G20 GERMANY 2017
BUSINESS 20 DIALOGUE

Digitalization for All

Future-Oriented Policies for a Globally Connected World

B20 TASKFORCE

DIGITALIZATION

POLICY PAPER 2017

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Foreword by Taskforce Chair Klaus Helmrich

Digitalization is inherently of a transfrontier character – full of challenges but also full of potential and opportunities.

Digitalization has revolutionized business models, interactions, and our daily lives, the ways we communicate, trade, produce and work. Worldwide, it fosters equal opportunities, global welfare, quality enhancement, and cost reductions. Digitalization is transforming production and production-related services along the whole value chain – from design, simulation and prototyping, as well as production planning to production and services. It is unlocking huge potential for individualized mass production, shorter time to market, higher productivity, and better utilization of resources – all based on smart use of data.

However, digitalization is inherently of a transfrontier character – full of challenges and possible threats but also full of potential and opportunities! Therefore, governments and business need to work closely together to tackle these obstacles together with future-oriented actions. The importance of close international coordination and collective action cannot be overstated.

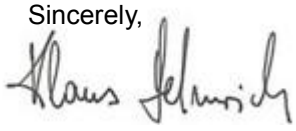
What is to be done now? First, the fundaments of global connectivity and cybersecurity need to be strengthened. Global cooperation is important to avoid fragmented regulation or processes and preserve the global and open nature of the Internet. Therefore, G20 members have to stand up against creeping digital protectionism, increase interoperability of legal frameworks, and facilitate the transfer of data in accordance with privacy requirements. Related to that, to achieve the goal of providing affordable Internet access to everyone, G20 members have to foster the expansion of ICT infrastructure. They have to set ambitious national goals for the expansion of broadband coverage and implement investment-conducive frameworks.

Second: The broadband to fully use the potential of Industry 4.0 and the Industrial Internet underlines that expansion of ICT infrastructure is needed in both developing and industrialized countries. To continuously encourage the use and dissemination of technological applications for production, G20 members have to foster and protect innovation. Furthermore, the industry-led development of globally coherent standards as well as reference architectures should be strengthened. Standards-based interoperability is at the basis of market efficiencies.

And Third: With the exponential development of Artificial Intelligence the next level of economic transformation is right at our doorstep. AI-enabled innovations such as self-driving vehicles, smart infrastructure, or advances in machine learning have tremendous potential to improve people's lives. However, its full implications are not yet fully understood. Spreading knowledge, an informed public dialogue, and supporting innovation are key issues to be addressed by policy-makers.

The G20 as the central hub for global governance needs to address these barriers to global connectivity, the expansion of Industry 4.0 and the Industrial Internet, and the development of AI. If it does, the G20 will go a long way in reaching its goal of increasing inclusiveness, welfare, and growth to the benefit of all.

Sincerely,



Klaus Helmrich

Chair of the B20 Digitalization Taskforce

Member of the Managing Board, Siemens

Recommendations

Recommendation 1: Foster Global Connectivity – The G20 should foster global connectivity through the definition of a harmonized cybersecurity baseline framework, by supporting norms for responsible state behavior, by enabling free and trustworthy cross-border data flows, and by fostering investment in ICT infrastructure as well as in skill and capacity building.

Policy Action 1.1: Improve Cybersecurity – The G20 should improve cyberrisk management by encouraging the development of a harmonized cybersecurity baseline framework as well as of a concept for a global interoperable information-sharing platform under OECD guidance, and support a process leading to norms for responsible state behavior.

Policy Action 1.2: Enable Cross-Border Data Flows – G20 members should commit in trade agreements not to prevent the free flow of data across borders – without prejudice to clearly defined exceptions for the protection of privacy and security. Furthermore, G20 members should strengthen efforts for interoperable data protection standards, facilitate the use of the accountability principle, and pursue additional bilateral and plurilateral agreements that enable cross-border data flows consistent with privacy and data protection requirements.

Policy Action 1.3: Expand ICT Infrastructure – To foster affordable broadband access for all, G20 members should encourage private investments in ICT by considering the established and important principle of technological neutrality, through a simplified, market-oriented, and transparent regulatory environment, and through incentives to invest in less profitable areas, as well as by fostering investments for skill and capacity building.

Recommendation 2: Strengthen Industry 4.0 and the Industrial Internet – The G20 should support the dissemination of Industry 4.0 and the Industrial Internet (I4.0&II) by fostering innovation, ICT infrastructure deployment, and the development and use of global standards.

Policy Action 2.1: Facilitate Innovation – G20 members should facilitate the use and dissemination of technology solutions for I4.0&II by increasing awareness of use cases and opportunities through the initiation of an international knowledge exchange platform of practice at the OECD and World Bank Group, and by supporting demonstration systems of private organizations and academia.

Policy Action 2.2: Foster ICT Infrastructure for I4.0&II – The G20 should encourage public-private cooperation for setting specific I4.0&II ICT infrastructure goals that serve business needs, implement forward-looking ICT infrastructure policies, and facilitate new business models as well as the use of new technologies by avoiding burdensome, needlessly constraining regulations.

Policy Action 2.3: Encourage Development of Global and International Standards – G20 members should foster the development and use of globally interoperable standards and specifications by supporting industry-led multistakeholder cooperation and market-driven standardization initiatives, as well as referring to consensus-based globally relevant standards and specifications in public procurement.

Recommendation 3: Embrace Artificial Intelligence – The G20 should support the evolution of human-centric artificial intelligence (AI) and related technologies by ensuring informed public dialogues on opportunities and challenges, supporting development and deployment of innovation, and accelerating the rollout of smart infrastructure.

Policy Action 3.1: Encourage an Informed Public Dialogue – The G20 should encourage the OECD to set up a multistakeholder initiative to analyze potential applications, benefits, and challenges of AI and provide guidance for governments on an informed public dialogue on AI.

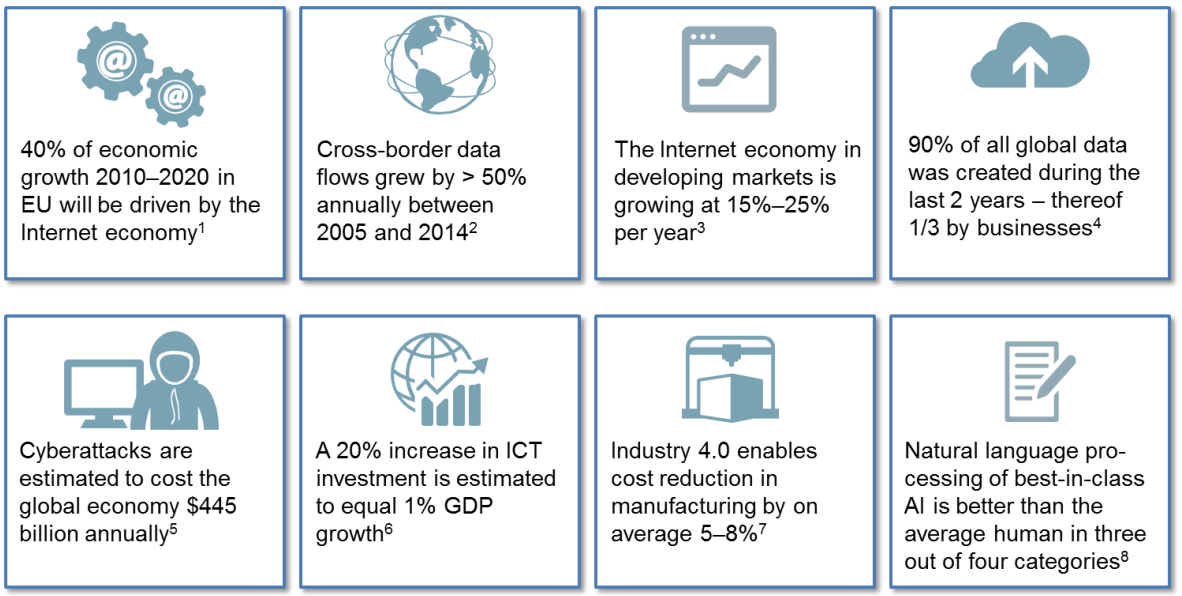
Policy Action 3.2: Provide a Favorable Ecosystem – G20 members should develop forward-looking policies that support the rollout of AI by adjusting regulations to facilitate the use of emerging technologies, such as big data, and foster related investment and innovation.

Policy Action 3.3: Facilitate Smart Infrastructure – The G20 and its members should support the implementation of smart infrastructure by mandating the Global Infrastructure Hub (GIH) to make available – jointly with the private sector – use and business cases to illustrate potential benefits, reducing barriers to foreign direct investments in ICT and smart infrastructure, and complement private investments in less profitable deployments.

Introduction

Digitalization[1] is changing economies and people's everyday lives (see Exhibit 1). Entire industries have been enabled to become more efficient, and new business models have been created. Consumers and businesses have access to higher-quality innovative products, services, or even completely new digital ecosystems and platforms. In the future, the industry expects tens to hundreds of billions of devices to be connected to the Internet, directly or through local area networks and specifically through nonwired connections.[2]

Exhibit 1 | Digitalization is Changing Our Economy and Everyday Lives



Sources: 1. BCG Perspectives, *Five Priorities for Achieving Europe's Digital Single Market* (2015), 7, accessed February 6, 2017, https://etno.eu/datas/publications/studies/FINAL_BCG-Five-Priorities-Europes-Digital-Single-Market-Oct-2015.pdf; 2. TeleGeography, *Global Bandwidth Forecast Service*, accessed February 6, 2017, www.telegeography.com; 3. BCG Perspectives, *Greasing the Wheels of the Internet Economy* (2014), 6, https://www.icann.org/en/system/files/files/bcg-internet-economy-27jan14-en.pdf; 4. SINTEF, *Big Data for better or worse* (ScienceDaily, 2013); 5. WEF, *Global Risk Report* (2016), 77, accessed February 6, 2017, http://www3.weforum.org/docs/Media/TheGlobalRisksReport2016.pdf; 6. Huawei, *Global Connectivity Index* (2015), 23, accessed February 6, 2017, *http://www.digitaleschweiz.ch/wp-content/uploads/2016/05/Huawei-global-connectivity-index-2015-whitepaper-en-0507.pdf* ; 7. BCG analysis; 8. Wang et al., *Solving Verbal Questions in IQ Test by Knowledge-Powered Word Embedding* (2016), 1–8, accessed February 6, 2017, http://www.datascienceassn.org/sites/default/files/Solving%20Verbal%20Comprehension%20Questions%20in%20IQ%20Test%20by%20Knowledge-Powered%20Word%20Embedding.pdf; Categories tested: analogy, classification, synonym, antonym.

[1] Digitalization is the use of technologies to transform and optimize existing organizations and enable new organizations through innovative and adapted workflows, processes, practices, data, and business models to take advantage of the opportunities inherent in the digital economy and information society.

[2] Nonwired connections to the Internet are typically in use cases such as the Internet of Things (IoT), machine to machine (M2M), connected cars, and e-health.

As one of the most measurable aspects of digitalization, the Internet economy alone – which includes for instance e-commerce and Internet-related investments in information and communication technologies (ICT) – was estimated to contribute about $4 trillion to the G20's gross domestic product (GDP) by 2016.[3] Studies suggest that the overall impact of digitalization – including digital skills, digital equipment,[4] intermediate digital products and services used in production – might account for up to 28 percent of today's GDP in mature market economies.[5] However, the total impact of digitalization extends far beyond a positive effect on GDP. Activities such as e-commerce, online advertising, and information transfer enable business development and improve welfare as well as consumer benefit: positive effects that are not necessarily captured in GDP figures.[6]

Digitalization is also transforming production and production-related services along the value chain, which is unlocking additional potential for further efficiency and productivity gains from better utilization of resources, new technologies, and new business models. The use of digital technologies in this field is often referred to as Industry 4.0 or the Industrial Internet (I40&II) and describes the digital transformation of the design, operation, and service of products and production systems.[7] Connectivity and interaction among machines through standardized, open interfaces as well as interaction with humans are expected to render production systems up to 30 percent faster and more efficient.[8] Levers like simulation tools, additive manufacturing, smart machines, sensors, real-time communication, and data-driven services like predictive maintenance can drive productivity gains of five to eight percent of total manufacturing costs.[9]

Another key aspect of digitalization is artificial intelligence (AI): a far-reaching field of innovation that could bring digitalization to the next level of economic transformation. AI refers to technologies that enable machines to perceive, learn, reason, and make or support decisions. AI technologies can give machines the ability to automate and optimize processes as well as services, or even solve complex problems. AI-enabled innovations such as self-driving vehicles, smart infrastructure, smart health care, or advances in machine learning have tremendous potential to assist humans, and improve people's lives. However, emerging technologies such as AI also raise significant issues for societies. Its potential impact and full implications are not yet fully understood, in particular when it comes to effects on the workforce such as labor-saving or shifting demand for skills. One underlying reason for societal skepticism is the lack of examples illustrating the breadth of AI applications across all sectors that assist and benefit humans in their work and everyday lives.[10]

[3] BCG Perspectives, *Greasing the Wheels of the Internet Economy* (2014), 6, op. cit.
[4] Digital equipment such as hardware, software and communications equipment, see Accenture, *Digital Disruption: The Growth Multiplier* (2016), 11, accessed February 6, 2017, https://www.accenture.com/_acnmedia/PDF-4/Accenture-Strategy-Digital-Disruption-Growth-Multiplier.pdf.
[5] See for example Accenture, *Digital Disruption: The Growth Multiplier* (2016), 3, op. cit.
[6] World Economic Forum, *Expanding Participation and Boosting Growth: The Infrastructure Needs of the Digital Economy* (2015), 7, accessed February 6, 2017, http://www3.weforum.org/docs/WEFUSA_DigitalInfrastructure_Report2015.pdf.
[7] In the context of this paper, Industry 4.0 and the Industrial Internet refer to the scope of production and production-related services along the value chain including product design, production planning, production engineering, and production execution, as well as processes such as documentation, maintenance, and monitoring. Under the Chinese G20 Presidency 2016 the term New Industrial Revolution was used. The G20 *New Industrial Revolution Action Plan* mentions a number of further initiatives of medium and long-term manufacturing strategies in a similar context see: http://www.g20chn.com/xwzxEnglish/sum_ann/201609/P020160912341429630547.pdf.
[8] BCG Perspectives, *Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries* (2015), 2, accessed February 6, 2017, http://www.zvw.de/media.media.72e472fb-1698-4a15-8858-344351c8902f.original.pdf.
[9] Ibid., 8.
[10] Peter Stone et. al., *Artificial Intelligence and Life in 2030* (Stanford: One Hundred Year Study on Artificial Intelligence, 2016), 10.

