



SDG ICT PLAYBOOK

FROM INNOVATION TO IMPACT



Acknowledgments

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Acknowledgments



NetHope is a collaboration between the 43 leading international nonprofit organizations and the technology sector. NetHope works with its members and corporate partners to foster collaboration and innovation and leverage the full potential of technology to support development and humanitarian programs. NetHope has extensive experience in delivering programs in partnership with its members and corporate partners. For more information visit www.nethope.org.



For over 40 years, Intel has created technologies that transform the way people live, work and learn. We are committed to connecting people to their potential and empowering them to seize the opportunities that technology makes possible. Collaborating with others, we champion programs that tap the power of technology to create value for society, expand access, and foster economic empowerment. At Intel, we believe that together, we can create a better future.



CRS is the official international humanitarian agency of the Catholic community in the United States. The agency alleviates suffering and provides assistance to people in need in more than 100 countries, without regard to race, religion or nationality. Our programs touch 85 million lives with innovative solutions and responses to poverty. For more information, please visit www.crs.org or www.crsespanol.org.



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CDW, together with Kelway, a CDW European-based IT solutions company, are leading providers of ICT solutions for small, medium and large business, government, education, healthcare and nonprofit customers. The CDW team provides international logistics operations and capabilities to meet the increasingly complex needs of customers working across multiple markets. At CDW, community involvement is a long-standing corporate objective. For over 30 years, CDW and coworkers have contributed millions of dollars and thousands of volunteer hours to help improve the communities where they live and work. For information about CDW's outreach to nonprofits, please visit www.cdw.com/nonprofit.

Foreword



Kathy Calvin

President and Chief Executive Officer
United Nations Foundation



Central to the charter of the United Nations is faith in fundamental human rights, in the dignity and worth of all people, and in equal rights of men and women, and of nations large and small. In September of 2000, world leaders committed to partner together to reduce extreme poverty in all its forms – a commitment that was expressed by the Millennium Declaration – and the world has made tremendous progress in the past 15 years. The number of people living in extreme poverty has declined by more than half, millions of deaths from malaria, tuberculosis and HIV/AIDS have been prevented, and more than 2 billion people gained access to better drinking water. Yet progress has been uneven between and within countries, and more than 800 million people still live in extreme poverty. Challenges stemming from climate change have accelerated, conflicts continue to hinder human development and persistent gaps in gender equality and between rich and poor continue to thwart access to basic services and opportunities.

The Sustainable Development Goals (SDGs) for 2016-2030 carry forward the commitment to creating a healthy, prosperous, and just world – one that eliminates poverty, provides dignity for all people and protects our planet for generations to come. The SDGs recognize that sustainable economic, social and environmental development are linked and must be addressed in a cohesive manner if we are to achieve our shared vision of a better future.

The SDGs also recognize that sustainable development requires the close collaboration of governments, business communities and civil society organizations throughout the world. The need for coordinated action has never been greater, nor has the use of information and communications technology (ICT) to support that action. In today's digital world, ICT holds tremendous potential to bridge economic and social gaps, to end isolation, to enhance dialogue, to link people to markets, to generate new livelihood opportunities, to improve our use of natural resources in ways that protect our planet and to provide inclusive access to information and services that better everyone's lives. ICT enables organizations across sectors and geographies to learn from each other, to modify the way they work and interact and to collaborate in reaching the SDGs.

To that end, the SDG ICT Playbook serves as product of collaborative thinking between leading organizations across the technology, government, education and humanitarian sectors. The people leading the way in each of these areas can benefit from collaboration and investments in the ICT strategies and tools that can help transform the way the world works. It is only through this deliberate and sustained effort that we will collectively accelerate our global achievements in reaching the SDGs.

Kathy Calvin



Foreword



Lauren Woodman
Chief Executive Officer
NetHope



The Sustainable Development Goals represent a unique opportunity for the world to work together on 17 critical measures that embody the collective aspirations of the world's citizens. Developed through the most consultative process in United Nations history, the SDGs are both an opportunity to improve the lives of millions and a challenge for our collective intent in the coming years. Reaching the SDGs will enable all of us to end poverty, protect the planet and ensure prosperity for all.

It will not be an easy task, and to make meaningful progress, we will need to leverage the best tools available. Undoubtedly, technology has tremendous potential to accelerate progress towards reaching the SDGs: from connectivity to cloud computing to the Internet of Things, new and evolving technologies can help increase scale, improve impact, enhance program design and measure results in ways that simply were not possible just a few years ago. Used well, technology can help us realize the SDGs for our collective benefit.

Nonprofit organizations are often at the forefront of addressing the SDGs. But for many nonprofits, understanding which technologies hold the most promise and how to implement technology most effectively is daunting and, sometimes, overwhelming. This playbook was designed to help bridge that gap and help all organizations committed to achieving the SDGs use technology effectively for real impact.

The playbook addresses ten technology areas and explores how each might be applied to achieve the SDGs. We provide a basic overview of each, discuss benefits, trends and challenges and make recommendations for what nonprofits, governments and the private sector can do to enhance the impact of these promising technologies against the SDGs. It is designed to be informative and actionable, a utilitarian resource for any organization seeking to leverage the most promising tools to address the highest priority challenges our world faces.

NetHope, a collaboration of the world's leading humanitarian and conservation nonprofits, is pleased to partner with CRS, Intel, Microsoft, CDW and the UN Foundation on the SDG ICT Playbook. Each of the supporting organizations has been generous with their expertise and knowledge to create a tool that will contribute to achievement of the SDGs. We hope you find it useful and that, as your organization explores solutions and finds promising approaches, you will share your learning with others.

Thank you for your commitment to achieving the Sustainable Development Goals and for striving to make our world a more just, inclusive, safe and prosperous one.

