and save bandwidth, is primarily driven by IoT, AI and other technologies that need to process vast quantities of data in real time. Apart from the cost savings, distributed cloud computing provides all parties with easy access to information, thereby simplifying collaboration between economic actors.

6) Augmented/Virtual Reality (AR/VR) – AR and VR are likely to add \$1.5 trillion of net economic benefits by 2030.⁶ More than 40% of the contribution will come from AR alone. From creating new customer experiences to speeding up product development, AR and VR can create a broad range of opportunities for businesses.

7) 5G – 5G networks can strengthen many technological developments. The fastest of them are expected to be at least 10 times faster than 4G LTE. 5G will provide the infrastructure to enable faster computing speeds too. It will also likely deliver a boost to 'The Economy of Things' when new value is created by IoT.

8) 3D Printing – Although 3D printing is primarily used for streamlining prototyping, it has been deployed in many more areas during the COVID-19 pandemic. For example, it is being used to produce medical devices. In future, 3D printing is likely to be explored further in the healthcare and defense industries, given its potential impact. The cost savings from 3D printing can be substantial and in addition to that, the technology is expected to create new highly skilled manufacturing jobs, especially in the US, and bring back jobs that were offshored to lower-cost production hubs.





*EMERGING TECHNOLOGIES ARE POISED TO
PLAY A MAJOR ROLE IN SIMPLIFYING AN
INCREASINGLY COMPLEX ENVIRONMENT.*

POTENTIAL OF EMERGING TECHNOLOGIES ACROSS ECONOMIC ACTORS

Emerging technologies are relevant to every economic actor (refer to Figure 2). However, the impact of emerging technologies varies between economic actors. Their

response to specific technologies will depend on the needs of their business and consumers, as well as the geographic context within which they operate.

Figure 2: Key Applications of Emerging Technologies for Governments, Corporates, and Financial Institutions

EMERGING TECHNOLOGIES	KEY APPLICATIONS		
	 Governments	 Corporates	 Financial Institutions
 Artificial Intelligence	<ul style="list-style-type: none"> • Predict Cases for Welfare Programs • Disease Tracking • Tax Evasion 	<ul style="list-style-type: none"> • Targeting and Personalization • Real-time Monitoring • Recommendation Engines 	<ul style="list-style-type: none"> • Customer Engagement • Risk and Compliance • Intelligent Operations
 Blockchain	<ul style="list-style-type: none"> • Sovereign Identity Solutions • Real-time Budgeting • Regulations Tracking 	<ul style="list-style-type: none"> • Supply Chain Tracking • Claims Processing • Record Keeping 	<ul style="list-style-type: none"> • Cross border Digital Payments • Trade Finance Digitization • Trade Processing & Reporting
 Internet of Things	<ul style="list-style-type: none"> • Smart Cities • Ecosystem for Agriculture • Smart Grids 	<ul style="list-style-type: none"> • Smart Homes/Appliances • Smart Factories • Health Monitoring 	<ul style="list-style-type: none"> • Ubiquitous Payments • Personalized Bank Offers
 Robotics	<ul style="list-style-type: none"> • Defense and Military • Application Processing 	<ul style="list-style-type: none"> • Automated Logistics • Digital Twins 	<ul style="list-style-type: none"> • Robo-advisors • Software Robots • Process Automation
 Distributed Cloud	<ul style="list-style-type: none"> • Government Agency Collaboration • IT Infrastructure Simplification 	<ul style="list-style-type: none"> • Robust Data Centers • Data Storage • Content Delivery Networks 	<ul style="list-style-type: none"> • Quick Product Roll Outs • Scalable Data Analytics
 Augmented and Virtual Reality	<ul style="list-style-type: none"> • Public Works • Public Health and Safety • Education Facilities 	<ul style="list-style-type: none"> • Virtual Modelling • Immersive Gaming • 3D Models for Healthcare 	<ul style="list-style-type: none"> • Branch Banking • Payments • Client/Employee Education
 5G	<ul style="list-style-type: none"> • Smart Homes/Smart Cities • Agriculture • Infrastructure 	<ul style="list-style-type: none"> • Smart Factories • Personalized Retail • Autonomous Cars 	<ul style="list-style-type: none"> • Bank Branch Networks • Real-Time Banking
 3D Printing	<ul style="list-style-type: none"> • Building Construction • Weapons Manufacturing for Defense 	<ul style="list-style-type: none"> • Rapid Prototyping • Product Customization • Inventory Rationalization 	<ul style="list-style-type: none"> • Fraud Prevention

Source: Citi Digital Policy, Strategy and Advisory Analysis.