Exhibit 2 | Human-Centric Digitalization

It is important to be aware of the changes that digitalization is bringing to societies and individuals. Digital technologies affect our everyday lives and how we interact with each other, with organizations, with administrations, and with governments. The B20 highlights that governments as well as companies need to take people's questions and concerns seriously. The social and cultural dimensions should be an integral part of international governance of digitalization.[11]

First of all, it is important to establish a holistic understanding of digitalization and its implications for societies. The application of digital technologies in areas such as communication, renewable energy, transportation, and logistics can generate smarter and greener economic activities and societies.[12] In order to address people's questions and concerns users may have, governments and companies should be transparent about the use of digitalization and should intensify the public dialogue with citizens.

Second, trustworthy digital technologies, systems, and solutions are essential to enabling the full potential of digitalization, fostering social process and growth in an inclusive way. Strong cybersecurity as well as data and privacy protection are fundamental to establish trust. Furthermore, it is important that governments and companies strengthen their efforts to develop people's skills and knowledge of how digital technologies can be leveraged to improve their lives.

It is equally important to identify and address the effect of digitalization on the workforce. Digital technologies will significantly change job profiles as well as employees' qualification requirements. The needs of people at all stages of the workforce continuum should be considered. G20 members and the private sector should work together to understand current and future skill needs and align education and training with these requirements. The teaching of required digital skills should be fostered in schools, vocational training, and universities, as well as in public and private organizations. Concepts for life-long learning need to give everyone the opportunity to adopt skills that are in demand.[13]

Global access to secure, trustworthy, and ubiquitous ICT infrastructure – including an open, globally interoperable Internet – is crucial for further digitalization across industry sectors. It is a precondition for fully utilizing the related prosperity and growth potential for people and businesses of all sizes in developed, developing, and emerging countries. Furthermore, adequate and affordable ICT infrastructure is an important horizontal enabler for achieving the Sustainable Development Goals (SDGs) and bridging the digital divide (see Exhibit 3).[14] In-line with the SDGs, the G20 should further support the efforts of the UN Broadband Commission for Sustainable Development to connect the next 1.5 billion people by 2020.[15]

[11] In this context, for instance the Japanese public-private concept of a "Super Smart Society" (Society 5.0) explicitly takes into account social and human aspects in the digitalization development of Japan's society.
[12] For B20 policy recommendations and case studies on how digitalization can lead to smart and efficient energy usage, for example in the mobility sector and in energy infrastructure, see also Policy Actions 2.1 and 2.2 of the B20 Germany Energy, Climate and Resource Efficiency Taskforce.
[13] For B20 policy recommendations on identifying skill needs and establishing vocational training programs for digital skills, please also see the Policy Actions 2.2 and 2.3 of the B20 Germany Employment & Education Taskforce.
[14] The Earth Institute & Ericsson, *ICT and the SDGs* (2016), 8–9, accessed February 6, 2017, https://www.ericsson.com/res/docs/2016/ict-sdg.pdf.
[15] UN Broadband Commission, *Working Together to Connect the Next 1.5 Billion by 2020* (2016), 1–9, accessed February 6, 2017, http://www.broadbandcommission.org/Documents/publications/davos-discussion-paper-jan2016.pdf.

Exhibit 3 | SDGs and ICTs

1 NO POVERTY	Target 1.4. By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources as well as access to basic services […], appropriate **new technology**, and financial services, including microfinance
2 ZERO HUNGER	Target 2.a. Increase investment in rural infrastructure, agricultural research and extension services, **technology development** and plant and livestock gene banks […] Target 2.c. Adopt measures to ensure the proper functioning of food commodity markets and facilitate timely **access to market information**, including on food reserves, to help limit extreme food price volatility […]
3 GOOD HEALTH AND WELL-BEING	* The use of ICTs in the health sector can result in higher quality as well as safer and more responsive to patient's needs. **E-Health** can be particularly important in rural and remote areas by enabling innovative models of care delivery, such as telemedicine and mobile health
4 QUALITY EDUCATION	Target 4.b. By 2020, substantially expand globally the number of scholarships available to developing countries […] for enrollment in higher education, including vocational training and **information and communications technology**, technical, engineering and scientific programs, in developed countries and other developing countries
5 GENDER EQUALITY	Target 5.b. Enhance the use of enabling technology, in particular **information and communication technology**, to promote the empowerment of women
6 CLEAN WATER AND SANITATION	* ICTs can contribute to improving water and energy access by using **mobile solutions, smart grids, and meters** to advance efficiency, manage demand and develop new ways to expand access
7 AFFORDABLE AND CLEAN ENERGY	
8 DECENT WORK AND ECONOMIC GROWTH	Target 8.2. Achieve higher levels of economic productivity through diversification, **technological upgrading, and innovation**. Target 8.3. Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, **creativity, and innovation**, and encourage the formalization and growth of MSMEs, including through access to financial services
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	Target 9.c. Significantly increase access to **information and communications technology** and strive to provide **universal and affordable access to the Internet** in least-developed countries by 2020
10 REDUCED INEQUALITIES	* ICTs, especially through mobile-based services, can contribute to reducing inequality by drastically **expanding access to information**, hence contributing to individual empowerment and social inclusion of individuals that used to fall outside of the reach of traditional services
11 SUSTAINABLE CITIES AND COMMUNITIES	* ICTs can be leveraged to organize cities and communities more efficiently. **Smart cities** use ICTs and big data to improve public-service delivery and to advance wide policy outcomes such as energy saving, safety, urban mobility, and sustainable development
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	* ICTs, especially broadband, have connected consumers and producers directly and given rise to **"on demand" markets** of products that can be customized and localized, which can save time, reduce transportation costs, and contribute to a more efficient and sustainable consumption
13 CLIMATE ACTION 14 LIFE BELOW WATER 15 LIFE ON LAND	* The use of **Internet of Things** can contribute to making environment-monitoring tasks cheaper, faster, and more convenient
16 PEACE, JUSTICE AND STRONG INSTITUTIONS	* The use of ICTs in the public sector can improve the offer and uptake of **digital government** services, strengthen the performance of public institutions, and improve transparency and citizen's participation
17 PARTNERSHIPS FOR THE GOALS	Target 17.8. Fully operationalize the technology bank and science, technology, and innovation capacity-building mechanism for least-developed countries by 2017 and enhance the use of enabling technology, in particular **information and communication technology**

Note: Not all SDGs had an ICT component officially included in a corresponding target by the UN. In those cases, identified by an asterisk (*), examples were identified by the OECD to depict how ICT could contribute to that particular goal.

Source: Adapted from OECD, *Key Issues for Digital Transformation in the G20* (2017), 18, accessed February 6, 2017, http://www.oecd.org/internet/key-issues-for-digital-transformation-in-the-g20.pdf.

While digitalization is advancing fast, certain issues need to be addressed by policy-makers, so that its potential for people, businesses, and public administration can be fully harnessed. As the Internet is – and should remain – global, open, and interoperable, policy solutions in the field of digitalization likewise require coordination and collective action at the global level. Greater global connectivity increases the need for global interoperability through coherent standards and specifications. The increase in cybercrime highlights the necessity of better and more efficient digital security risk management. Policy-

makers need to ensure that cybersecurity measures are advancing as fast as digitalization. Today, cyberattacks cause globally economic damage of up to $445 billion per year.[16] Furthermore, the global nature of the Internet and digitalization leads to an increasing need for internationally aligned, transparent, and predictable policies as well as consideration of the established and important principle of technological neutrality. Investment, labor, and educational strategies have to be updated so that the opportunities of digitalization can be fully leveraged by individuals, business, and governments alike.

Exhibit 4 | Compact with Africa

Digitalization provides significant opportunities for the socioeconomic development of African countries. At the same time, the rapid advancement of digital technologies requires targeted and cooperative action to prevent a digital divide – both globally and on a national level. Required infrastructure investments should build on previously initiated development frameworks.

There are established frameworks, like the African Union's (AU) Agenda 2063, to bolster socioeconomic development in Africa. There is significant potential for building on these initiatives in a cooperative manner for the implementation of necessary action. The AU defined a collective roadmap in its Agenda 2063. The AU is also targeting a concerted push to finance and implement major infrastructure projects in ICT that would bring the continent as an information society to the same level as developed countries. The main objectives are to establish an integrated e-economy with universal access and reliable as well as affordable ICT services. Furthermore, the AU wants to increase broadband penetration by 10 percent by 2018 and broadband connectivity by 20 percentage points, providing access to ICT in schools and venture capital to ICT entrepreneurs and innovators. Often, however, concrete implementation steps to reach these targets are lacking.[17]

The B20 welcomes these initiatives and the proposal of the G20 presidency for a Compact with Africa to foster development through private investment flows to Africa, which would also contribute to the achievement of the SDGs. In terms of digitalization, G20 members should cooperate with African countries to create the necessary environment and framework conditions for private and infrastructure investments in ICT. Potential measures would be to support private investments in ICT through the development of best practice regulations that increase transparency and legal security, as well as investment incentives in less-profitable scenarios. G20 members should further support the development of self-sustainable programs for skill and capacity building in African countries. This provides a central foundation for exploiting the full potential of digitalization for socioeconomic development. Furthermore, G20 members should encourage adoption of best practices for cybersecurity, cross-border data flows, and e-commerce.

One key enabler for realizing the social and economic benefits of digitalization are employees with adequate digital skills. These are required especially in fields like data management, data security, software development, programming, data science, and analytics. Respective challenges related to workforce skills, training and education are covered in the policy paper of the B20 Germany Employment & Education Taskforce.

Furthermore, the governance of digitalization requires consideration of MSME-specific challenges and needs. These needs include, for example, knowledge about innovation and capabilities to utilize benefits of digitalization as well as adequate financing mechanisms. Respective recommendations are provided in the policy paper of the B20 Germany SME Cross-Thematic Group.

The G20 has already set first cornerstones to harness the potential of digitalization with the G20 Digital Economy Development and Cooperation Initiative and the G20 New Industrial Revolution Action Plan. G20 members should now build on these commitments and develop policies – jointly with business – that foster a resilient, responsible, and responsive journey towards future-oriented, sustainable digital economies.

[16] WEF, *Global Risk Report* (2016), 77, op. cit.
[17] African Union, *Agenda 2063* (2014), 16, accessed February 6, 2017, http://www.un.org/en/africa/osaa/pdf/au/agenda2063.pdf.

Recommendation 1: Foster Global Connectivity

The G20 should foster global connectivity through the definition of a harmonized cybersecurity baseline framework, by supporting norms for responsible state behavior, by enabling free and trustworthy cross-border data flows, and by fostering investment in ICT infrastructure as well as in skill and capacity building.

Policy Actions	
1.1	**Improve Cybersecurity –** The G20 should improve cyberrisk management by encouraging the development of a harmonized cybersecurity baseline framework as well as of a concept for a global interoperable information-sharing platform under OECD guidance, and support a process leading to norms for responsible state behavior. • The G20 should make cybersecurity a permanent agenda topic. • The G20 should encourage the OECD to guide the development of the cybersecurity baseline framework together with international institutions and agencies, international standardization bodies, and private-sector technical experts, while involving non-OECD G20 members. • The concept for an interoperable information-sharing platform should take into account national needs and ensure the possibility of global exchange between existing national platforms. • G20 members should foster security-by-design by encouraging the development and adoption of secure software development practices, as well as self-certification practices. • G20 members should aim to reach a global agreement on norms for responsible state behavior in cyberspace by 2020 – dialogues could be facilitated by the United Nations Group of Governmental Experts (UN GGE), as well as relevant regional organizations with critical input from the private sector and civil society.
Owner G20,[18] G20 members,[19] OECD, UNCTAD, business, UN GGE	**Timing** 2017-2020
1.2	**Enable Cross-Border Data Flows –** G20 members should commit in trade agreements not to prevent the free flow of data across borders – without prejudice to clearly defined exceptions for the protection of privacy and security. Furthermore, G20 members should strengthen efforts for interoperable data protection standards, facilitate the use of the accountability principle, and pursue additional bilateral and plurilateral agreements that enable cross-border data flows consistent with privacy and data protection requirements. • G20 members should address cross-border data flows in their discussions on digital trade and aim for guarantees for unimpeded transfer, access, and storage of data across borders in their trade agreements. These should include appropriate safeguards for privacy and security. • The G20 should ask UNCTAD and the OECD to guide a dialogue with all relevant stakeholders – including governments as well as experts from private and public organizations – on interoperable data protection and privacy protection standards. The process should lead to the development of a framework of common guiding policy principles that increase interoperability. • G20 members should facilitate the use of accountability-based legal instruments and pursue bi- or plurilateral agreements, such as the Privacy Shield to enable cross-border data flows while safeguarding privacy requirements. • To increase legal certainty related to cross-border data flows, G20 members should review efficiency and cooperation processes within the framework of mutual legal assistance treaties.
Owner G20, G20 members, OECD, UNCTAD, business	**Timing** 2017-2020

[18] Ownership by G20: Collective action via the G20 process (such as commitments, Principles, Action Plans, or Toolkits).
[19] Ownership by G20 members: Differentiated action by individual governments in their own right.

1.3 **Expand ICT Infrastructure** – To foster affordable broadband access for all, G20 members should encourage private investments in ICT by considering the established and important principle of technological neutrality, through a simplified, market-oriented, and transparent regulatory environment, and through incentives to invest in less profitable areas, as well as by fostering investments for skill and capacity building.