Foreword



Gordon Graylish
Vice President and General Manager
Intel Corporation, Government and World Ahead



Michael Jacobson
Director
Intel Corporation, Corporate Affairs Group



Information and Communications Technology (ICT) has a profound effect on society and the world. It fuels the knowledge economy and creates possibilities, innovation and sustainable economic empowerment. Over the last few decades, there has been massive growth in technological development and opportunities that have continued to transform people's lives and the planet. However, the benefits from ICT have not been evenly distributed—with significant gaps in Internet and technology access, affordability and availability. These gaps have implications for which groups have access to education, economic opportunities, health care and livelihoods. We only advance as a society, as a planet, as businesses and as governments when all people can reap the full benefits of economic growth and the knowledge economy, using technology as an enabling tool for development.

The Sustainable Development Goals (SDGs) represent a global, multi-stakeholder, action-oriented commitment and an opportunity for collaboration on driving economic, social and environmental development for all. ICT can play an enabling role in the implementation of the SDGs. Public-private partnerships are critically important to achieving and tracking progress towards them.

These partnerships must be characterized by collaboration and open dialogue among innovators, academia, local, regional and international development organizations, the private sector and governments to foster innovations that can have a profound impact on these global challenges. To leverage ICT most effectively, it is critical to understand the latest technology trends, the challenges and realistic recommendations that can be implemented for the greatest impact.

There has been much innovation, research and testing of new ideas in the last decade on the role ICT can play in development, many lessons learned, and innovative ways to move forward based on what has and has not worked. This SDG ICT Playbook is designed to foster dialogue and the development of strategies for stakeholders to leverage ICT in the implementation of the SDGs. At Intel, we see significant opportunities to do business with positive social impact. We hope that together we can drive more equitable access to ICT, new thinking and new skills to address these global challenges.

Foreword



Ann Mei Chang

Executive Director, U.S. Global Development Lab,
U.S. Agency for International Development
USAID



In the past two decades alone, advances in mobile technology and digital connectivity have revolutionized how we interact with the world around us. Information and Communication Technologies (ICT) provide unparalleled opportunities to deliver social impact and economic returns to millions of people in developing countries. Booz & Company has predicted that the 'digitization' of the economy over the next ten years could yield as much as \$4.4 trillion in GDP for the world's poorest people.

There are countless examples of how enhanced access to digital information and services can empower individuals and open new windows for delivering more effective and scalable development projects. Digital tools and advances can help developing countries break through to the next level of economic gain and result in transformative innovations to improve development outcomes.

The Sustainable Development Goals create an inclusive plan of action to end poverty in all its dimensions. At the U.S. Agency for International Development (USAID), we are working with our partners to meet the ambitious goal of eliminating extreme poverty. No one organization can achieve this alone. Governments, the private sector, civil society, academia and donors must all work together to discover, fund and scale innovative solutions and business models to longtime development challenges. Through these partnerships we can find new ways to achieve greater

impact at lower cost. Catalyzing increased connectivity, enabling a digital workforce, and expanding the reach and usage of digital financial services are a few critical paths to digital development.

This SDG ICT Playbook presents some of the key tech trends to consider when strategizing on how Information and Communication Technology can support and accelerate progress toward the SDGs. It is a resource that can assist organizations within each development sector in planning their use of Information and Communication Technology to enhance effectiveness and scalability of development initiatives. Through partnership, we can facilitate access and promote business models and technology innovation to reach communities in need.

A handwritten signature in blue ink, appearing to read 'Ann Mei Chang'.

Foreword



Dr. Carolyn Y. Woo
President & CEO
Catholic Relief Services



The Sustainable Development Goals (SDGs) represent a renewed commitment on the part of leaders around the world to ending poverty in all its forms. These goals recognize that a holistic approach is needed to combat hunger, disease, injustice, and the degradation of our planet and to build a world that allows all human beings to realize their full potential in an atmosphere of peace, social justice and human dignity. And the goals also recognize the need for governments, businesses and civil society organizations to work together to build this world.

The crises we face today, whether they be social, environmental, or economic, are all interrelated. Without a solution to these crises that results in inclusive access to the resources needed to live healthy and prosperous lives, that ensures a peaceful and just world for all peoples, and that protects the earth for current and future generations, we will continue to experience instability, suffering, and destruction of our home – the planet and the resources on which we depend. Finding this solution will take the talent and cooperation of organizations and people from all walks of life and all parts of the globe. We need to understand what has not worked, and what is likely to work in the future in combating such crises. We need to encourage innovation and be prepared for the hard work of scaling those innovations which prove to have merit in combatting these crises. Inevitably, each of us and our organizations will be called upon to work and interact in new and different ways.

Today, it is more important than ever to put Information and Communications Technology (ICT) to use in dealing with development challenges. We have seen Information and Communications Technology

(ICT) become a strategic enabler of both organizations and individuals to prosper in today's digital economy. It is time to leverage the power of ICT to benefit all peoples – to end the isolation of the world's most vulnerable, to give them a voice and opportunity to fully engage in the society in which they live, and to help them access the resources they need to live healthy, peaceful and prosperous lives. ICT provides not only tremendous opportunities for us to understand what is working in development programming and what is not and to make better evidence-based decisions in our work. It offers numerous opportunities for us to improve the efficiency of our work, to reduce our utilization of scarce resources, and to stem negative impacts on our environment. It opens new opportunities to entrepreneurs that strengthen local economies. And, if we work together, it gives us means to empower individuals with inclusive access to critical resources that improve health, safety, livelihoods, and educational opportunities.

It is CRS' hope that this SDG ICT Playbook will help each organization understand the potential that ICT has to help them to increase their contributions to the SDGs and take action to align their ICT investments to achieve that potential.

A handwritten signature in black ink that reads 'Carolyn Y. Woo'.