REGULATORY REQUIREMENTS, PRESSURE FROM INSTITUTIONAL INVESTORS AND SHIFTING CONSUMER ATTITUDES HAVE PUSHED ESG UP THE CORPORATE AGENDA. EMERGING TECHNOLOGIES CAN HELP DRIVE THE ESG AGENDA.

For Governments, the focus should be on building digital infrastructure to expand access to public services and address key challenges such as lower living standards, especially in emerging economies. The key steps that Governments can take include expanding and upgrading cable networks to improve access to faster broadband, especially in the developing world, where internet penetration is low relative to the west; providing digital identity solutions to unlock access to banking, education and other critical services; launching 'smart grids', or localized energy networks that bring supply closer to demand, enabling Corporates, Government and Households to function normally during power outages caused by extreme climate events. More broadly, 'smart cities' that leverage IoT, 5G and AI technologies can reduce traffic, boost public safety, and protect the environment, underscoring how governments can frame policies to drive the global Environmental, Social and Governance (ESG) agenda. Blockchain and Robotics are also especially useful for Governments in the short to midterm. Central bank digital currency (CBDC), for instance, could deliver a significant boost to government coffers. As per the Bank of England, issuance equivalent to 30% of gross domestic product (GDP) could permanently raise GDP by as much as 3% due to reductions in real interest rates, distortionary taxes, and monetary transaction costs.⁷ Robotics, meanwhile, can deliver economic benefits including efficiency, productivity gains and is increasingly used in defense and military.

Financial Institutions have been at the heart of recent efforts to improve financial inclusion. Expanding access to financial services remains a challenge in the world's most underbanked populations, such as parts of the Middle East and Africa. Technology is a driving force for change. Financial technology startups have created novel ways

to further financial inclusion and serve unbanked groups, whether by improving data collection and streamlining credit decisions, or devising electronic payments systems and mobile money solutions. The success of these initiatives has led to more frequent collaborations between fintech startups and incumbent Financial Institutions, which were once portrayed more as competitors. Yet, banks have been cornerstone investors in fintech companies, which raised \$44 billion overall in 2020, an increase of 14% from 2019,⁸ despite the economic uncertainty caused by COVID-19. Meanwhile, central banks across the world are exploring the potential of digital currencies, led by China's drive to become a cashless society. The development of CBDC is still at an early stage but interest is growing. As per Citi GPS research, 60% of central banks were conducting experiments or proofs of concept in 2020, compared to 42% in 2019.⁹ Banks in general are also adopting AI to better understand their clients' needs and to build real-time payments and collections services. Multiple concepts leveraging Blockchain, AI and Robotics are in the pipeline, with a focus on developing ecosystem and platform models.

Corporates have been driving the digital revolution, but different industries are at different levels of digital maturity. Information and communications technology, along with the media and professional services are leading the way in terms of digitization. The digital laggards include agriculture, construction, hospitality, and healthcare, among other economic sectors. In the last few years, key technological breakthroughs have come from Corporates, such as autonomous vehicles and social media. These innovations have been driven by digital natives with leaders who grew up in the digital era. Increasingly, companies are creating digital ecosystems, or offering an interconnected set of services like Alibaba with its retail, payments and credit scoring services. As a result, new value streams are