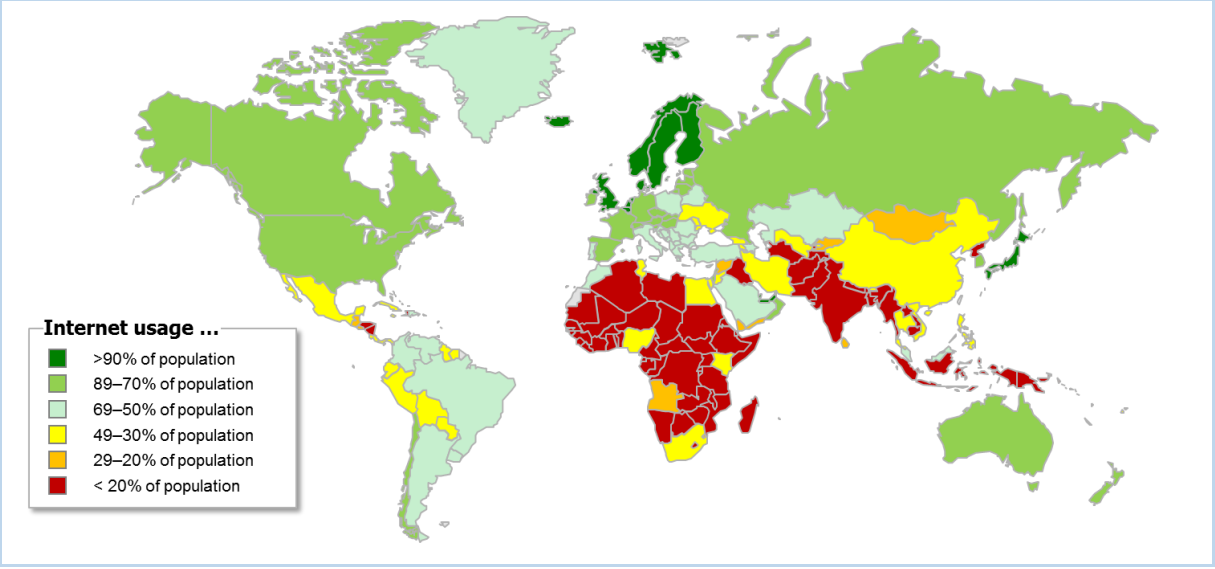
- G20 members should minimize the regulatory burden for operators and service providers, reduce barriers to foreign direct investment, ensure fluid venture capital markets, and complement private investments with public funds in less profitable deployments and remote areas.
- To consider the established and important principle of technological neutrality and ensure that regulations are simple, market-oriented, and transparent, G20 members should implement three policy principles: 1) simplified and streamlined access regulation, 2) forward-looking spectrum policy to cover accelerated demand, and 3) competition policy with more emphasis on dynamic efficiencies.
- To support the demand side of ubiquitous connectivity, G20 members should foster public-private partnership initiatives for skill and capability building – especially in developing countries.

Owner G20, G20 members **Timing** 2017-2020

Context

ICT infrastructure is becoming the essential infrastructure of the 21st century.[20] While the Internet is a part of everyday life for many people, some four billion people still do not use the Internet (see Exhibit 5). Affordable access to a secure, trustworthy, and adequate ICT infrastructure is crucial to enabling digitalization and thereby boosting prosperity in developed, emerging, and developing economies (see Exhibit 3). Difficulties in accessing adequate ICT infrastructure also have a greater impact on the competitiveness of micro, small, and medium enterprises (MSMEs) compared to large firms. Studies find that among all factors determining firms' ability to internationalize, the biggest gap between small and large firms is in connectivity, particularly in the least-developed countries (LDCs).[21]

Exhibit 5 | Global Internet Usage (Internet Users as a Percent of the Population)



Source: ITU, *World Telecommunication/ICT Development Report and Database*, accessed February 6, 2017, http://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx; BCG analysis. Note: Internet usage refers to the percentage of individuals who have used the Internet in the year 2014. Internet can be used via a computer, mobile phone, or personal digital assistant.

The number and reach of cyberthreats and cyberattacks is increasing along with greater connectivity. Cybersecurity has become one of the major concerns of companies across all industries. Studies suggest that cyberattacks alone cost the global economy $445 billion annually.[22] Creating a more secure and trustworthy digital environment is critical to ensuring that the opportunities of digitalization can be fully realized. Governments around the world are developing cybersecurity strategies, guidelines, regulations, and national standards. Frequently, this results in public policies with an undue focus on compliance instead of risk-based security performance – which creates additional costs. Although states are adopting the Budapest Convention on Cybercrime or defining regional cybersecurity regulations,[23] overall, there is little international alignment. The fragmentation of cybersecurity regulations hampers cross-border activities and diminishes actual security, adversely impacting the growth potential of digitalization.

[20] WEF, *Delivering Digital Infrastructure: Advancing the Internet Economy* (2014), 4, accessed February 6, 2017, http://www3.weforum.org/docs/WEF_TC_DeliveringDigitalInfrastructure_InternetEconomy_Report_2014.pdf.
[21] International Trade Center, *SME Competitiveness Outlook* (2015), 130, accessed February 6, 2017, http://www.intracen.org/uploadedFiles/intracenorg/Content/Publications/SME_Comp_2015_Jan_version_low_res.pdf. For recommendations on SME Internet access, compare Policy Action 2.1 in the policy paper of the B20 Germany SME Cross-Thematic Group.
[22] WEF, *Global Risk Report* (2016), 77, op. cit.
[23] For instance the EU's Network and Information Security (NIS) Directive.

Exhibit 6 | Connect 2020 Agenda

Through the Connect 2020 Agenda, the International Telecommunication Union (ITU) member states committed to working towards the shared vision of "an information society, empowered by the interconnected world, where telecommunication/ICT enables and accelerates socially, economically and environmentally sustainable growth and development for everyone." The ITU member states invited all stakeholders to contribute their initiatives, qualifications, and expertise to ensure the implementation of this ambitious agenda.

Goal 1: Growth

Enable and foster access to and increased use of telecommunication/ICT

Targets by 2020:

- 1.1: Worldwide, 55% of households should have Internet access
- 1.2: Worldwide, 60% of individuals should be using the Internet
- 1.3: Worldwide, telecommunication/ICT should be 40% more affordable

Goal 2: Inclusiveness

Bridge the digital divide and provide broadband for all

Targets by 2020:

- 2.1.(A) In the developing world, 50% of households should have access to the Internet
  2.1.(B) In the least-developed countries (LDCs), 15% of households should have access to the Internet
- 2.2.(A) In the developing world, 50% of individuals should be using the Internet
  2.2.(B) In the least-developed countries (LDCs), 20% of individuals should be using the Internet
- 2.3.(A) The affordability gap between developed and developing countries should be reduced by 40%
  2.3.(B) Broadband services should cost no more than 5% of average monthly income in developing countries
- 2.4: Worldwide, 90% of the rural population should be covered by broadband services
- 2.5.(A) Gender equality among Internet users should be reached
  2.5.(B) Enabling environments ensuring accessible telecommunication/ICT for persons with disabilities should be established in all countries

Goal 3: Sustainability

Manage challenges resulting from telecommunication/ICT development

Targets by 2020:

- 3.1: Cybersecurity readiness should be improved by 40%
- 3.2: Volume of redundant e-waste to be reduced by 50%
- 3.3: Greenhouse gas emissions generated by the telecommunication/ICT sector to be decreased per device by 30%

Goal 4: Innovation

Lead, improve, and adapt to the changing telecommunication/ICT environment

Targets by2020:

- 4.1: Telecommunication/ICT environment conducive to innovation
- 4.2: Effective partnerships of stakeholders in telecommunication/ICT environment

Source: ITU, *Connect 2020 Agenda*, accessed February 6, 2017, http://www.itu.int/en/connect2020/Pages/default.aspx.

Policy Action 1.1: Improve Cybersecurity

The G20 should improve cyberrisk management by encouraging the development of a harmonized cybersecurity baseline framework as well as of concepts for a global interoperable information-sharing platform under OECD guidance, and support a process leading to norms for responsible state behavior.

The G20 should foster cyberresilience, trustworthiness, and security in an increasingly digital economy. In doing so, cybersecurity cannot only be seen as a technical issue. Given the increasing importance of the Internet for individuals, businesses, and public administration, related risks also need to be considered with respect to broader economic and social perspectives. Therefore, G20 members should make cybersecurity a permanent G20 agenda topic.

G20 members should work together to understand the growing challenges of systemic cyberrisk. The G20 should encourage authoritative international organizations and agencies,[24] international standardization bodies,[25] and private-sector technical experts to develop a harmonized, sector-neutral cybersecurity baseline framework. [26] This process could be guided by the OECD. In general, the OECD should implement G20 initiatives and mandates through its committee work, while involving non-OECD G20 members.

The baseline framework should include a set of standards, methodologies, procedures, and processes that align policy, business, and technological approaches to address cyberrisks. It should incorporate voluntary consensus standards and industry best practices to the fullest extent possible. In doing so, a clear preference should be given to existing international standards.[27] The overall framework should enable effective cyber risk management across economic sectors and national borders, as well as all members along the value chain. This would facilitate target 3.1 of the Connect 2020 Agenda (see Exhibit 6) on improving cybersecurity readiness.[28]

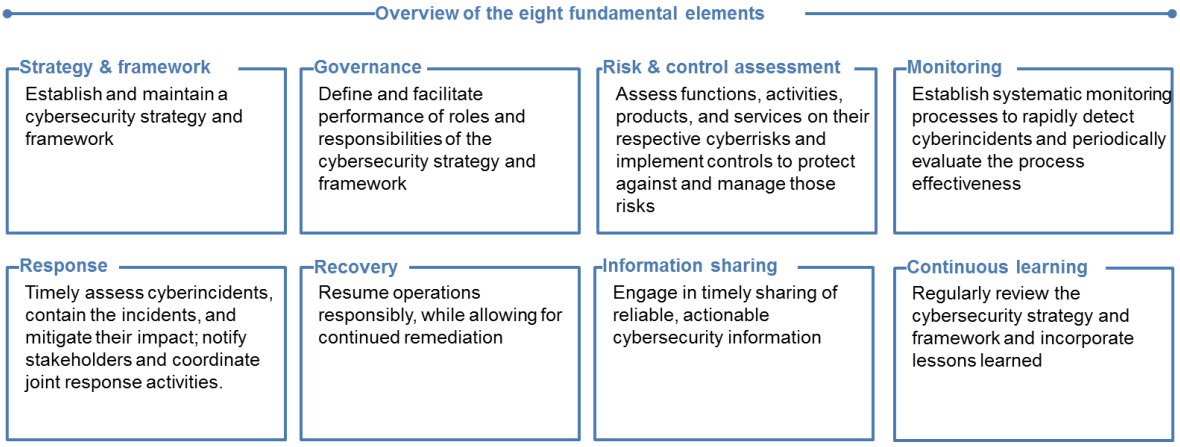
Guidance of the OECD in the development of the baseline framework would enable an efficient and effective cooperation between public and private organizations. The OECD could build on its existing Working Party on Security and Privacy in the Digital Economy, the work done for the elaboration of the recommendation on Digital Security Risk Management for Economic and Social Prosperity, and the G7 Fundamental Elements of Cybersecurity for the Financial Sector (see Exhibit 7).

The implementation of the baseline framework by governments through adoption in national or regional policies as well as the implementation by businesses in their practices would enable an application of digital technologies in a way that facilitates cybersecurity management and sharing of threat intelligence. The national or regional policies should not focus on compliance rules but should be outcome-based, meaning policy-makers would avoid the need to frequently adapt policies to new digitalization scenarios, while continuously ensuring the policies' purpose. Governments should cooperate with companies for the definition of these national or regional policies to ensure an exchange of knowledge and awareness of requirements.

[24] Such as OECD, BIAC, ICC, UNCTAD, WEF, and FIRST.
[25] Such as International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), Institute of Electrical and Electronics Engineers (IEEE), Internet Engineering Task Force (IETF), World Wide Web Consortium (W3C), 3rd Generation Partnership Project (3GPP), and Global System for Mobile Communications Association (GSMA).
[26] Cybersecurity baselines define a common set of cybersecurity principles across sectors. They can be extended by further, sector-specific policies on top of the baselines.
[27] Standards such as the ENISA Cloud Certification Schemes Metaframework (CCSM), the NIST Cybersecurity Framework (CSF), or the Global Financial Markets Association (GFMA)/International Swaps and Derivatives Association ISDA/European Banking Federation (EBF) cybersecurity principles.
[28] ITU, *Connect 2020 Agenda*, op. cit.

Exhibit 7 | The G7 Fundamental Elements of Cybersecurity for the Financial Sector

With the Fundamental Elements of Cybersecurity for the Financial Sector, the G7 countries provide eight basic elements as a basic guarantee for cybersecurity in the financial sector. The elements serve as building blocks on which organizations can design and implement their cybersecurity strategy and operating framework, informed by their approach to risk management and culture. Developed by the G7 Cyber Expert Group, the basic elements got endorsed by the finance ministers and central bank governors in 2016.



Source: Adopted from G7 Cyber Expert Group, *Fundamental Elements of Cybersecurity for Financial Sector* (2016), accessed February 6, 2017, http://ec.europa.eu/info/publications/g7-fundamental-elements-cybersecurity-financial-sector_en.

G20 members should also foster and support the adoption of secure software development practices across different industry sectors and software types (including proprietary and open source software), as well as self-certification schemes.[29] This would help to establish security-by-design. Existing security practices could be referenced in public procurement, for example those embedded in globally recognized and implemented standards.[30]

Furthermore, the G20 should ask the OECD convene a process to collect and review globally interoperable and adaptable concepts for a cross-sector online information-sharing platform on which organizations can globally exchange information on current threats, vulnerabilities, cyberattacks, incidents, and best practices. This could build upon the valuable role that Computer Emergency Response Teams (CERTs) play in the exchange of such information today. The platform should help organizations having relevant information that allows them to detect possible cyberrisks early and respond to them effectively. Information should be shared on a voluntary basis with the option of anonymous contributions and protection from attributed disclosure or discovery. The concept should include guidance on what information should be shared to enable the early detection and prevention of cyberattacks, with caution to avoid further compromise or exploitation of a threat. In addition, the concept should be adaptable to regional needs for a successful national implementation by G20 members while ensuring the option of global exchange between national platforms.[31] G20 members should strive to incorporate existing platforms in the implementation of the concept, such as the Forum of Incident Response and Security Teams (FIRST), Financial Service Information Sharing and Analysis Center (FS-ISAC) (see Exhibit 8), and regional concepts such as the CSIRT Network in the context of the Network and Information Security (NIS) Directive of the European Union (EU) with the goal of bundling current information sharing for cybersecurity at the global level. Other public-private partnerships for exchanging and developing cybersecurity products and services should also be incorporated.

[29] Schemes such as the UK's Cyber Essentials program or the U.S. NIST Cybersecurity Framework.
[30] Standards such as ISO/IEC 27034, IEC 62443-4-1, or ISO/IEC 15408.
[31] National needs and requirements such as existing comparable concepts, legislation, or regional industry specifics.