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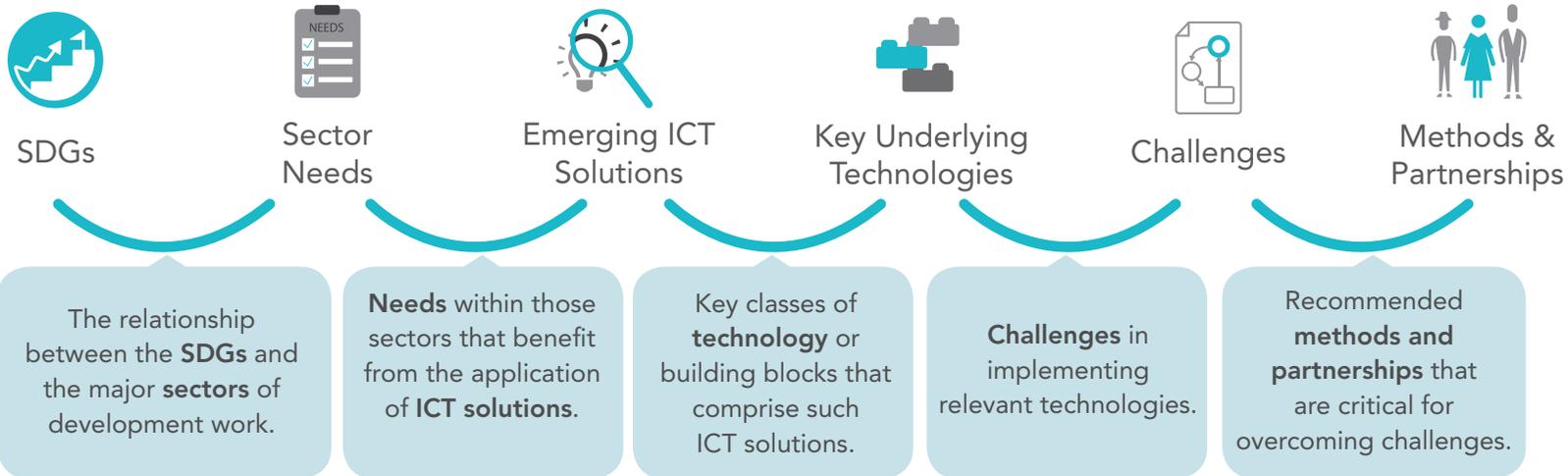


Sustainable Development Goals

Purpose & Audience

This playbook recommends where investments in information and communications technology (ICT) should be made in order to support achievement of the United Nations Sustainable Development Goals (SDGs).

The playbook examines:



The audience for this playbook includes senior managers, senior technical advisors and leadership of public, private and civil society organizations that play a role in the development ecosystem and are committed to attaining the Sustainable Development Goals:



Individuals who influence ICT strategies to support the organization's mission and goals.



Individuals who influence the way an organization carries out its work pertaining to development.



Individuals who influence the products and services that benefit developing communities.

The playbook demonstrates how ICT can support and accelerate progress toward the SDGs. It assists organizations within each development sector in planning their use of ICT to enhance and strengthen the contributions they make to a better future for all people.





Sustainable Development Goals

Overview

In September 2000, at the largest gathering of its kind in history, world leaders committed to partner together to reduce extreme poverty in all its forms – a commitment that was expressed by the Millennium Declaration and captured in the Millennium Development Goals. While the world has made tremendous progress in the past 15 years, overall progress has been uneven and 836 million people still live in extreme poverty. The Sustainable Development Goals (SDGs) reflect the continuing resolve of UN member states and leaders from all walks of life to work together to promote sustained and inclusive economic growth, social development and environmental protection in the interest of creating a world that is just, equitable and inclusive.

This shared commitment focuses on ensuring healthy lives, achieving dignity, prosperity and justice for all people and protecting our planet for all future generations. It relies on partnerships to catalyze global solidarity for sustainable development in all its dimensions (economic, social and environmental).¹

ICT has tremendous potential to accelerate achievement of the SDGs by:



Enhancing our capability to measure progress toward all the SDGs, evaluate the methods used to achieve them, learn what is working and not working, and improve the timeliness and quality of decision-making.



Providing opportunities to streamline and enhance the efficiency and effectiveness of the activities we undertake across the development landscape.



Providing access to a whole new range of digitally enabled products and services which strengthen local economies, local innovation and local communities.





Related Development Sectors

SDGs by Development Sector

To achieve the SDGs, changes are required in the way public, private and civil society organizations function, the way they partner, the way they engage with individuals and communities and the way government policies influence their operations. The challenge facing organizational leaders is understanding the benefit of ICT in enabling such changes.

Development Sector	Primary Related Goal
 Livelihoods	G1 End poverty in all its forms everywhere. G8 Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
 Agriculture	G2 End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
 Health	G3 Ensure healthy lives and promote well-being for all at all ages.
 Education	G4 Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
 Water, Sanitation & Power	G6 Ensure availability and sustainable management of water and sanitation for all. G7 Ensure access to affordable, reliable, sustainable and modern energy for all.
 Infrastructure	G9 Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. ² G11 Make cities and human settlements inclusive, safe, resilient and sustainable.
 Disaster Relief	G11 Make cities and human settlements inclusive, safe, resilient and sustainable.
 Governance & Human Rights	G5 Achieve gender equality and empower all women and girls. G10 Reduce inequality within and among countries. G16 Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
 Environmental Protection	G12 Ensure sustainable consumption and production patterns. G13 Take urgent action to combat climate change and its impacts (taking note of agreements made by the UNFCCC forum). G14 Conserve and sustainably use the oceans, seas and marine resources for sustainable development. G15 Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss.
 Cross Cutting	G17 Strengthen the means of implementation and revitalize the global partnership for sustainable development.





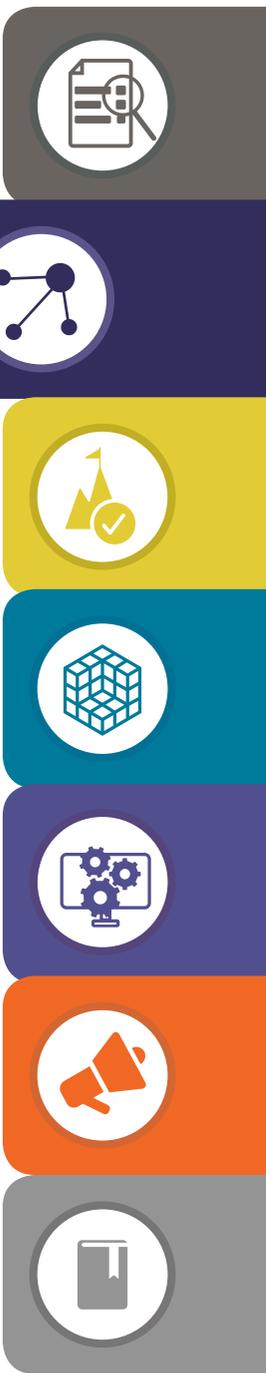
Related Development Sectors

Sector Needs

Across all development sectors, there are tremendous and dynamic information needs. ICT can address those needs in ways that accelerate achievement of the SDGs and at the same time provide benefits to the organizations and individuals working in each sector and consuming its services.