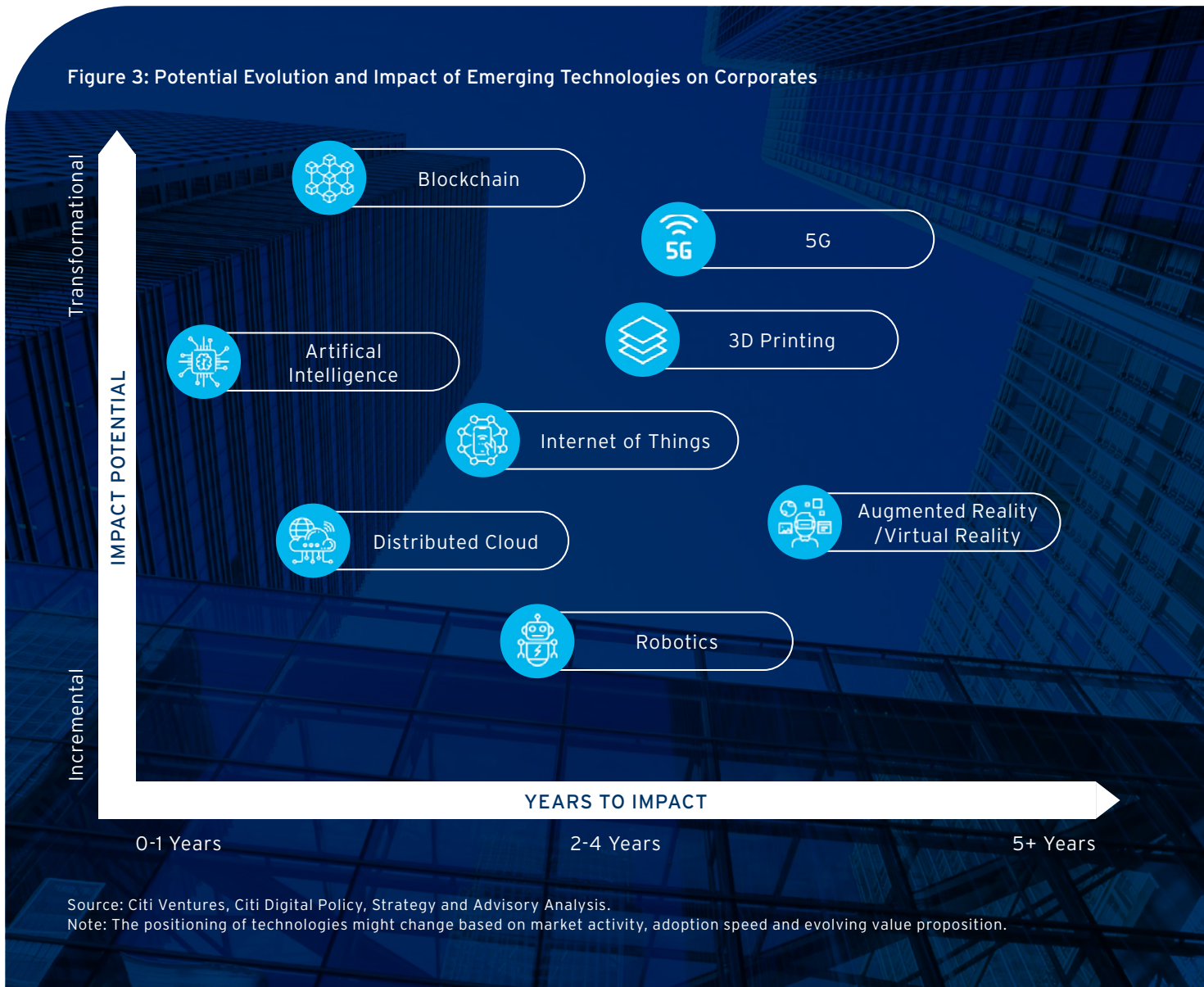
emerging, such as subscription-based models, along with the close integration of insurance, healthcare and automotive companies, for example. It is estimated that 30% of global corporate revenues will be generated by digital ecosystems by 2025, representing \$60 trillion.¹⁰ Corporates are acquiring new customers by finding novel ways to use or commercialize emerging technologies, bringing them from the research lab into the marketplace. AI, Blockchain, IoT, Robotics, Distributed Cloud and 5G are relevant and appropriate for most companies.

- AI can help businesses operating in complex environments to make difficult decisions, far beyond the capability of any human, almost instantly. AI-powered voice-enabled assistants may one day make us more productive workers by managing schedules, setting reminders, taking notes and sharing information. AI can also completely automate

routine and mundane tasks, freeing up time for humans to carry out higher-value work. A 2019 McKinsey survey found a 25% year-on-year increase in companies using AI in standard business processes. Most executives whose companies had adopted AI said that it had increased revenues, and 44% said the AI had reduced costs.¹¹

- Blockchain is another key technology that is being adopted by companies across the major economic sectors. Today, there are more than 350 active use cases being explored. For example, Blockchain enables more transparent and accurate tracking in global supply chains. Blockchain is also fast-tracking the processing of insurance claims, while the technology could reshape trade finance by creating efficiencies and opportunities for new revenue streams while lowering costs.

Figure 3: Potential Evolution and Impact of Emerging Technologies on Corporates



Source: Citi Ventures, Citi Digital Policy, Strategy and Advisory Analysis.