Exhibit 8 | Examples of Cybersecurity Exchange Platforms: FIRST and FS-ISAC

FIRST

FIRST is an exchange platform for improving cybersecurity. It brings together a wide variety of security and incident response teams from the government, commercial, and academic sectors. FIRST comprises more than 360 member organizations from 78 countries that pay an annual membership fee. The platform aims at information exchange and cooperation on issues of mutual interest like new cybervulnerabilities or wide-ranging cyberattacks – especially on core systems like the DNS servers or the Internet as a critical infrastructure itself. Besides sharing information on cyberincidents, the members share best practices, tools, methodologies, and processes to strengthen their cybersecurity activities. In 2014, FIRST established a collaborative effort on cybersecurity with the ITU to facilitate the interaction between ITU and FIRST members.

FS-ISAC

FS-ISAC (Financial Service Information Sharing and Analysis Center) is a nonprofit platform for information exchange on cyber- and physical threats in the financial services industry. The platform fosters information exchange between the public and private sectors to help protect critical infrastructure in the United States. Information can be shared anonymously and is verified and analyzed by industry experts selected by FS-ISAC. The experts also identify solutions for the reported threats and alert the FS-ISAC members. FS-ISAC was established in 1999 by the U.S. financial sector. In 2013, FS-ISAC extended its scope to worldwide information sharing between financial services firms.

The 2015 G20 Leaders' Communiqué affirmed that international law is applicable to states' conduct in the use of ICTs and underlined their support for the development of cybersecurity norms by the UN Group of Governmental Experts (GGE).[32] Given the growing indications of irresponsible state behavior in cyberspace, G20 members should redouble their efforts and align their intention to reach a global agreement on norms for responsible state behavior in cyberspace. This process could be facilitated by the UN, relevant regional organizations, and fora such as the "London Process" with critical input from the private sector and civil society. Dialogues should aim at norms that ensure the protection of all economic stakeholders and protection of critical infrastructure by taking business interests into account. G20 members should especially align on not forcing companies to program vulnerabilities into products and services (such as back doors) or undertake actions that would undermine public trust. They should also strive to prohibit and renounce state-sponsored IP theft. The norms should also touch on pressing issues of international cybersecurity such as a commitment to improve attribution of cyberattacks and cooperation in the fight against cybercrime. Ideally, the G20 will proclaim the goal to conclude a set of international cybersecurity norms by 2020. To inform the dialogues on cybersecurity norms, the G20 should convene a conference on cybersecurity norms, which would include representatives from international organizations, the private sector, and civil society.

[32] G20, *G20 Antalya Leaders' Communiqué* (2015), 6, accessed February 6, 2017, http://www.mofa.go.jp/files/000111117.pdf.

Policy Action 1.2: Enable Cross-Border Data Flows

G20 members should commit in trade agreements not to prevent the free flow of data across borders – without prejudice to clearly defined exceptions for the protection of privacy and security. Furthermore, G20 members should strengthen efforts for interoperable data protection standards, facilitate the use of the accountability principle, and pursue additional bilateral and plurilateral agreements that enable cross-border data flows consistent with privacy and data protection requirements.

G20 members should acknowledge that digital trade requires a new set of rules that preempts the use of discriminatory localization of data and ICT infrastructure. Restricting cross-border data flow significantly hampers international trade, investment, and financing – especially as the use of digital technologies increases within international value chains. Data flows are needed to manage international supply chains, trade in digital services and products, and in general to conduct business.[33] G20 members should strive for enforceable rules in trade agreements – including under the WTO umbrella – that ensure the free flow of data and restrict obligatory data localization, for both personal and nonpersonal data. A guarantee in trade agreements that governments will not prevent the transferring, processing, or storing of data within or outside their territory should be made in full compliance with and without prejudice to respective data protection and data privacy rules that meet the exemption requirements of GATS Article XIV.[34] International trade law generally allows for appropriate safeguards for the protection of privacy and national security. Measures in this regard must not be applied in a manner that would constitute "a means of arbitrary or unjustifiable discrimination between countries where such conditions prevail," or "a disguised restriction on trade in services."[35] While forced governmental data localization has to be avoided, citizens and companies should be free to rely on local server and data infrastructures without transferring their data, if they wish to do so.

Cybersecurity and data protection are a prerequisite for free and trustworthy cross-border data flows. The G20 should ask UNCTAD and the OECD to facilitate and guide an inclusive dialogue towards consensus-building among all G20 members on interoperable standards for nonpersonal data protection as well as privacy protection.[36] Senior experts of private and public organizations should be involved in the dialogue to ensure a holistic view on this topic. As a starting point, UNCTAD and OECD should use the results of the work with relevant stakeholders at the OECD on cross-border data flows, which was initiated as a follow-up to the OECD Ministerial Meeting in Cancún. Furthermore, UNCTAD and OECD should develop an interoperable framework of guiding principles on policies related to cross-border data flows with the involvement of senior experts of private and public organizations, which – respecting the right of governments to regulate where necessary and appropriate – can be adapted by countries.[37] The principles should incorporate a holistic approach that ensures cybersecurity, data and privacy protection, and free and trustworthy cross-border data flows in a way that reflects the needs of international business solutions and supply chains.

To foster legal certainty and transparency related to cross-border data transfer or storage, UNCTAD and OECD should – together with G20 members and abovementioned senior experts – propose a set of global guiding principles that clarify which jurisdiction applies under which circumstances.[38] The guiding

[33] For measures that could deal with the aforementioned challenges, see the policy paper of the B20 Germany Trade & Investment Taskforce, especially Recommendation 2.
[34] WTO, *General Agreement on Trade in Services (GATS),* Article XIV, 294–296.
[35] Ibid.
[36] This is in-line with UNCTAD's proposal of a platform on joint dialogue and fields in data protection regulation and international data flows that need to be addressed. See UNCTAD, *Data Protection Regulations and International Data Flows* (2016), xiii, 109–110, accessed February 6, 2017, http://unctad.org/en/PublicationsLibrary/dtlstict2016d1_en.pdf.
[37] National regulations should be compatible with the developed framework and should be drafted narrowly to accomplish the compelling objective while minimizing the possible impact on innovation or the creation of needless burdens or unintended consequences.
[38] In certain cases, not pertaining to criminal law, the applicable jurisdiction can be determined by the concerned parties in

principles should facilitate further transparency and certainty for global businesses and consumers by examining potential solutions related to concurrent jurisdictions and concurrent mutual legal assistance treaties (MLATs). While concurrent MLATs can be part of the problem, aligned MLATs generally facilitate legal transparency and certainty. To improve the effectiveness of MLATs, the G20 members should review their existing MLATs for their application in digital economies. In particular, the speed and efficiency of MLAT cooperation processes has to be increased.[39]

While making data protection policies more interoperable is an important way to facilitate cross-border data flows, substantial differences in legislation might in some cases not be avoidable due to diverging needs and societal preferences. Therefore, G20 members should facilitate the possibility of using the accountability approach. Under this approach the data protection obligations pursuant to which the data was collected and used (including applicable legal obligations in that jurisdiction) are transferred across borders together with the relevant data.[40] The transferring controller or processor should take appropriate steps to assure that the receiving parties in other territories commit to comply with these obligations. This creates a responsible process for cross-border data flows consistent with the data protection obligations that existed when collected. The legal requirements for data protection of the jurisdiction to which the personal data is transferred also continue to apply. This allows for cross-border data flows without risking a reduction in the level of data protection. The use of instruments for this, such as contractual clauses or binding corporate rules, should be made easier. Reducing related compliance costs and time requirements is especially crucial to enable SMEs to make use of these opportunities – small firms are considerably more affected by red tape.

G20 members should also pursue other options that enable free and trustworthy cross-border data flows while safeguarding privacy in compliance with existing applicable legal frameworks – for instance bilateral or plurilateral agreements such as the EU-U.S. Privacy Shield, which builds on applicable principles and practices found to meet adequacy requirements (see Exhibit 9). Options for engaging in trustworthy cross-border transfer of data without excessive compliance costs is particularly beneficial for small firms.

Exhibit 9 | APEC Cross-Border Privacy Rules System and the Privacy Shield

APEC Cross Border Privacy Rules System

In 2011, the Asia-Pacific Economic Cooperation (APEC) endorsed the Cross Border Privacy Rules (CBPR) system that facilitates data flows among APEC economies while safeguarding privacy. The CBPR system is a voluntary accountability-based system that bridges the differences between the privacy laws in the APEC region by ensuring accountability in information flows. The CBPR system ensures that organizations respect the privacy regulations of the country of origin. Organizations that want to participate need to comply with a set of requirements and apply for an APEC CBPR certification to ensure sufficient data privacy protection. Currently the United States, Mexico, Japan, and Canada are part of the system. Additionally, a common referential for the requirements with the EU Binding Corporate Rules is available to ease double certification.

EU-U.S. Privacy Shield

Under EU law personal data originating in the EU can generally only be transferred to territories that have an adequate data protection regime (in practice "essentially equivalent" to EU data protection requirements). This currently only applies to eleven territories. For personal data transfers from the EU to the United States a special framework exists that bridges differences in EU and U.S. data protection regimes. Under the so called "EU-U.S. Privacy Shield" personal data originating from the EU can be transferred to operators in the United States that commit to treat the relevant data in accordance with EU data protection requirements. The U.S. Federal Trade

commercial contracts – this option should remain valid.

[39] ICC, *Using Mutual Legal Assistance Treaties (MLATs) to Improve Cross-Border Lawful Intercept Procedures* (2012), 5, accessed February 6, 2017, http://www.iccindiaonline.org/policy-statement/3.pdf.

[40] Example: When company A is collecting personal information in country X and transfers it to country Y, the privacy requirements of country X continue to apply. If personal information is transferred to a third-party company B, company A remains responsible for assuring appropriate means for the compliance of the privacy requirements of country X.

Commission is tasked with monitoring and enforcing compliance. The EU-U.S. Privacy Shield replaced the Safe Harbour framework, which was declared invalid in 2015. The importance of such frameworks is reflected by the fact that over 4,000 firms from 103 different industries used the Safe Harbour framework. Over half the firms had fewer than 100 employees, highlighting how much data flows matter for SMEs. The Privacy Shield remains a crucial data transfer mechanism for SMEs, which rely on a streamlined, efficient method for sending and receiving data between the EU and the United States.

Sources: Asia-Pacific Economic Cooperation, *Cross Border Privacy Rules system*, accessed January 16, 2017, http://www.cbprs.org; European Commission, *Guide to the EU-U.S. Privacy Shield* (2016), 7–14, accessed January 16, 2017, http://ec.europa.eu/justice/data-protection/files/eu-us_privacy_shield_guide_en.pdf; OECD, *Economic and Social Benefits of Internet Openness* (2016), 12, accessed January 16, 2017, http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/ICCP(2015)17/FINAL&docLanguage=En.

Policy Action 1.3: Expand ICT Infrastructure

To foster affordable broadband access for all, G20 members should encourage private investments in ICT by considering the established and important principle of technological neutrality, through a simplified, market-oriented, and transparent regulatory environment, and through incentives to invest in less profitable areas, as well as by fostering investments for skill and capacity building.

As stated in the G20 Digital Economy Development and Cooperation Initiative, the G20 should support the ITU Connect 2020 Agenda to ensure the full implementation of the ambitious agenda goals. G20 members need to double their efforts to promote both the supply side to enable the growth, inclusiveness, and sustainability goal, and the demand side to realize the innovation goal of the ITU Connect 2020 Agenda.[41] To facilitate and ensure the implementation of the Connect 2020 Agenda for high-quality ICT infrastructure – which sets, inter alia, the goal of ensuring the provision of broadband for all – three principles should be implemented by G20 members with respect to their national requirements.[42]

1. Simplified and streamlined access regulation: Consideration for the established and important principle of technological neutrality as well as investment-conducive and market-based policies are needed given the variety of telecommunication technologies in high-speed access that are dependent on diverse legacy decisions and consumer preferences. Through this type of regulation, the competition among all market players has to be guaranteed. Overall, access regulation should concurrently promote competition and the consumers' interests as well as strengthen the predictability of returns on network investments.

2. Forward-looking spectrum policy to cover accelerated demand for wireless Internet: G20 members should make available more spectrum in a more predictable way (e.g., through longer or indefinite spectrum licensing terms), also by allowing for spectrum-sharing models where appropriate.[43] Spectrum allocation and assignment should target the best possible efficiency in spectrum use and target the maximum benefit for the economy. Nondiscriminatory allocation of spectrum, for example by avoiding favoritism for state-owned or other domestic providers in allocation auctions, can contribute to this.

3. An approach to competition policy with more emphasis on dynamic efficiencies and overall benefits for all market participants: G20 members should share and implement best practices on competition policies geared towards more investment and corresponding metrics. While the

[41] ITU, *Connect 2020 Agenda* (2014), op. cit.
[42] Compare BCG and ETNO, *Building the Gigabit Society: An Inclusive Path Towards Its Realization* (2016), 4–17, accessed February 6, 2017, https://etno.eu/datas/ETNO%20Documents/Gigabit_society_final_ETNO-BCG_2016.pdf; BCG Perspectives, *Five Priorities for Achieving Europe's Digital Single Market* (2015), 12–39, op. cit.
[43] Spectrum sharing allows the use of frequencies allocated but not being used for a specific service – such as television broadcasting or marine radar – to be utilized by alternative noninterfering services.

Average Revenue per User (ARPU) has been the dominant metric for the regulatory objective of competition, G20 members could adopt a more comprehensive and balanced assessment. Studies show that metrics for the regulatory objectives of competition and market performance that focus on investment and technological progress, including quality of service, consumption levels, and innovation can lead to more efficient results. In particular, unit pricing can be a more meaningful metric than monthly spending (see Exhibit 10 in relation to the mobile Internet). Moreover, regulators should shift the focus of merger remedies from new market entry to encouraging network investments, innovation, and quality of service through merged entities. Regulators should, for example, focus on the sustainability and ability of respective companies on their own.

Exhibit 10 | Metrics for Competition on the Mobile Internet

At present, many authorities assess the level of competition in mobile networks by looking at ARPUs, for example when evaluating proposed mergers and acquisitions. This may need to be thought through as subscriptions exceed populations in many economies today. For other utilities, such as water, gas, and fuel, unit prices are the relevant figures for evaluating competition levels and the affordability of services or goods. These markets are not entirely comparable, but a study of IDATE in 2015 compared mobile markets in the five largest EU countries with the United States, Japan, and South Korea. According to this study, levels of mobile data consumption in the United States, Japan, and South Korea are about three times higher, also resulting in higher levels of ARPUs, whereas prices per gigabyte can be significantly lower than in Europe. This finding suggests that regulatory policies that reduce the amount consumers spend do not necessarily enhance consumer welfare and may inhibit the growth of the mobile wireless ecosystem.