Stakeholder	Sector Interest	Examples	ICT Applications
Consumers	Benefit from sector services	Food production Medical services Water Power	<ul style="list-style-type: none"> Learn about, access and take advantage of sector services to improve living conditions, livelihoods and opportunities. Be recognized and advocate for changes to sector services to better meet needs. Hold institutions accountable for making those changes.
Frontline Workers (entrepreneurs or employees)	Deliver sector services at a community level	Agriculture extension workers Community health workers Local school teachers	<ul style="list-style-type: none"> Build worker capacity and improve work quality. Record service delivery and obtain feedback. Advocate for changes in working conditions. Hold institutions accountable for fair labor practices.
Businesses	Provide sector-specific commercial services and products	Family farms Large agro-enterprises Health clinics Major hospitals Mini-grid entrepreneurs On-grid energy providers	<ul style="list-style-type: none"> Access information services that affect market opportunities. Reduce market transaction costs. Link to new markets. Optimize business processes and use of resources to improve profitability and reduce negative social and environmental impacts.
Government Agencies	Provide sector-specific government services	Agriculture ministry Education ministry Health ministry Justice ministry	<ul style="list-style-type: none"> Improve the transparency of government services and assess their impact. Improve service quality and lower service delivery costs. Optimize use of resources. Foster innovation. Proactively engage citizens and business communities.
Civil Society Organizations	Advocate for and serve consumer, citizen and sector worker interests	Farmer cooperative Learning alliance Conservation group NGO	<ul style="list-style-type: none"> Improve operational efficiency. Improve service impacts.

The [Technology Uses section](#) of this document provides examples of how ICT supports new ways of working in each of the development sectors required to achieve all of the SDGs.





Related Development Sectors

Example: Agriculture Sector

Agriculture requires new ways of working not only to end hunger, but also to improve the livelihoods of vast populations engaged in subsistence farming. To produce crops, farmers need a significant amount of information.

- Suitable crop varieties and types, given plot size and characteristics, soil conditions, weather patterns, available water sources, disease and pest patterns, market preferences and family nutritional needs.
- Optimal times to plant, fertilize, weed and harvest.
- Recommendations for soil and water improvement.
- Techniques to maximize crop yields and sustain natural resources.
- Quantity, cost and availability of seeds, fertilizers, agro-chemicals, labor and tools.
- Available sources of finance and crop insurance.
- Early warning of adverse weather conditions, disease and pest infestations.
- Projected crop yields, how much to retain (for food and seed) and how much to sell.
- Location and costs of available storage facilities, transportation and current markets prices.
- Anticipated income and profits.
- Accurate records of farm land rights.
- Information needed by supply chain actors so that goods can be purchased, transported and sold.



To build effective business plans and improve yields and profitability, smallholder farmers need to learn about innovative production and natural resource management practices and develop the group organization and financial and marketing skills required to link to markets in sustainable ways. They need timely and precise information to optimize their farming operations and respond to changes in their environment.



To become valued business advisors, extension agents that support smallholder farmers need training and information. They need to track the services they deliver and the farmers they support. They need farmer feedback on the value of their services and their impact on farmer business results.



So that they are able to improve the extension services they offer, governments need to monitor the impact of extension workers and their services on farming livelihoods, farm family health and the environment. They also need feedback on the level of community satisfaction with those services.



To reduce transaction costs and facilitate farmer linkage to markets, agriculture value chain players (those businesses who provide the goods and services necessary to grow and move an agricultural product from the farm to final customer) need information about farmers' business plans.



To manage complex farming operations, optimize use of natural resources and improve yields, large agro-enterprises not only need access to the same information as smallholder farmers, but they must be able to rapidly collect and process information at a much larger scale to detect changes in growing conditions and modify their operations to respond with the right amount of treatment at the right time to the right location within a field.





Related Development Sectors

Measuring Impact

ICT also provides new, more automated means to monitor and evaluate progress toward the SDGs. Over the past five years, the world has seen rapid growth in the application of ICT solutions that provide rapid data collection, analysis, visualization and dissemination capabilities. These solutions provide valuable opportunities to evaluate the economic, social and environmental impacts of SDG-related activities, to determine what is working and not working with respect to achieving the SDGs so that future activities can be adjusted. In short:



David Gadsden,
Nonprofit Director,
Environmental Systems
Research Institute, Esri

"A convergence of open content, mobile sensors, location analytics and interoperable platforms is ushering in a new era of collaboration, real time monitoring, and adaptive management of development programs."

- Integrated data management tools create efficiencies in the monitoring and evaluation process.
- Automated data collection systems using mobile handsets improve the quality, timeliness and precision of data needed for planning and decision-making through data driven maps and reports.
- IoT devices, satellites and UAVs produce data that enriches understanding of current and changing situations.
- Analytics and visualization tools greatly simplify complex data into accessible, actionable information to support planning, coordination and decision-making.
- Platforms and open data standards facilitate sharing and foster transparency and accountability.

To realize the potential that ICT solutions offer in understanding progress towards the SDGs, organizations must develop a data culture - one that values the insights that data visualization and analytics offer and reflects the courage and commitment to use those insights to make changes in the way the organization works and interacts.





Planning for the Future

ICT Strategy

Each organization operating in a development sector needs a long-term plan to optimize the value of its ICT investments. The scope of that plan, as well as the need for alignment with plans of other organizations, will depend on the organization's footprint – the scope of its work, its size and geographic reach.