Note: The positioning of technologies might change based on market activity, adoption speed and evolving value proposition.

- The Internet of Things represents a significant growth opportunity for businesses. It has already enhanced the brand value of the world's largest technology companies, which have found a clear purpose for IoT. Some use cases include smart homes and appliances along with health monitoring. The 'industrial internet of things', meanwhile, can help manufacturers to predict problems before they occur. It can also increase network agility, or the ability to respond to real-time changes while maintaining resiliency and security.

All these emerging technologies provide companies with new ways to collaborate, internally and with other organizations, but uptake and impact vary. Based on the estimated time it will take the technologies to generate impact, and the potential of that impact, we conclude that Blockchain and AI will impact business models and generate

new revenue streams in the short term (refer to Figure 3). Technologies like Augmented and Virtual Reality along with 3D Printing are most applicable in select industries (retail, gaming and manufacturing) and hence it will take time for Corporates to explore their potential. The evolution pattern might vary between industries and the pattern might change based on market activity, adoption speed and the technologies' changing value proposition.

Emerging technologies can democratize economic opportunities, for instance by providing small businesses with access to finance, or helping companies find resources by tapping into the gig economy, and even drive the ESG agenda. But realizing these benefits will require greater adoption and collaboration between economic actors.



Collaboration of Economic Actors to Drive ESG Agenda by Using Emerging Technologies

Research published in September 2020 found that more than 1,500 organizations globally have set a goal to reach net zero emissions by the end of the century.¹² Regulatory requirements, pressure from institutional investors and shifting consumer attitudes have pushed ESG up the corporate agenda. Governments across the world are nudging companies into climate action with policies directed at specific sectors, underscoring the power of collective action. A number of countries are phasing out vehicles powered by internal combustion by 2050 or earlier. In addition, Governments are issuing 'green bonds' that help fund sustainable projects, such as investments in wind and hydrogen power. The global market in green bonds reached \$269.5 billion in 2020, as per a report by Climate Bond Initiative.¹³ On top of regulation mandating climate disclosure, Governments can improve data regulations and implement policies that would allow Corporates and Financial Institutions to make their ESG data more transparent, so that data sharing among parties becomes easier. This will help to establish transparent and objective ESG scores, which measure a company's relative ESG performance across a range of metrics.

Emerging technologies can help to address ESG concerns. Governments can use AI, Robotics and IoT to capture changing climate patterns, predict pandemics and help Corporates by providing this information in a timely fashion. Corporates can use the data to evolve their ESG agenda and also strengthen their social and governance policies. The Cloud also provides simplified infrastructure for collaboration between government agencies, organizations and households. And AI, Blockchain and Robotics will play a key role in industries such as Energy, Consumer Retail, Automotive and Aviation, in terms of helping companies track ESG criteria, ensuring sustainable sourcing practices across the supply chain, and reducing the carbon footprint (for instance reducing paper usage).

Financial Institutions, meanwhile, have a plethora of opportunities to utilize emerging technologies, not only to drive the ESG agenda internally, but to collaborate with Governments and Corporates to launch green bonds, provide access to sustainable supply chain finance, money market funds and funding for development projects (which are largely driven by public-private partnerships). ESG-linked financial services can be used to incentivize suppliers to adopt sustainable practices too. For instance, information pertaining to shipment can be entered in the distributed ledger, tracked via IoT devices and AI in real time, so that Corporates can ensure the material is procured sustainably and ethically.

POWER OF TECHNOLOGIES IN COMBINATION

It is important to invest in standalone technologies, but technologies used in unison will generate a higher return for organizations and also address societal needs, such as better living conditions (through smart grids and smart

cities), access to finance (through agile supply chain platforms, future of work models, ubiquitous payment capabilities), and solve for sustainability issues (through circular economy models that reduce the carbon footprint).



Case in Point: Smart Cities

Smart cities offer new opportunities for collaboration and growth. The five key focus areas for smart cities are (1) Transport/Mobility (2) Health and Living (3) Security and Safety (4) Environment and (5) Services. Emerging technologies such as IoT, Distributed Cloud, AI, Robotics and 5G networks will play a key role in the development of smart cities (refer to Figure 4). Smart cities use IoT devices such as connected sensors, lights, and meters to collect data and analyze it using AI. Governments can collaborate with Corporates to host large volumes of data on cloud that can help automatically schedule repairs of failed infrastructure like street lighting or bridges, and intelligently manage energy use and pollution. These tasks can be automated by deploying robots. 5G is the foundation for realizing the full potential of IoT. Its unique combination of high-speed connectivity, low latency, and ubiquitous coverage will support smart vehicles and transport infrastructure such as connected cars, trucks, and buses. It is expected that \$20 trillion worth of economic development can happen via smart cities in next decade,¹⁴ equivalent to 62% of US GDP in 2030.