Source: Data from IDATE, *Mobile Operator's Investments* (2015), accessed February 20, 2017, https://www.ericsson.com/res/docs/2015/mobile-operators-investments-whitepaper.pdf.

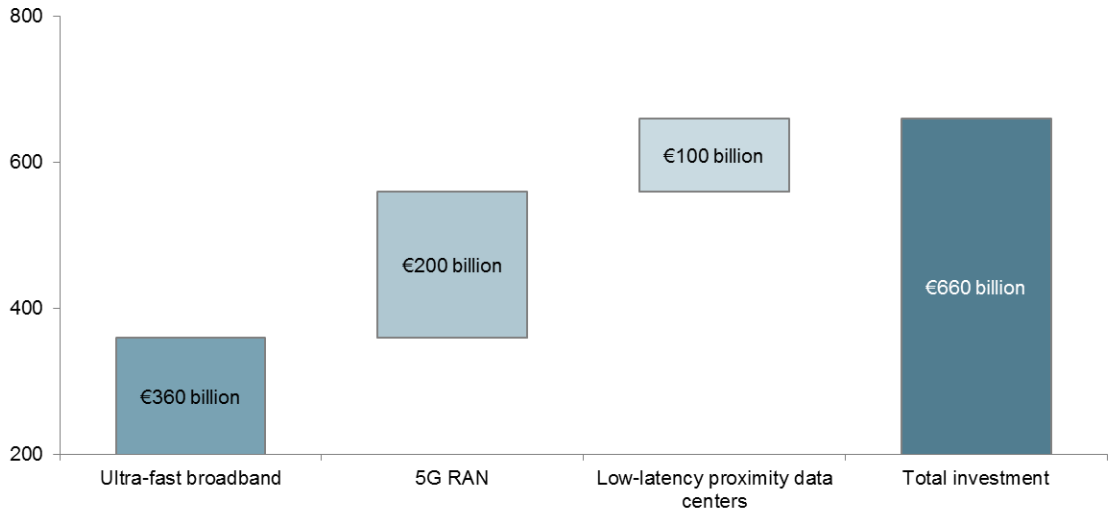
Additionally, private investment should be facilitated by reducing barriers to foreign direct investments and by ensuring fluid venture capital markets.[44] Complementing private investments with public contributions, for example by funding projects from international development organizations as appropriate, might be advisable for economically unprofitable business cases in more rural and remote areas. These efforts are critical to bridge the digital divide.[45] G20 members should focus their efforts in this regard not only on ICT network investments but also on appropriate enabling policies for other IT investments such as data centers.

Moreover, the G20 members should foster public-private partnership initiatives, such as the Internet for All Project (see Exhibit 12) of the World Economic Forum (WEF), through funding of projects that develop both the supply and demand/user side of ICT infrastructure. For emerging and developing countries in particular, the G20 members should support projects that address a lack of sufficient skills and awareness as well as a lack of relevant content and services in local languages.[46]

[44] For detailed B20 recommendations on financing, see Recommendation 2 and 3 of the B20 Germany Financing Growth & Infrastructure Taskforce Policy Paper.
[45] For recommendations on the digital divide see also Policy Recommendation 2 of the B20 Germany SME Cross-Thematic Group Policy Paper.
[46] For the described lack in sufficient skills, awareness, and content and services see: WEF, *Internet for All: A Framework for Accelerating Internet Access and Adoption* (2016), 9–10, accessed February 20, 2017, http://www3.weforum.org/docs/WEF_Internet_for_All_Framework_Accelerating_Internet_Access_Adoption_report_2016.pdf.

Exhibit 11 | Investment Needed for a Sufficient ICT Infrastructure – Example Europe

Europe has launched a transformation path towards a Gigabit Society, aiming to have each and every European citizen benefit from full digital empowerment by 2025. To enable new, innovative services and products, ranging from connected cars to e-government and from e-health to connected devices, investments in the ICT infrastructure are needed.



Overall, investments of around €660 billion will be required to implement this vision.

- About €360 billion are to be invested in ultrafast broadband at home, enabling nearly 100 percent of European households to access mainly fiber-to-the-premises (FTTP) networks.
- About €200 billion are to be invested in 5G RAN (radio access network), driven by the sevenfold densification required in cities for small cell solutions, fiber backhaul for all base stations, and the completion of the 4G rollout.
- About €100 billion are to be invested in low-latency proximity datacenters in existing central office/switch locations.

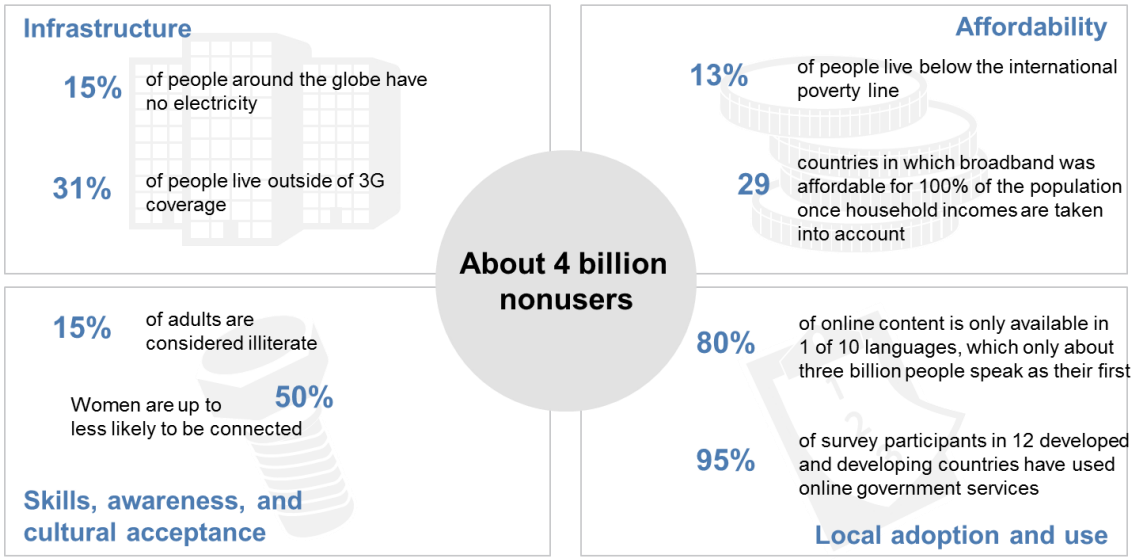
Most of the investment will have to be privately funded. However, it is essential that industry and institutions cooperate to ensure a favorable environment for private investment.

Source: BCG and ETNO, *Building the Gigabit Society: An Inclusive Path Toward Its Realization* (2016), 6, op. cit.

Furthermore, G20 members should ensure fair competition and minimized regulatory burden for operators and service providers. To minimize the regulatory burden, G20 members should review whether existing regulations are fit for this purpose, consistent, transparent, and conducive to investments.

Exhibit 12 | ICT Demand Side – WEF Framework "Internet for All"

ICT infrastructure alone is not sufficient to bridge the digital divide. Barriers to greater Internet use include: 1) infrastructure, 2) affordability, 3) skills, awareness, and cultural acceptance, and 4) local adoption and use.



Source: WEF, *Internet for All: A Framework for Accelerating Internet Access and Adoption* (2016), 10, op. cit.

Recommendation 2: Strengthen Industry 4.0 and the Industrial Internet

The G20 should support the dissemination of Industry 4.0 and the Industrial Internet (I4.0&II) by fostering innovation, ICT infrastructure deployment, and the development and use of global standards.

Policy Actions	
2.1	**Facilitate Innovation –** G20 members should facilitate the use and dissemination of technology solutions for I4.0&II by increasing awareness of use cases and opportunities through the initiation of an international knowledge exchange platform of practice at the OECD and World Bank Group, and by supporting demonstration systems of private organizations and academia. • The G20 should mandate the OECD, UNCTAD, and UNIDO to compile and provide respective use cases on I4.0&II for the platform in cooperation with businesses. • G20 members should financially incentivize the setup of demonstration systems/plants of state-of-the-art I4.0&II implementations through tax deductions or research and development funding, which should also target the cooperation between academia and business.
Owner G20, G20 members, OECD, UNCTAD, UNIDO, WBG, businesses	**Timing** 2017-2019
2.2	**Foster ICT Infrastructure for I4.0&II –** The G20 should encourage public-private cooperation for setting specific I4.0&II ICT infrastructure goals that serve business needs, implement forward-looking ICT infrastructure policies, and facilitate new business models as well as the use of new technologies by avoiding burdensome, needlessly constraining regulations. • The definition of specific national I4.0&II ICT infrastructure goals should pursue the implementation of chapter 4.5 (New Industrial Infrastructure) of the G20 New Industrial Revolution Action Plan and involve industry representatives to ensure the integration of business needs. • To implement the defined I4.0&II goals, G20 members should define national ICT infrastructure plans that reflect specific business requirements, such as broadband communication capacities and national infrastructure needs. • To implement forward-looking ICT infrastructure policies, G20 members should: 1) allocate more spectrum without discriminating against private or foreign providers, 2) facilitate new business models such as value-based pricing, and 3) facilitate development and use of new technologies such as software-defined and virtual networks by replacing outdated policies with flexible regulations.
Owner G20, G20 members	**Timing** 2017-2020
2.3	**Encourage Development of Global and International Standards –** G20 members should foster the development and use of globally interoperable standards and specifications by supporting industry-led multistakeholder cooperation and market-driven standardization initiatives, as well as referring to consensus-based globally relevant standards and specifications in public procurement. • G20 members should help realize cooperation of formal standardization bodies with open, voluntary, consensus-based standardization bodies and industry fora of market-driven initiatives, like the Reference Architecture Model Industrie 4.0 (RAMI4.0) within Plattform Industrie 4.0 or the Industrial Internet Consortium. • The G20 should draft and maintain an exemplary list of globally relevant informal standardization bodies, to inform relevant stakeholders and foster potential cooperation.
Owner G20, G20 members, standardization bodies	**Timing** 2017 - 2019

Context

Digitalization is changing the way industries and companies work. In production and related services, sensors, machines, intermediate, and final products, as well as IT systems become connected along the value chain beyond a single enterprise, allowing new smart services.

This (r)evolution is often referred to as Industry 4.0 and the Industrial Internet (I4.0&II) and is based on multiple foundational technological advances. With developments such as simulation tools, additive manufacturing, smart machines, sensors, real-time communication, or data-driven services, I4.0&II enable new business models as well as efficiency, faster time-to-market, and higher production flexibility. I4.0&II has the potential to enable economic growth in developed (see Exhibit 13), emerging, and developing countries.

While many digital technologies for I4.0&II are already developed, the use of these is not sufficiently widespread. Studies have shown that only 19 percent of German and 16 percent of U.S. companies have implemented either full I4.0&II concepts for production (like a smart factory) or initial measures towards such a concept (like the introduction of autonomous robots).[47] The following five levers are essential for the dissemination of I4.0&II:

1. Knowledge of use cases is required to assess investments and their return. Companies are often unaware of I4.0&II solutions for their business or do not have sufficient know-how to evaluate the implications that an investment has on the company's operating profits.

2. Adequate ICT infrastructure is required for I4.0&II, as it is the basis for connectivity of products and services. To participate in I4.0&II, companies need a high-quality ICT connection with sufficient bandwidth enabling the exchange of increased data volume as well as low latency to enable real-time communication between different subsidiaries and companies.[48]

3. Common interoperable I4.0&II standards are required to enable communication between products, services, and systems. As the number of different technologies for I4.0&II grows, globally relevant standards are becoming increasingly necessary to efficiently integrate existing solutions. To develop such standards, formal standardization bodies should collaborate with open, voluntary, consensus-based standardization bodies as well as with industry fora from different sectors to establish new and align existing standards.[49] Market-driven initiatives involving business, government, and academia such as the Plattform Industrie 4.0, the "Smart Service World, or the Industrial Internet Consortium's Reference Architecture are examples of open and consensus-based processes that ensure timely, flexible, and globally relevant standardization.[50]

4. Qualified employees are required especially in fields like data management, data security, software development, programming, data science, and analytics.[51] Challenges related to workforce skills are covered in the policy paper of the B20 Germany Employment & Education Taskforce.[52]

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[47] BCG Perspectives, *Time to Accelerate in the Race Toward Industry 4.0* (2016), 4, http://metalonia.com/w/documents/BCG-Time-to-Accelerate-in-the-Race-Toward-Industry-4.0-May-2016_tcm80-209674.pdf.
[48] WEF, *Expanding Participation and Boosting Growth: The Infrastructure Needs of the Digital Economy* (2015), 4–5, op. cit.
[49] "Formal standardization bodies" refers to international standards-development organizations such as ISO, IEC, ITU, and ETSI; "open, voluntary, consensus-based standardization bodies" refers to bodies such as IETF, W3C, and IEEE.
[50] Details on Plattform Industrie 4.0 are available at http://www.plattform-i40.de; details on Smart Service World are available at http://www.digitale-technologien.de/DT/Navigation/EN/Foerderprogramme/Smart_Service_Welt/smart_service_welt.html; (all accessed January 16, 2017) details on Industrial Internet Consortium Reference Architecture are available at http://www.iiconsortium.org/IIRA.htm, accessed February 22, 2017.
[51] BCG Perspectives, *Time to Accelerate in the Race Toward Industry 4.0* (2016), 6–8, op. cit.
[52] With reference to the B20 Germany Employment and Education Taskforce, the G20 should foster the understanding of and training of skills required for digitalization to realize the related potential social and economic benefits. This is important not only in college majors and in jobs related to software and information technology. Rather, enabling basic digital skills is crucial for all professions and academic subjects.

5. Security of IT systems and ICT infrastructure is especially important for companies in the context of I4.0&II, as they increasingly transfer confidential or critical data. Interruptions in IT systems could cause production outages or worse (for cybersecurity policies, see Policy Action 1.1).

In 2016, the G20 recognized the importance of I4.0&II. The New Industrial Revolution Action Plan and the Digital Economy Development and Cooperation Initiative were first steps towards finding a common understanding of specific I4.0&II requirements. The B20 welcomes this development and recommends proceeding further in this direction with the following policy actions towards improved ICT infrastructure, increased innovation, and global and international standards.