Start with business needs

Develop a deep understanding of the specific needs of individuals and groups the organization aspires to serve as well as the communities, institutions and government agencies that have a stake in meeting those needs. ICT solutions must be appropriate to the context in which they are used and easily adapted to changes in that context if they are to have long-term value.

Align with organizational strategy

Consider not only the ways in which the organization currently operates, but necessary changes to meet its strategic goals and contribute to achievement of the SDGs.

Build an enterprise architecture

An enterprise architecture aligned with an organization's strategy is an invaluable asset for guiding the selection, development and adaptation of technologies to meet evolving business needs. It should define the building blocks that comprise the organization's ICT solutions and how they will interoperate and exchange data.

Invest in a technology portfolio

Reduce the time, cost and risk of embedding new technologies in an organization's work by establishing a portfolio of field-tested technologies – a platform of plug-and-play components – that addresses common business needs and can be quickly adapted and extended to address local variations in needs.

Develop strategic partnerships

Create partnerships needed to build, evolve, scale and sustain a portfolio of ICT solutions and products over time.

Stay abreast of technology innovations

Ensure the organization's strategy refresh cycle keeps pace with changes in the technology landscape.



Local Innovation

"The extent to which local governments, businesses and communities make effective use of technology has a direct impact on a nation's ability to prosper and compete in a digital world. The need to develop the local ICT sector is paramount to building this capacity.

A robust local ICT sector not only contributes to new livelihoods, it is essential to fostering innovation and ensuring ICT solutions keep pace with local needs and are supported and maintained over time."

*Dr. Bitange Ndemo,
University of Nairobi and
former Secretary of Kenya's
Ministry of Information and
Communication*





Planning for the Future

ICT Portfolio

A core set of technologies have emerged that have great potential to improve development program impacts and empower communities. These are the building blocks that comprise many impactful ICT solutions. Some are in use in developing countries today. Others will take time to make their way into global use, but are essential to addressing complex development problems in the face of scarce resources. While new technologies inevitably will emerge, these are a good starting point for aligning an organization's ICT investments with its strategic goals.

ANALYTICS

turn vast amounts of geocoded, structured and unstructured data into actionable information and knowledge.



SOCIAL MEDIA

connect people to people across the globe.



DIGITAL SERVICES

connect people to information and allow people to engage, share and transact, regardless of location.



CLOUD COMPUTING
provides a universally accessible place to store data and host applications.



SMART SYSTEMS

generate efficiencies by automating work, responding to events that impact that work and optimizing the use of resources.



3D PRINTING

enables the production of objects such as tools and spare parts on demand from any location.



MOBILE DEVICES

allow people to stay connected and take advantage of ICT solutions anywhere and anytime.



CONNECTIVITY

provided by data and telecommunication networks connects people to people, information and digital services.



SATELLITES & UAVs

put information in the context of the planet on which we live.



POWER

and the innovative approaches for providing it eases the deployment of technology even in remote locations.



THE INTERNET OF THINGS

connects anything from sensors to intelligent devices to people and systems over the Internet to support evidence-based decision-making.





Planning for the Future

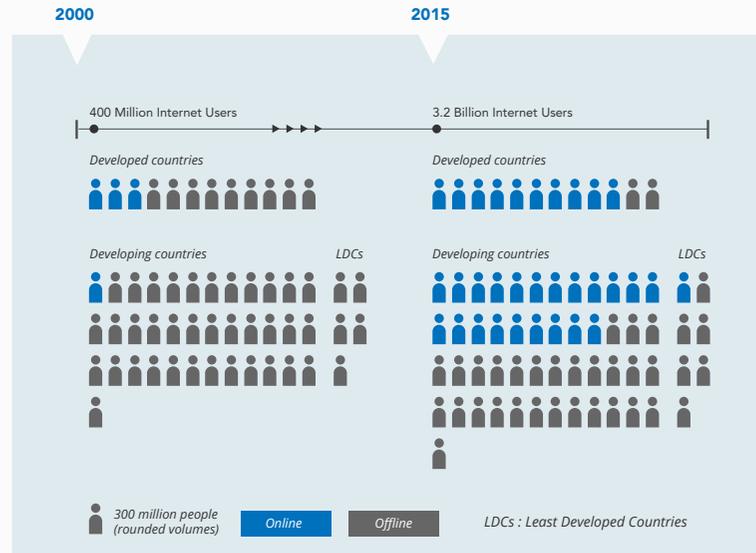
Major Challenges and Recommendations

Despite the growing ubiquity, availability and affordability of technology, there are often challenges in adoption, adaptation and deployment. Recognizing and developing mitigation plans as part of the planning process is critical for success.

Affordable Access

The first challenges that must be addressed in planning the use of ICT solutions are barriers to affordable access.

- 1.1 billion people have no access to electricity, and this figure does not reflect broader deficiencies in the affordability, reliability and quality of service.⁴
- At the end of 2014, only 50% of the world's population had a mobile subscription.⁵ Gaps persist in mobile device ownership (as measured by unique subscribers) between regions (mobile penetration is at 39% in Sub-Saharan Africa) and between urban and rural communities.
- Coverage of second generation mobile networks (95%)⁶ is all but ubiquitous. While these networks provide valuable voice communication and text messaging capabilities to poor people, their value pales in comparison to the Internet access provided by more advanced networks. More than half the world's population, including the vast majority of individuals in the least developed countries, do not have Internet access.
- Even when barriers related to power, mobile devices and Internet access are overcome, relevancy becomes an issue. Without content and digital services that are relevant to local populations, Internet access is not valuable to them. Without data that is relevant to an organization's operations, decision-making cannot be



Internet Usage³

improved. Without data about its citizens and their locations, governments cannot serve them.

- While the IoT, Smart Systems and 3D Printing hold great promise for improving decision-making, generating efficiencies and managing natural resources, the ecosystem of policies, standards, talent and business models needed to make such tools widely available, affordable and adaptable is still maturing.