Figure 4: Combined Role of Emerging Technologies in Launching Smart Cities



01. Artificial Intelligence

AI can help measure energy consumption, traffic behavior to improve efficiency and safety

03. Internet of Things

IoT for smart meters, appliances, vehicles, cameras, sensors, trackers, and many more

04. Robotics

Robotics will help improve urban service provision and automate routine tasks

05. Distributed Cloud

Distributed Cloud to provide capability to compute and reduce total cost of ownership

07. 5G

5G will support smart infrastructure for transportation, gathering readings, etc. through high speed networks

CITI'S PERSPECTIVE ON DRIVING ADOPTION OF EMERGING TECHNOLOGIES

Citi has been investing in business solutions that leverage multiple emerging technologies such as Vehicle Commerce, Embedded Trade and Telemedicine, among many others, through Citi Ventures and Citi Innovation Labs. Citi utilizes emerging technologies to evolve its own technology architecture and to help address client challenges. For example, Citi® Smart Match leverages AI and Machine Learning to automate receivables reconciliation and Citi® Payment Outlier Detection supports risk mitigation by detecting payment anomalies. Another example relates to use of Citi's data analytics tools with a leading healthcare multinational to identify inefficiencies in their payment processes. The data driven insights led to the company standardizing supplier payments with embedded FX, switch expat payroll to the receiver's local currency, and reduce overall transaction costs by 30%.

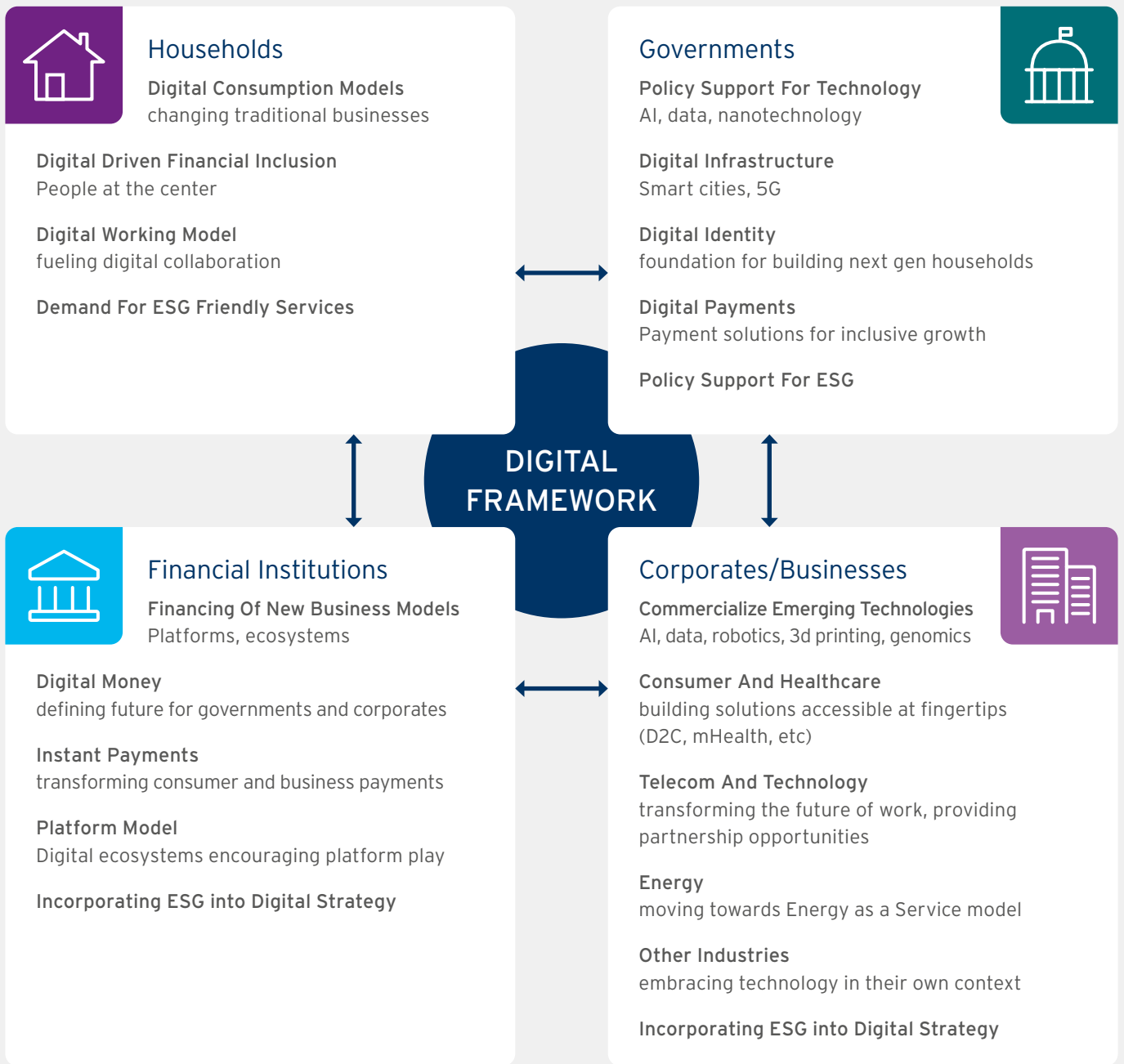
Given Citi's experience and insights from working with clients across all segments, we believe that partnership and collaboration amongst economic actors will lead to greater value creation and economic progress. Progress is required along below dimensions:

- Provide all-encompassing digital policy and infrastructure for implementation of these technologies
- Commercialize technologies and ensure that platforms are available to relevant participants
- Improve financial inclusion and build real-time, secure systems for consumers and businesses
- Address sustainability concerns by developing ESG policies and through a better understanding of the role of technologies in driving the ESG agenda

With these considerations in mind, Citi has developed a proprietary Digital Policy, Strategy and Advisory (DPSA) framework that unites economic actors to operate along a "digital paradigm" to achieve economic and societal goals (refer to Figure 5). It offers guidance and thought leadership to Governments, Corporates and Financial Institutions to help evolve their digital agenda and transform their business and operating models to stay relevant in an increasingly digital world.



Figure 5: Citi Digital Policy, Strategy and Advisory Framework



Source: Citi Digital Policy, Strategy and Advisory Analysis

To recognize the disruptive potential of emerging technologies and their implications for economic actors, a robust framework and approach to execution is required. It is vital to understand the digital maturity of the organization, understand customer/citizen needs, identify gaps, and consider the combined impact of emerging technologies to drive business growth. Equally important is a portfolio approach to acquiring, partnering, or investing

in emerging technologies, clearly defined KPIs to assess their impact, robust risk and control processes and fostering a culture of innovation.

Ultimately, cross-functional collaboration within organizations and with ecosystem partners is at the heart of successful digital transformation.

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Digital Thought Leader

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Chetna is responsible for shaping digital strategy agenda and thought leadership for Citi Treasury and Trade Solutions. She has advised Fortune 500 clients in Financial Services and Consumer sector. Chetna has been instrumental in developing digital frameworks for corporates, developing integrated product propositions, and prioritizing strategic investments for the business.

Chetna is a digital thought leader in the emerging technologies domain.



Swati Mitra

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In addition to the expertise Swati brings to our DPSA practice, she is also the Global Practice Lead for Digital Client Advisory in Citi Treasury and Trade Solutions. The focus of her role is to bring advisory and insights to corporate and public sector clients across the globe on the impact of digital disruption and new technologies on business models, industry ecosystems, supply chains and risk management for treasury and shared service centers. This effort is underpinned by digitization frameworks, research, client use cases and intellectual capital drawn from a large resource pool across Citi and TTS.

Swati has worked at Citi for 27 years in senior sales leadership roles in Australia, Singapore, Hong Kong and United Kingdom.



Seshadri R

Digital Thought Leader

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In addition to the expertise Sesh brings to our DPSA practice, he is also the Practice Lead for the Digital Analysis and Insights Team for Treasury and Trade Solutions. In this role, Sesh works with TTS businesses to drive their digital strategy and transformation. Seshadri has thoroughly analyzed the impact of digital technology, with a specific focus on understanding digital disruption in the telecoms and financial services industries.

Seshadri is a thought leader in digital money and public policy, as he regularly publishes thought leadership and leads Citi's annual report on Digital Money Readiness across 90 countries.

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