Exhibit 13 | GDP Effect of Industry 4.0 and the Industrial Internet – Example Germany

	Industry	Gross production share Germany	Trend	Additional growth p.a.[1]	Comments on productivity potential
Mechanical engineering	Automotive	22%	↗	2–3%	Additional sales with **flexible small batch sizes** and **configuration varieties**
	Food & beverage	10%	↗	2–3%	**Higher varieties** in the production process, e.g., high diversity in flavors
	Components	6%	↑	2–5%	Additional demand driven by **product upgrades** with **intelligent sensors** and **growth of machinery segment**
	Machinery	6%	↑		**Additional demand** for **machinery upgrades** with **intelligent controls** and **sensors**
	Wind	1%	↗		Additional demand for product upgrades with **intelligent design** and hence **higher effectiveness**
	Other	55%	↗	1–2%	**High varieties**, e.g., furniture industry
	Weighted average			avg. 1–2%[2]	~ 1.1% of GDP p.a.

Note: 1. Base=gross production 2. Additional net effect of Industry 4.0 per year; additional to regular growth.
Sources: BCG analysis; expert interviews.

Policy Action 2.1: Facilitate Innovation

G20 members should facilitate the use and dissemination of technology solutions for I4.0&II by increasing awareness of use cases and opportunities through the initiation of an international knowledge exchange platform of practices at the OECD and World Bank Group, and by supporting demonstration systems of private organizations and academia.

The G20 should extend the G20 Innovation Action Plan and mandate the OECD and World Bank Group to build an exchange platform of practice for I4.0&II innovation to facilitate voluntary knowledge sharing and open science. The exchange platform should be integrated into the new G20 Innovation Forum of the OECD/World Bank Innovation Policy Platform (IPP) and enable public as well as private organizations alike to contribute knowledge (see Exhibit 14).[53] As a follow up to the joint OECD, UNCTAD, and UN Industrial Development Organization (UNIDO) G20 report on opportunities and challenges related to the new industrial revolution,[54] the G20 should ask these organizations to provide use cases on I4.0&II in cooperation with businesses. The use cases, which would serve as initial content of the exchange platform, should cover different industries, and should explicitly include use cases for MSMEs to support digitalization in all organizations. As an enabling factor for knowledge sharing, G20 members should further strive to align on adequate and effective intellectual property rights (IPR) protection and enforcement by intensifying their collaboration among each other and with the World Intellectual Property Organization (WIPO) and the WTO.

Exhibit 14 | Knowledge-Sharing Platform for Innovation

In the 2016 G20 Innovation Action Plan, the G20 decided to set up an Innovation Forum by building a new community of practice within the existing IPP, which is operated by the OECD and the World Bank.

The IPP is a web-based interactive space that provides easy access to knowledge, learning resources, indicators and communities of practice on the design, implementation, and evaluation of innovation policies. The platform contains practical information on a wide range of innovation-related topics, such as financing innovation, technology transfer and commercialization, and innovative entrepreneurship. In the communities of practice, users can discuss innovation topics, exchange documents, and access learning events such as webinars. The IPP facilitates knowledge exchange and collaboration across countries and regions.

G20 members should financially incentivize the construction of demonstration systems/plants for state-of-the-art I4.0&II implementations through private organizations or academia. Potential means would be funding of research and development projects related to those demonstration systems/plants or offering tax incentives. Demonstration systems/plants enable organizations and businesses (especially MSMEs) to experience the applications and benefits of I4.0&II use.[55] As part of this, G20 members should encourage close cooperation between academia and business.

[53] The OECD and World Bank Innovation Policy Platform (IPP) is available at https://www.innovationpolicyplatform.org, accessed January 16, 2017.
[54] The G20 *New Industrial Revolution Action Plan* includes the release of a report by OECD with UNCTAD and UNIDO, which provides an overview of opportunities and challenges brought about by the New Industrial Revolution.
[55] With reference to the B20 Germany SME Cross-Thematic Group, the G20 should seek adequate financing mechanisms that support MSMEs in implementing I4.0&II technologies. This is especially important for MSMEs as capital expenditure requirements might otherwise be a critical barrier to I4.0&II adoption.

Exhibit 15 | Example Use Cases for Industry 4.0 and the Industrial Internet

Virtual product design

Virtual factory and product design

A software company and a producer of industrial machinery offer a joint solution for integrating factory and product design. The solution enables, for example, manufacturing optimization through factory simulation, based on the actual manufacturing needs of the product.

Integrated, automated & optimized production

Integrated design data

An electronics factory utilizes vertical data integration from design to the end-of-line of its 75% automated manufacturing process for the optimization of their operations.

Flexible production

Flexible manufacturing robots

An automotive OEM uses flexible industrial robots to switch between manufactured car types within 18 seconds, which helps to decrease plant-line and setup costs.

Learning and self-optimizing production

Self-optimizing injection molding

A machine construction company works on a research project to optimize the quality of the injection molding process. The company developed a recognition mechanism for disturbances in the basic materials mix in order to stabilize the process.

Automated commissioning and logistics

Laser-guided automated guided vehicle

An automotive OEM operates a laser-guided automated guided vehicle (AGV) logistics system at its assembly and stamping factory where the host computer controls inventory, schedules, and deliveries while routing the AGVs.

End-to-end integration of activities

"Digital twins" for activity integration

An aviation company is working with digital copies of its products to integrate activities from design, simulation, and work preparation, to production and maintenance. During all of these activities, information is saved in the digital twin. The information is used, for example, for complex prognostics, intelligent maintenance, or finding root causes of quality issues.

Case Study: Open Cloud Platform for Data-Driven Services – MindSphere

MindSphere is an example of an open cloud platform for data-driven services in production. The platform allows companies to record and analyze large volumes of their production data directly in the cloud.

Based on the gathered production data, data-driven services can generate insights for improving plant efficiency, reducing warranty expenses, and optimizing assets for maximized uptime. In order to do so, MindSphere provides applications and services in areas including predictive maintenance, energy data management, and resource optimization. Additionally, it is possible to develop and install custom or third-party applications.

Overall, the cloud platform provides companies access to I4.0&II technologies without the need of developing and implementing a proprietary system, also enabling companies with lower financial capabilities such as MSMEs to benefit from digital technologies.

Source: Siemens, *MindSphere,* accessed February 6, 2017, http://www.siemens.com/global/de/home/unternehmen/themenfelder/digitalisierung/mindsphere.html; BCG analysis.

Policy Action 2.2: Foster ICT Infrastructure for Industry 4.0 and the Industrial Internet

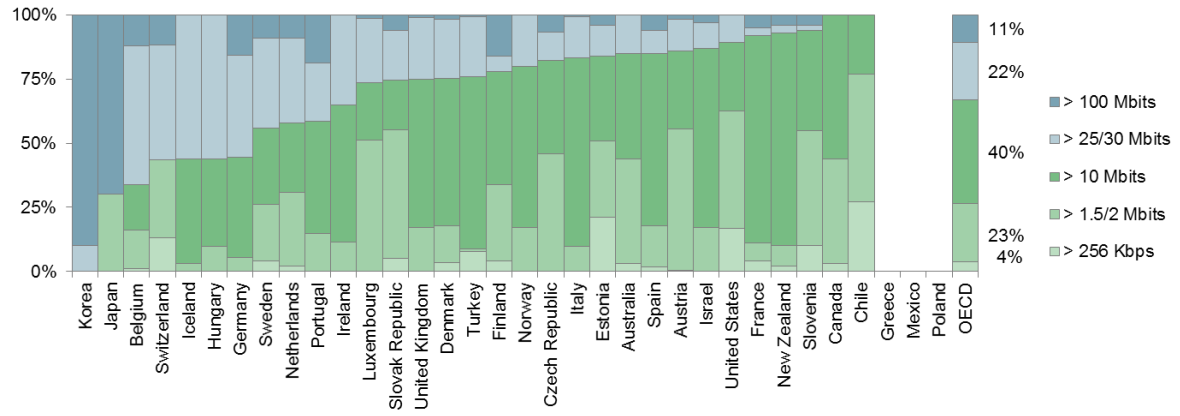
The G20 should encourage public-private cooperation for setting specific I4.0&II ICT infrastructure goals that serve business needs, implement forward-looking ICT infrastructure policies, and facilitate new business models as well as the use of new technologies by avoiding burdensome, needlessly constraining regulations.

To implement chapter 4.5 (New Industrial Infrastructure) of the G20 New Industrial Revolution Action Plan, particularly with respect to the importance of high-speed fixed and mobile Internet for I4.0&II, G20 members should define specific national I4.0&II ICT infrastructure goals. To maximize effectiveness, G20 members should ensure a good comprehension of business needs and potential by involving industry representatives early on, thus supporting the identification and realization of business opportunities.

Exhibit 16 | Broadband Improvement Needs for Industry 4.0 and the Industrial Internet

Applications of Industry 4.0 and the Industrial Internet often require high-speed fixed and mobile broadband Internet connections. The lower boundary for high-speed broadband is usually 25 megabits per second (Mbps) or 50 Mbps. Comparing this with existing fixed broadband speed distributions illustrates the need for further improvements. (For improvement needs in mobile broadband Internet see Exhibit 17.)

Fixed broadband speed distribution by country



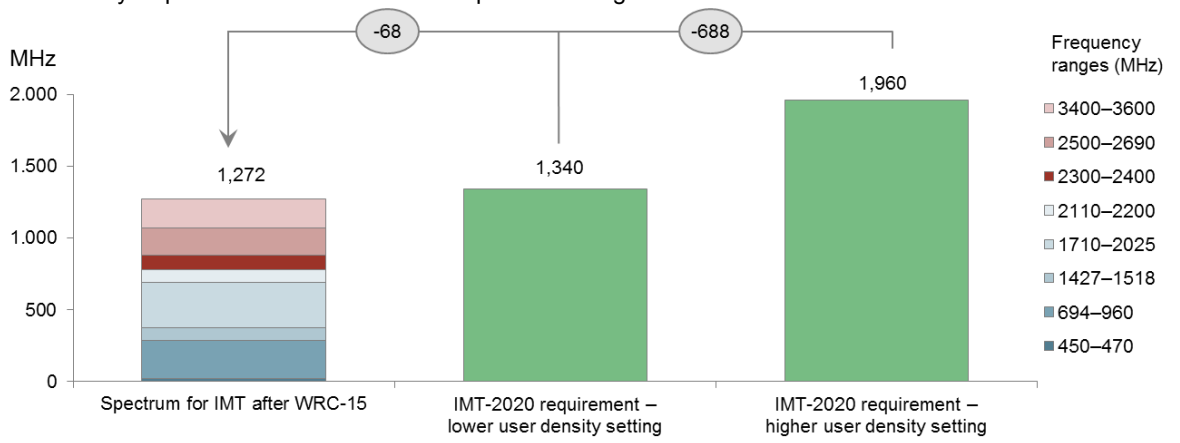
Sources: OECD, *Digital Economy Outlook* (2015), accessed February 6, 2017, http://ec.europa.eu/eurostat/documents/42577/3222224/Digital+economy+outlook+2015; OECD, *Key ICT Indicators*, accessed February 6, 2017, http://www.oecd.org/internet/broadband/oecdkeyictindicators.htm; BCG analysis.

Furthermore, G20 members should define national ICT infrastructure plans for the implementation of the defined I4.0&II goals that reflect business requirements such as higher bandwidth especially for data upload, real-time capability (transmission within guaranteed latency and jitter range), scalability, guaranteed quality of services, and additional spectrum (see Exhibit 16 and Exhibit 17 on the needs fixed and mobile broadband requirements of I4.0&II).[56] These plans should include specific timetables for ultimate implementation, financing, and investment options for private companies. The G20 should additionally provide policy guidance for developing regions such as Africa by defining a forward-looking G20 I4.0&II ICT infrastructure investment plan to attract private investments in those regions.

[56] See, for example, WEF, *Expanding Participation and Boosting Growth: The Infrastructure Needs of the Digital Economy* (2016), 9–12, op. cit. For latency requirements, see A. Varghese and D. Tandur, *Wireless requirements and challenges in Industry 4.0* (2014, International Conference on Contemporary Computing and Informatics), 636 – less than 5 ms of latency is needed.

Exhibit 17 | Spectrum Need for Future Mobile Broadband Communication

Studies by ITU's Radiocommunication Sector (ITU-R) in 2013 indicated that nearly 700 MHz of additional spectrum in lower and medium bands are required for the higher user density setting of their International Mobile Telecommunication system (IMT) 2020 vision. The IMT 2020 describes a future vision of mobile broadband communications including elements such as 5G. In preparation for the WRC-19, studies suggest that 5G will additionally require substantial amounts of spectrum in high bands above 24 GHz.



Note: WRC-15 stands for World Radiocommunication Conference 2015.

Source: ITU-R, *Report M.2290-0* (2013), accessed February 6, 2017, https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2290-2014-PDF-E.pdf; BCG analysis.

To enable ICT companies to fulfil specific I4.0&II needs, G20 members should adopt three forward-looking infrastructure policies:

1. G20 members should allocate more spectrum, reflecting the requirements of I4.0&II applications as well as allowing spectrum sharing and dynamic allocation of spectrum to services.[57] This should include low-frequency spectrum for wide area coverage (e.g., connected cars, distributed sensors) and higher-frequency spectrum for data-intense short-distance applications (e.g., cloud uploads). To increase mobile Internet coverage, G20 members should support the rollout of small cells that can be placed almost anywhere (e.g., on buildings or street lights), by reducing cost-intensive regulatory burdens like large scale transceiver stations. In addition, the development of Long-Term Evolution (LTE) Advanced and 5G should be supported by defining national rollout plans together with businesses and complementing private investments with public contributions for economically unprofitable business cases in more rural and remote areas.
2. G20 members should consider new and innovative business models such as value-based consumer pricing (derived from factors such as usage, speed, bandwidth, latency, or time of day). Value-based pricing plans may improve ARPUs for network operators.[58] If coupled with effective competition, this might potentially enable additional investments and innovations. G20 members should strive for policies that do not prohibit these innovations while ensuring an open Internet.
3. G20 members should support new technologies such as software-defined and virtualized networks, which can enable higher capacity utilization or the automation of network provisioning by replacing outdated policies with flexible, light-touch regulations to reflect shifting needs.

[57] While allowing spectrum sharing, G20 members must ensure the rights of existing spectrum licensees and users appropriately.
[58] WEF, *Expanding Participation and Boosting Growth: The Infrastructure Needs of the Digital Economy* (2016), 26–27, op. cit.

Policy Action 2.3: Encourage Development of Global and International Standards

G20 members should foster the development and use of globally interoperable standards and specifications by supporting industry-led multistakeholder and market-driven standardization initiatives, as well as referring to consensus-based standards and specifications in public procurement.