Governments, private sector businesses and civil society organizations all have a role to play in increasing affordable access to ICT, ranging from regulatory reforms to demand aggregation to technology innovations that reduce costs.





Planning for the Future

Major Challenges and Recommendations



Gender Equity

In the words of Kofi Annan, “There is no tool for development more effective than the empowerment of women.”⁷ Decades of research have demonstrated that sustainable poverty reduction and community development are only possible when women and women’s interests are considered a top priority, as women are the primary caretakers and agricultural producers in the community and are responsible for providing and upholding the educational and cultural health of the community, while also suffering the greatest brunt of poverty.⁸ Health and development experts, economists, non-governmental organizations, UN agencies and even banks agree that expanding the freedoms, education and opportunities for women holds the key to kick-starting inclusive economic growth.⁹

However, around the world, women have diminished access to and control of the resources they need to attain status in the community – education, financial credit and material resources including housing and agricultural products. Without equal access to these resources, women are further marginalized and opportunities for development and access to markets are closed to them. One of the reasons women bear such a disproportionate burden of poverty is their lack of access to the very information that could help them mitigate or manage these circumstances. Women’s access to ICT is the third most important development issue for women globally after poverty and violence against women.¹⁰



Women are 14% less likely than men to own a mobile phone in low and middle-income countries.¹¹



Up to 25% fewer women than men are online today.¹²



An increase in Internet access for 600,000 women in developing countries would contribute \$13-\$18 billion to their combined annual GDP.¹³

Yet, ICT initiatives generally fail to take gender-specific barriers to ICT access and use into consideration. These barriers typically include lack of affordable devices and familiarity with their use, poor quality of network services, lack of gender-relevant content and digital services, and safety issues and culture norms that discourage ICT use. Development organizations, technology providers and governments need to keep these barriers in mind in designing development programs. They need to specifically target women when developing strategies to improve technology access and its impact on development issues. They need to educate program participants on benefits gained from women’s access to technology: greater social and political participation; access to online support networks; and development of skills needed to improve women’s livelihoods and contribute to the prosperity of their families.





Planning for the Future

Major Challenges and Recommendations



Regulatory Environment

The regulatory environment in which technology solutions are deployed greatly influences affordability, availability and adoption. Local governments have a major role to play. Significant factors that favorably influence technology adoption include: laws that protect intellectual property rights, promote open and transparent licensing, and ensure open competition; the willingness and ability of government and civil institutions to uphold and enforce those laws; a regulatory framework that favors a strong, innovative local business community; and an ICT sector that provides incentives for achieving inclusive and affordable access to technology.



Sustainable Business Models

New business models are needed to increase the financial sustainability of ICT solutions. Technology use by governments, businesses and civil society organizations is easy to justify and sustain when the technology creates cost efficiencies and improves results. ICT costs can also be lowered by aggregating demand across government agencies or civil and business consortia. Achieving financial sustainability for a consumer service, such as market information for smallholder farmers, can be more difficult and requires a clear benefit to the party funding the service as well as to the consumer. For example, input providers have been willing to pay for farmer advisory services when they can bundle the service with sales of seed and fertilizer as a means to gain customer loyalty.



Development Procurement Reform

Multi-year development programs are often incompatible with the rapid innovation cycle needed to introduce new technology-enabled practices. The current currency of development is projects – and projects start and end. Too often sustainability of the solutions and innovations a project introduces are an afterthought. Further, development organizations are not often incentivized to experiment with new approaches and share results. Without incentives, development organizations are likely to shy away from using ICT solutions for fear of failure and are less likely to share their experiences with others. In addition, individual projects are not structured to contribute to investments in platforms, applications and devices that have utility across projects. A major shift in procurement practices is needed to fully leverage technology as a strategic asset for development. Procurement policies must encourage innovation by providing flexibility in changing approaches during a project lifecycle, fostering the implementation of business models which lead to sustainability, contributing to investments that have utility across multiple projects, and reinforcing the application of data and interoperability standards that enhance the value of project ICT solutions and the data they generate in a broader context.





Planning for the Future

Major Challenges and Recommendations



Dr. Carolyn Y. Woo,
President & CEO,
Catholic Relief Services

The Courage to Innovate

"As leaders, we have both the privilege and obligation to work together to build a world where all individuals live in dignity and freedom and have the resources they need to develop their human potential. To deal with the issues our planet faces today, we must up our game and continuously innovate to make sustainable development a reality. Innovation requires not only courage but a responsibility to understand and plan for the inevitable challenges that will arise."



Behavior Change

ICT solutions change the way people work and interact. Those changes must be managed by: understanding how the solution affects each group of stakeholders; informing stakeholders of these impacts and the benefits they will derive; building sponsorship among those who have the power to accelerate or impede progress; engaging users in adapting the solution for their use; and providing users the information, training and support they need to be successful. Change management programs benefit from evidence-based methods that are appropriate to the environment in which they are applied and are led by strong change agents.



Capacity Building

The need to develop capacity to adapt, deploy, operate, maintain and use ICT solutions varies by the maturity of the technology involved and the ecosystem that supports its use. It also varies between rural and urban areas and between developed and developing countries. The need to build local capacity within each country cannot be overemphasized - to sustain new solutions and ensure they remain locally relevant, to support new livelihood opportunities, to develop a strong, vibrant business community and to participate in global markets.





Planning for the Future

Major Challenges and Recommendations



Architecture, Interoperability and Open Standards

ICT solutions typically require the use of multiple technologies. These technologies have the greatest impact when integrated into a platform that can be easily adapted and extended for local use. All organizations need to establish an enterprise architecture that is aligned with their mission, guides their investments in specific technologies, and provides a roadmap for technology integration and data exchange. Organizations also benefit from cross-sector collaboration to establish system and data standards and mechanisms that ensure network and system interoperability and facilitate the exchange of data across the development sector. A multi-stakeholder model (public, private and civil society) is essential to establishing system and data standards that are realistic, inclusive and serve the interests of all stakeholder groups.



Paul Arnpriester,
National BDM/Global Strategy,
CDW Nonprofit

"It is the combining, linking, and connecting of different 'data islands' that turns data into knowledge – knowledge that can ultimately help create positive change in our world. Interoperability and especially data Interoperability, is the key to making the whole greater than the sum of its parts."



Privacy and Security

As the use of Internet technology grows and the worlds of mobile, cloud, social media and data analytics converge, challenges regarding regulatory compliance, data protection and security become more complex. The global regulatory environment is rapidly changing as many, but not all, African nations move to adopt European Union privacy laws. Different laws in the U.S. and many Asian countries further increase the complexity of compliance. While the value of shared data in addressing development challenges is well recognized, there is tension between the need for data to advance the SDGs and the need to ensure security and protect privacy. These tensions will undoubtedly be exacerbated by the growing use of biometrics, data gathered via IoT devices and UAVs, and the rapidly

increasing ability to analyze and draw insight from large data sets. Governments of both developed and developing countries also are reluctant to share data in the face of the threat of global terrorism.

The development ecosystem needs standards and processes that strengthen the practices for managing data privacy and enabling data collection, management and transparency in a secure environment. With such practices in place, the development ecosystem will be able to harness technology to accelerate the achievement of the SDGs while protecting each and every participant from dangers related to inappropriate use and dissemination of their information.





Technology Building Blocks

The following sections explore the benefits and trends of “building block” technologies and make recommendations for overcoming challenges sometimes encountered in implementation.

Power

POWER	MOBILE DEVICES	CONNECTIVITY	INTERNET OF THINGS	CLOUD COMPUTING	ANALYTICS	SOCIAL MEDIA	DIGITAL SERVICES	SMART SYSTEMS	3D PRINTING
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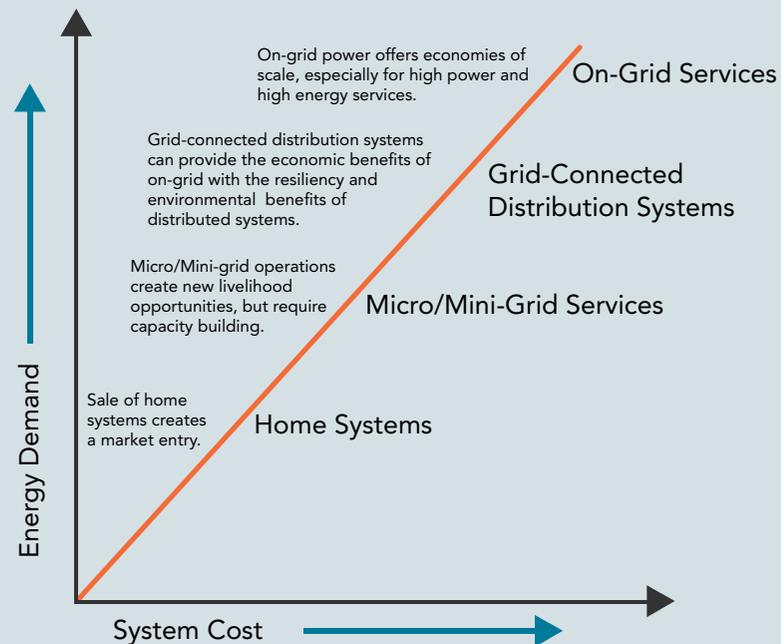
★ Benefits

- Access to affordable, reliable, sustainable and modern energy enables the use of ICT solutions in developing areas.
- Modern energy services open up new livelihood activities, eliminate health hazards such as “kitchen smoke” and free women of time-consuming tasks such as collecting fuel.
- Innovations in use of renewable energy sources protect our environment and reduce climate change impacts.

🌐 Trends

Emerging Services include:

- Home Systems: Ranging from simple, low-cost 100-watt off-grid solutions that generate enough energy to power a small phone or tablet to solar power systems with storage capabilities that power an entire home.
- Micro/Mini-grid Systems: Small-scale power grids operated by entrepreneurs to provide energy for consumers across a small geographic area.
- Off-grid Services: Subscription services offered by energy companies on a “pay as you go” basis through mobile payment systems.





Technology Building Blocks

Power



Trends (continued)

Grid and Device Improvements include:

- Micro/Mini-grid systems that rely on excess mobile network operator base station power as an energy source.
- Micro/Mini-grid solutions that mitigate outages and spikes in energy demands within the primary grid system.
- Smart systems that manage and optimize power distribution within on-grid systems, improving the efficacy of energy solutions regardless of the underlying system.
- ICT device innovations that reduce energy consumption.

Renewable Energy Sources (Solar, Wind, Hydro and Geothermal):

- Are now produced at industrial scale at prices commensurate with non-renewable energies.
- Are bundled with fuel-based technologies based on the characteristics of the local geography to reduce emissions and cost.
- Are increasingly available due to innovations in energy storage.

Challenges

- **Mature local ecosystems** (logistics, technical and financial infrastructure, and expertise) are required to sustain successful use of power solutions, but such ecosystems are often underdeveloped in many developing countries.
- **Continued innovation** is required to make solutions affordable and to reduce their impact on the environment.
- **Cross-regional cooperation** is required to reduce up-front infrastructure costs and optimize use of new energy facilities.





Technology Building Blocks

Power



✓ Recommendations

All **organizations** seeking to use ICT solutions to improve their work should:

- Ensure solution design incorporates a strategy for powering necessary devices.
- Plan funding for the lifecycle cost of the energy needed to power the ICT solution.
- Create backup solutions to mitigate the impact of power outages on ICT operations.

Network service providers should invest in low cost power solutions for the ICT networks, in order to reduce network costs and increase affordability of network services to end-users.

Energy providers should:

- Partner with local governments, businesses and/or entrepreneurs to develop local capabilities to install, operate and maintain power solutions before deployment.
- Educate energy consumers on efficient operation and energy conservation that allows for the best use of the energy technologies to meet their needs.