G20 members should foster industry-led multistakeholder cooperation on globally interoperable standards for I4.0&II as stated in the G20 New Industrial Revolution Action Plan and the G20 Digital Economy Development and Cooperation Initiative. The G20 should facilitate the cooperation of formal standardization bodies with open, voluntary, consensus-based standardization bodies and industry fora to encourage timely, flexible, concerted, consensus-based, and globally relevant standardization for global and international standards in I4.0&II. To improve existing standardization processes, G20 members should support established, market-driven initiatives. These include, for instance, the Plattform Industrie 4.0 (combining, for example, OPC Foundation[59] as well as ISO and IEC standards in RAMI4.0 – see also Exhibit 18) or the Industrial Internet Consortium (including inter alia ISO 27000, IEC 62443, IEEE, and Object Management Group standards). Both develop reference architectures that ensure interoperable, secure communication based on flexible, open, voluntary, industry-led, market-driven and consensus-based standards from formal and open, voluntary, consensus-based standardization bodies including industrial consortia. Through increased participation of private-sector organizations, standardization will proceed in an efficient market-driven approach taking into account actual needs.

Exhibit 18 | RAMI 4.0 – A Reference Architecture by Plattform Industrie 4.0

The Plattform Industrie 4.0 is a joint project of the German government, business sector, scientific community, professional associations, and trade unions. The platform unites over 250 stakeholders and bundles national and international activities surrounding the digital transformation of production in Germany.

The platform's activities are categorized into five working groups: 1) Reference Architectures, Standards, and Norms, 2) Research and Innovation, 3) Security of Networked Systems, 4) Legal Framework, and 5) Work, Education and Training.

The major task of the first working group is to incorporate existing norms and standards in the new Reference Architecture Model Industry 4.0 (RAMI 4.0). RAMI 4.0 is an initial proposal for a solution-neutral reference architecture model, building on a consensus-based standardization process. The working group analyzes existing standards and norms in order to identify overlaps and gaps, and to draw up recommendations for preferred solutions. The platform does not develop standards but rather coordinates the standardization activities across a range of organizations and associations. Overall, the working group strives to minimize the number of standards. Companies are an essential part of the process and contribute actively.

Source: Plattform Industrie 4.0, *RAMI 4.0*, accessed February 7, 2017, http://www.plattform-i40.de/.

To facilitate the use of globally interoperable open standards and specifications, the G20 Taskforce on the Digital Economy should also draft and maintain a list highlighting open, voluntary, consensus-based standardization bodies and industry fora.[60] The list should be available online and updated on a regular basis by the G20 Taskforce.

In public procurement and certification of ICT goods and services, G20 members themselves should give a clear preference to referencing available international and global standards that have been developed in an open, bottom-up, consensus-based, and market-driven process.[61] Thereby, public organizations would contribute directly to the use and application of global standards. Additionally, G20

[59] OPC: open platform communications.
[60] While efforts should be made to make the list comprehensive it might not be exhaustive, but provide a good overview on relevant standardization bodies and industry fora.
[61] In general, certification should be used as little as possible.

members should commit to refraining from using standardization processes to discriminate against foreign companies and isolate the local economy from global competition. When it comes to the use of standards in regulation, governments should commit to implementing the WTO Technical Barriers to Trade (TBT) principles and consider the established and important principle of technology neutrality.[62] Overall, the use of standards must remain voluntary and economic operators should always have the option to prove that their technical solution meets the essential requirements of the applicable legislation in alternative ways.

[62] Compare WTO, *Agreement on Technical Barriers to Trade – Annex 3*, accessed January 16, 2017, https://www.wto.org/english/docs_e/legal_e/17-tbt_e.htm.

Recommendation 3: Embrace Artificial Intelligence

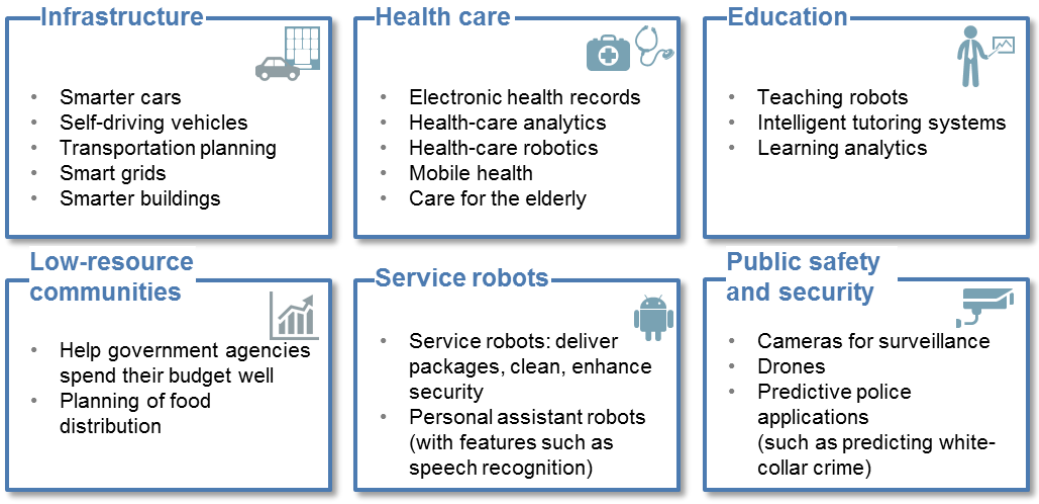
The G20 should support the evolution of human-centric artificial intelligence (AI) and related technologies by ensuring informed public dialogues on opportunities and challenges, supporting development and deployment of innovation, and accelerating the rollout of smart infrastructure.

Policy Actions	
3.1	**Encourage an Informed Public Dialogue –** The G20 should encourage the OECD to set up a multistakeholder initiative to analyze potential applications, benefits, and challenges of AI and provide guidance for governments on an informed public dialogue on AI. • The G20 should acknowledge the importance of international cooperation to exploit the potential of AI and make it a G20 agenda item. • The G20 should ask the OECD to organize an international forum comprising representatives from business, governments, academia, and societal institutions and guide the preparation of a report on opportunities, risks, and challenges related to AI. Non-OECD G20 members have to be fully involved in this project. • The report should provide guidance on how governments can foster an informed public dialogue on AI.
Owner G20, G20 members, OECD, business, academia, societal institutions	**Timing** 2017-2018
3.2	**Provide a Favorable Ecosystem –** G20 members should develop forward-looking policies that support the rollout of AI by adjusting regulations to facilitate the use of emerging technologies, such as big data, and foster related investment and innovation. • G20 members should review as well as adjust existing regulations and avoid the introduction of new policies that impede the use of emerging technologies including big data and advanced data analytics. • G20 members should increase funding of AI research projects in academia and incentivize AI research and pilot projects in business, for instance through taxation. • G20 members should make appropriate public-sector data available for analytics and research projects to harness the related innovation potential.
Owner G20 members	**Timing** 2017-2020
3.3	**Support Smart Infrastructure –** The G20 and its members should support the implementation of smart infrastructure by mandating the Global Infrastructure Hub (GIH) to make available – jointly with the private sector – use and business cases to illustrate potential benefits, reduce barriers to foreign direct investments in ICT and smart infrastructure, and complement private investments in less profitable deployments. • The G20 should mandate the GIH to draft a report on the potential of smart infrastructure including use and business cases as illustration and proof of value. • The GIH should catalog best practices that emerge from lighthouse projects to accelerate smart infrastructure implementation. • Utilizing the GIH best practices catalog, G20 members should further support the implementation of smart infrastructure by informing standardization of interfaces between different smart infrastructure solutions and technologies.
Owner G20, G20 members, GIH, businesses	**Timing** 2017-2020

Context

AI describes the field of intelligent products and services that leverage advanced information processing, such as speech recognition and big data analytics, as well as those that use sensors, mobile devices, and other autonomous machines. Innovations, such as self-driving vehicles, smart infrastructure, smart agriculture, and advances in machine learning illustrate the transformational potential of AI. By combining advanced information processing, new sources of data, and interconnected, intelligent systems, AI enables intelligent augmentation (such as high-speed decision support systems, improved learning leveraging big data, and knowledge management) as well as intelligent automation (such as self-optimizing process automation with fast and continuous build-measure-learn cycles). Through AI, machines may address complex problems by learning from data and the environment via advanced programming that does not require explicit new instructions for each emerging situation. Societies can benefit directly from many AI applications designed to assist people, such as improved pattern recognition in health care or fraud detection in financial transactions. Furthermore, AI can generate new, data-driven business models, increase the speed of production, and drive quality improvements. Through automation and decision support systems, AI rollout might allow up to 40 percent cost savings in services like lead generation, sales, customer services, or IT management.[63] Overall, AI has the potential to double annual economic growth rates of developed economies by 2035.[64]

Exhibit 19 | Examples Use Cases of Artificial Intelligence



Source: Peter Stone, et. al., *Artificial Intelligence and Life in 2030* (Stanford, 2016); BCG analysis.

One potentially large area for AI application is smart infrastructure. AI has the potential to solve public-sector challenges such as traffic management, energy conservation, sustainable consumption, and urban planning. With the use of sensors, controls, and software, smart infrastructure empowers cities, service providers, and citizens to access the full potential of existing and new infrastructure systems: 1) by allowing for better informed decision-making due to available real-time information, 2) by further integrating systems and organizations through information sharing, which will allow the elimination of silos and optimize performance, 3) and by leveraging automated processes in order to boost efficiency and reduce costs.

[63] The overall savings potential of Service 4.0 can reach up to 40 percent of the addressable costs. For further explanation, see BCG Perspectives, *Tapping into the Transformative Power of Service 4.0* (2016), 9, accessed January 16, 2017, http://www.bcg.de/documents/file217371.pdf.
[64] Accenture, *Why Artificial Intelligence is the Future of Growth* (2016), 3, accessed January 16, 2017, https://www.accenture.com/lv-en/_acnmedia/PDF-33/Accenture-Why-AI-is-the-Future-of-Growth.pdf.

Notwithstanding expected benefits and opportunities, AI might also raise new societal issues and create public debates on ethical questions. The potential impact on the workforce and the question of liability in scenarios that could result in harm based on automated, nonhuman-mediated decisions are examples of imminent issues. It is important to consider and address people's concerns as an integral part of AI-related policies. To that end, businesses have formed partnerships such as the Partnership on AI to conduct research, provide information, organize public discussions about AI including ethical and societal questions, and develop best practices.[65] Many technology companies are aligned on designing AI applications to assist people – following the principle of augmented intelligence.[66] With augmented intelligence, we will continue to see the need for human interaction. In the short to medium term AI will rather augment the current workforce and new labor roles may emerge, as experts will be needed to design, operate, and manage "intelligent" systems.

Given the nascent nature of the AI rollout, it is crucial not to throttle its potential and innovation with preemptive regulation. Governments need to work with all stakeholders to increase the understanding of potential socioeconomic impacts and find solutions for risks and challenges. Furthermore, governments need to develop forward-looking policies that facilitate further development of AI in a way that is beneficial for businesses and societies.

Policy Action 3.1: Encourage an Informed Public Dialogue

The G20 should encourage the OECD to set up a multistakeholder initiative to analyze potential applications, benefits, and challenges of AI and provide guidance for governments on an informed public dialogue on AI.

Despite its great potential and implications on business and societies, AI has not yet been covered by the G20. The G20 should acknowledge the importance and potential of AI as well as the need for global cooperation to make full use of related opportunities and mitigate potential challenges. Data-driven applications will not only improve economic growth but also help in addressing global socioeconomic challenges, inter alia through sustainable cities, smart agriculture, or pattern recognition in cancer detection (see Exhibit 20).[67]

Exhibit 20 | AI in Health Care

Watson Health for Oncology

With Watson, IBM developed an artificial intelligence system that is capable of processing and responding accurately to natural language queries at scale. Watson Health has the vision of enabling better care by surfacing insights from large amounts of academic and practical health care data that is generated every day all over the world. Nowadays, about 80 percent of all health data is invisible for current systems because it is unstructured.

As one part of the Watson Health project, IBM uses Watson for oncology to provide evidence-based treatment and optimization. The system provides solutions using data and training from Memorial Sloan Kettering. Clinicians and analysts are using Watson in a first step to get a holistic picture of a patient's health based on health records and journal articles. In a second step, Watson provides decision support by bringing up various state-of-the-art treatment options for each individual patient.

[65] The Partnership on AI is an initiative of The Association for the Advancement of Artificial Intelligence, American Civil Liberties Union of Massachusetts, amazon.com, Apple, DeepMind, Google, Facebook, IBM, Microsoft, and OpenAI, which aims to support best practices, advance AI understanding, and create an open platform for discussion and engagement on AI. Further information is available at https://www.partnershiponai.org, accessed January 30, 2017.
[66] See statements and discussions during the WEF Meeting 2017 in Davos, such as https://www.weforum.org/press/2017/01/artificial-intelligence-must-be-designed-to-augment-human-ability-and-opportunity/. Accessed on February 13, 2017.
[67] Compare IBM, *Watson Health for Oncology*, accessed January 16, 2017, http://www.ibm.com/watson/health/oncology/.

Beside the use in oncology, Watson Health is leveraged for use cases such as explorative health care data analytics or for matching patients to clinical oncology trails.

Machine Learning Against Cancer

Microsoft's research labs are developing methods to solve the complex challenge of cancer. Different research teams are using artificial intelligence to improve cancer detection and treatment.

One of the most recent research successes is an early warning system for people who are at risk for lung cancer. The system is using anonymized web search data to learn more about lung-cancer risk factors. As an outcome, it is able to warn Internet users with corresponding searches.

While the findings of this artificial system are associations, not evidence of a cause, they can suggest directions for future clinical studies on lung cancer.

Sources: IBM, *Watson Health for Oncology*, op. cit; Microsoft, *Computing Cancer*, accessed January 16, 2017, https://news.microsoft.com/stories/computingcancer/.

The G20 should encourage the OECD – given its experience in target-oriented multistakeholder collaboration and digitalization-related issues – to host an international forum comprising representatives from business, government, academia, and societal institutions, while fully involving non-OECD G20 members in this process.[68] The forum should prepare a report that summarizes and illustrates opportunities as well as risks and challenges related to AI for society and the economy. The report should provide initial proposals on how to maximize benefits, appropriately address potential challenges and risks while preserving the benefits, and indicate additional areas for research. As a reference the forum might consider recent business discussions on design principles for AI.[69] With augmented intelligence as a design principle, companies strive for a human-machine cooperation that ensures societal improvement and provides guidance on how to avoid human labor replacement.

Finally, the forum hosted by the OECD should develop guidance on how governments can foster informed public dialogues on AI, enabling G20 members to improve their activities in this direction.

Policy Action 3.2: Provide a Favorable Ecosystem

G20 members should develop forward-looking policies that support the rollout of AI by adjusting regulations to facilitate the use of emerging technologies, such as big data, and foster related investment and innovation.

The G20 needs to foster innovation and entrepreneurship in AI. Therefore, the G20 should support investment, review regulations to enable the use of emerging technologies like big data, and act consistently with the B20 recommendations on cybersecurity and data protection. Big data and access to data are particularly important for analytics that have the potential to enhance valuable innovation in fields such as medical research.

G20 members should ensure that fair, lawful, and open international access to existing technologies is not hampered by governmental regulations.[70] Access to data and the use of data-analytic technologies are key enablers of AI and should therefore be supported without undermining data protection, privacy, or IP. Hence, G20 members should carefully review regulations that impede the use of big data or advanced analytics to ensure they are fit for their purpose.[71] G20 members should implement less

[68] "Societal institutions" refer, for example, to churches, aid organizations, or charities.
[69] Compare for example statements and discussions during the WEF Meeting 2017 in Davos, such as https://www.weforum.org/press/2017/01/artificial-intelligence-must-be-designed-to-augment-human-ability-and-opportunity/, accessed February 13, 2017.
[70] Regulation that hampers access to or use of AI-related technologies refers to regulations that include restrictions that are not required for the intended, compelling objective.
[71] For example regulations that restrict the use of personal data – to a specific purpose, context or for a limited period – can be

intrusive, more future-oriented policies on data and privacy protection while still accomplishing the intended policy objectives. The review should aim to set a framework conducive to innovation and growth that lets businesses generate value and social benefit from the use of data analytics, while complying with regulations and rules of data and privacy protection.

G20 members should increase funding of AI research projects in academia and incentivize AI research and pilot projects in business, for instance with tax incentives. This would especially benefit MSMEs and start-ups in realizing the economic and societal potential of AI innovation.[72] Additionally, G20 members should support analytics and research projects by making public-sector data available (subject to privacy and national security considerations).

Policy Action 3.3: Facilitate Smart Infrastructure

The G20 and its members should support the implementation of smart infrastructure by mandating the Global Infrastructure Hub (GIH) to make available – jointly with the private sector – use and business cases to illustrate potential benefits, reduce barriers to foreign direct investments in ICT and smart infrastructure, and complement private investments in less profitable deployments.

Smart infrastructure can solve infrastructure challenges such as transportation shortages, energy conservation, sustainable consumption, or urban planning (see Exhibit 21).[73] It can reduce the cost of construction, operation, and maintenance of infrastructure (see Exhibit 22).[74] Smart infrastructure may also enable new business models and services, for example predictive maintenance for ICT infrastructure.[75] At the same time, the lessons learned from the application of AI in the field of smart infrastructures will lead to further improvements in AI technologies – including self-learning – and vice versa.

The G20 should mandate the G20 GIH to draft a report on the potential of smart infrastructure for governments, including opportunities enabled by AI technologies. To quantify the potential for governmental projects, the report should utilize use cases and business cases as illustration and proof of value. The report should cover intelligent digital solutions and services in the area of energy (e.g., smart meters), transportation (e.g., intelligent transportation systems), water and waste (e.g., leak detection), social aspects (e.g., e-health), and buildings (e.g., building information modelling). The G20 GIH could refer to existing publications such as the WEF report "Expanding Participation and Boosting Growth: The Infrastructure Needs of the Digital Economy".[76]

Furthermore, the G20 GIH should catalog best practices that emerge from lighthouse projects in order to accelerate smart infrastructure implementation and inform industry-led standardization. To ensure interoperability among different smart infrastructure systems, the G20 members should foster standardization of interfaces between those systems. To that end, the G20 should implement the recommendations on global and international standards described in Policy Action 2.3.

problematic if they are interpreted strictly, since the benefits of big data may come from unanticipated uses long after the original purpose has been served, and public-interest exceptions are limited. Another example is regulations that prohibit discrimination also impede analytics, which include for example age, gender, or marital status.

[72] For recommendations on financing mechanisms of SMEs, compare the policy paper of the B20 Germany SME Cross-Thematic Group.

[73] WEF, *Expanding Participation and Boosting Growth: The Infrastructure Needs of the Digital Economy* (2015), 31–32, op .cit.

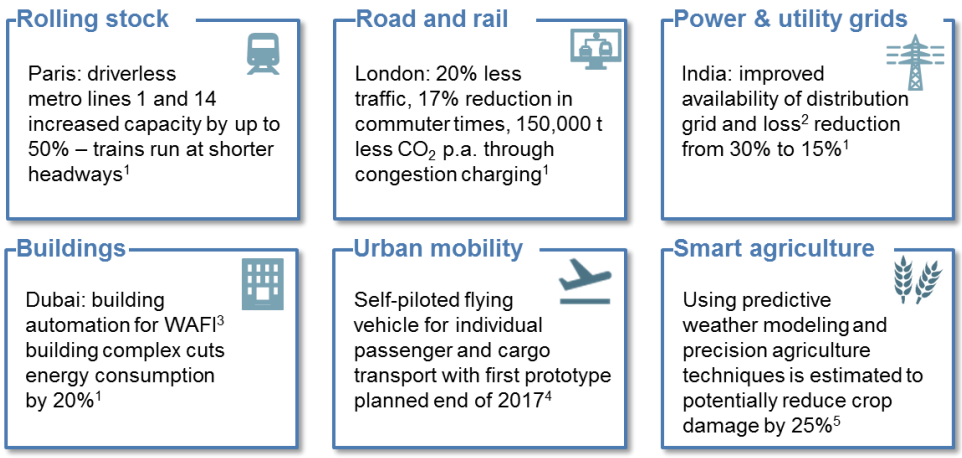
[74] BCG Perspectives, *Digital in Engineering and Construction* (2016), 9–11, accessed January 16, 2017, http://futureofconstruction.org/content/uploads/2016/09/BCG-Digital-in-Engineering-and-Construction-Mar-2016.pdf.

[75] BCG Perspectives, *Tapping into the Transformative Power of Service 4.0* (2016), 9, op. cit.

[76] WEF, *Expanding Participation and Boosting Growth: The Infrastructure Needs of the Digital Economy* (2015), op. cit.

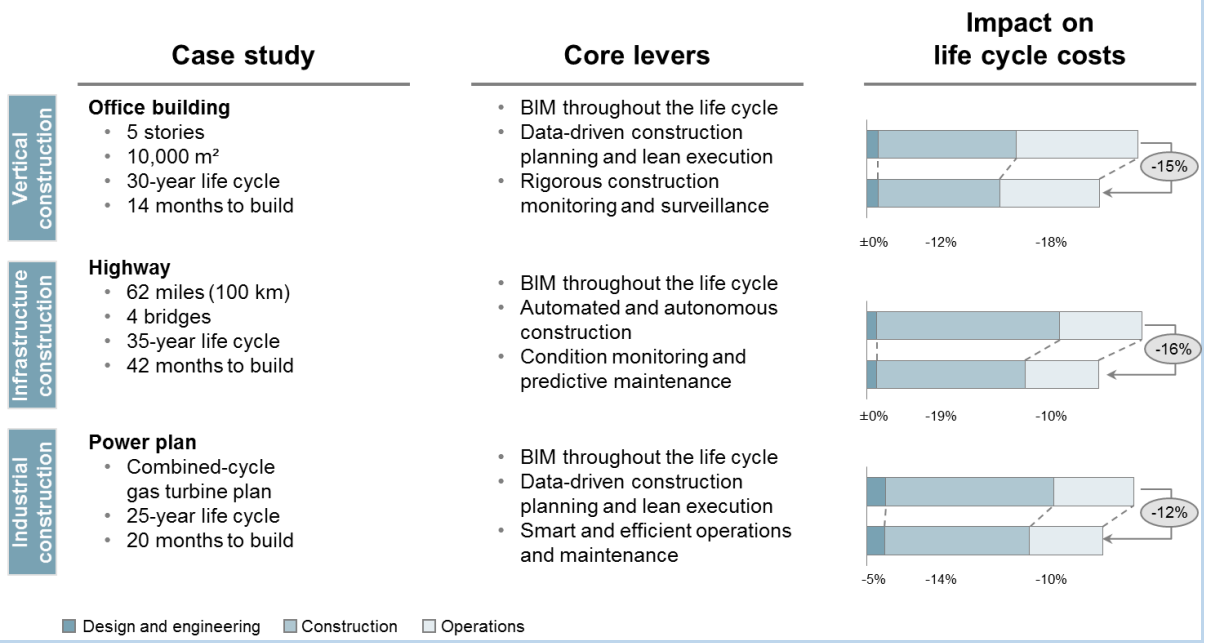
Additionally, G20 members should facilitate private investment by reducing barriers to foreign direct investments and by ensuring fluid venture capital markets. Complementing private investments with public contributions might be advisable for investments where smart infrastructure technologies have to compete against low-cost offers (investor-user dilemma) and low technology offers (such as smart meter versus. standard technology). These efforts are especially important for developing the demand/user side of smart infrastructure and preventing additional digital divides in developing countries with low income per capita.

Exhibit 21 | The Potential of Smart Infrastructure Applications



Notes: 1. Information provided by Siemens; 2. Technical and commercial losses; 3. WAFI building complex (also WAFI city) is a mixed-use complex in Dubai; 4. Information provided by Airbus; 5. Information provided by IBM.

Exhibit 22 | Potential Costs Savings in Construction, Operation, and Maintenance of Buildings, Infrastructure, and Industrial Sites



Source: IHS Markit, *Global Construction Service Data Base*, accessed February 13, 2017, https://www.ihs.com/products/global-construction-service.html; BCG analysis; Note: BIM = building information modeling.

Annex

Acronyms

3GPP	3rd Generation Partnership Project
AI	artificial intelligence
BIM	building information modeling
CERT	Computer Emergency Response Team
cPPP	contractual public-private partnership
EU	European Union
FIRST	Forum of Incident Response and Security Teams
FTTP	fiber to the premises
GDP	gross domestic product
GHz	gigahertz
GIH	Global Infrastructure Hub
GSMA	Global System for Mobile Communications Association
I4.0&II	Industry 4.0 and the Industrial Internet
ICT	information and communication technologies
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IPP	Innovation Policy Platform
IPR	intellectual property rights
ISO	International Organization for Standardization
LDCs	least-developed countries
LTE	Long-Term Evolution
Mbps	megabits per second
MLATs	mutual legal assistance treaties
MSMEs	micro, small, and medium enterprises
NIS	network and information system security
OECD	Organisation for Economic Co-operation and Development
OPC	Open Platform Communications
OTT	over-the-top content
PC	personal computer
RAMI 4.0	Reference Architecture Model Industrie 4.0
RAN	radio access network
SDGs	Sustainable Development Goals
TBT	technical barriers to trade
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
UN GGE	United Nations Group of Governmental Experts
W3C	World Wide Web Consortium
WBG	World Bank Group
WEF	World Economic Forum
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

Schedule of Taskforce Exchanges

#	Date	Location	Theme
1	October 26, 2016	Conference call	Discussion of taskforce focus topics
2	December 2, 2016	Berlin	Discussion of taskforce recommendations in first policy paper draft and exchange with G20 presidency representatives
3	January 23, 2017	Conference call	Refinement of taskforce policy proposals in second policy paper draft
4	February 20, 2017	Conference call	Refinement of policy paper following first G20 Taskforce on the Digital Economy Meeting
5	March 22, 2017	Paris	Discussion of final draft and exchange with OECD and G20 Sherpas

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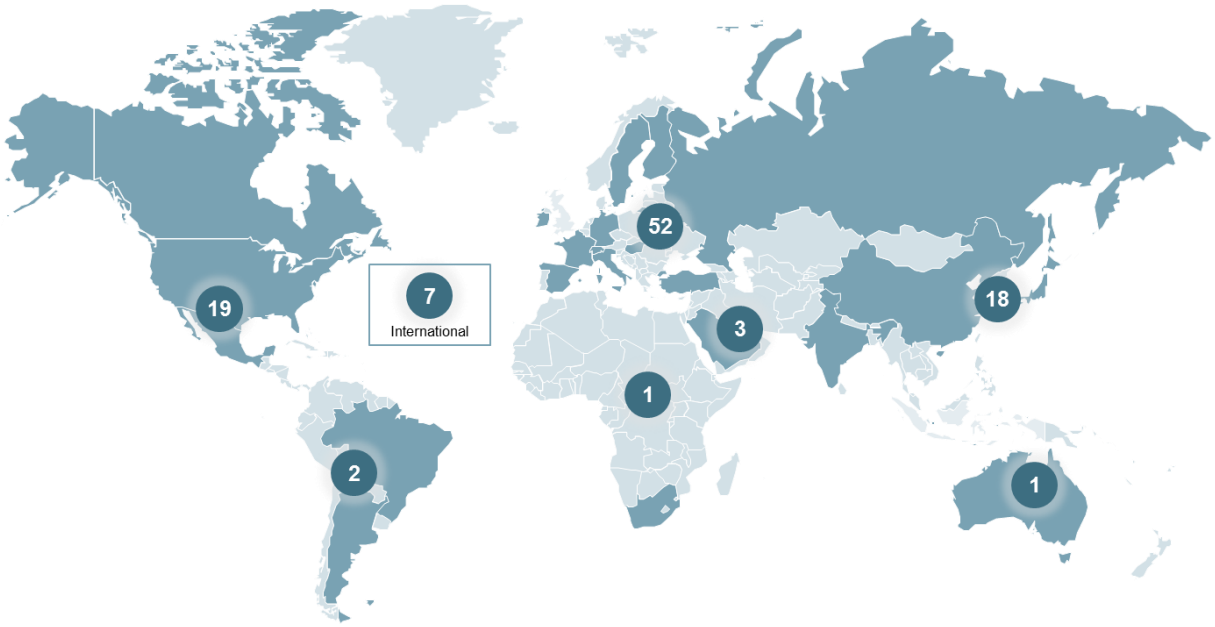
Country	#	Country	#	Country	#	Country	#
Argentina	1	Germany	19	Russia	4	International	7
Australia	1	India	5	Saudi Arabia	2	Other	5
Brazil	1	Italy	4	South Africa	1	Total	103
Canada	2	Japan	2	Turkey	9		
China	8	Korea	1	United States	15		
France	5	Mexico	2	EU (other)	9		



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