Governments should:

- Foster cross-regional cooperation in developing energy strategies.
- Strive to optimize the combination of energy sources that will best meet local demands given geographic constraints.
- Monitor and learn from the experiences of other countries in addressing resiliency challenges.





Technology Building Blocks

Mobile Devices

- POWER
- MOBILE DEVICES
- CONNECTIVITY
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- ANALYTICS
- SOCIAL MEDIA
- DIGITAL SERVICES
- SMART SYSTEMS
- 3D PRINTING

★ Benefits

Mobile devices are one of the most transformative technologies of our time. Mobile devices:

- End isolation, amplify the voices of the disadvantaged, and provide a means for individuals to influence the systems and structures that govern their lives.
- Connect even the poor to information and services that enable them to improve their livelihoods and quality of life.

🔗 Trends

Ownership of devices will continue to grow rapidly as:

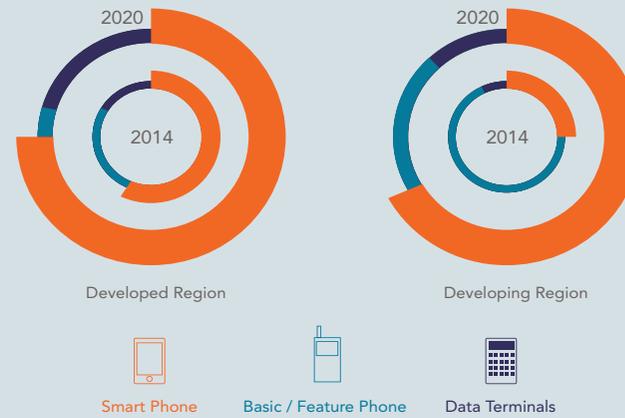
- Affordable access to mobile broadband becomes more widely available in the developing world.
- Businesses adopt “mobile-first strategies” to address the needs of an increasingly mobile workforce worldwide.

Combined growth of smart devices that can provide greater access to information and online services will accelerate as:

- Smartphone costs decline to the level of feature phones*: subscriptions will grow to 5.9 billion by 2020.¹⁵
- Businesses around the world will continue to increase their investment in tablets¹⁶ and other smart devices.
- PC, smartphone and tablet technologies and capabilities converge.

Device **power consumption** will decline as:

- Innovations lower power consumption across all categories of end-user devices.
- Consumers’ investments in devices favor those with low ICT environmental impacts.



Proportion of smartphone connections by region¹⁴

*A feature phone is a mobile phone that incorporates features such as the ability to access the Internet and store and play music but lacks the advanced functionality of a smartphone.





Technology Building Blocks

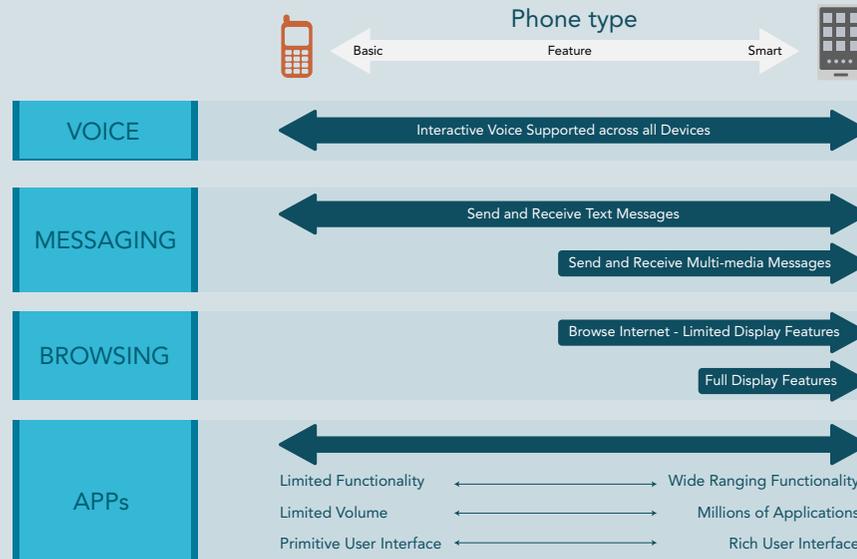
Mobile Devices

- POWER
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- 3D PRINTING

Trends (continued)

Users' **mobile experience** will be greatly enhanced as:

- All users' communications and information are delivered seamlessly across any device.
- Natural human-computer interfaces open up new ways of communication and interaction that span languages and benefit both literate and illiterate users.
- Virtual reality (the blending of real and virtual experiences) opens up new avenues for learning and decision-making.



What works on different handsets?¹⁷

Challenges

- **Device affordability** remains a challenge in low income settings, but it pales in comparison to the costs of connectivity. Although trends are promising, it will take several years for smart devices to become widely available across all geographies.
- Lack of **digital literacy** and **locally relevant content** and digital services lowers demand for mobile devices. As long as USSD* and SMS[†] remain the only mobile technologies broadly available, digital literacy and content relevance will be significant challenges.
- **Cultural barriers** account for a portion of the gender gap in use of mobile devices, but **cost** remains the greatest barrier to women owning and using a mobile phone since they typically have less financial independence than men.¹⁸
- Businesses profoundly impact the **human rights** of employees, consumers and communities wherever they operate when issues such as use of conflict minerals in manufacturing, handling of electronic waste, or implementation of fair labor practices are not take into consideration.

*Unstructured Supplementary Service Data (USSD) is a protocol used by cellular telephones to communicate messages of up to 182 characters in length with the service provider's computers.

† Short Message Service (SMS) is a text messaging service component of phone, Web, or mobile communication systems used to allow fixed line or mobile phone devices to exchange messages up to 160 characters in length.





Technology Building Blocks

Mobile Devices

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✓ Recommendations

Governments, particularly those in the developing world, should:

- Improve mobile device affordability by:
 - Reducing or eliminating government tariffs on imported devices.
 - Developing cooperative, shared procurement programs beginning with consolidation of needs across government agencies.
 - Providing incentives and subsidies to increase penetration by using, for example, existing universal service funds or implementing specialized government programs.
- Adopt incentives and procurement strategies that engage the local business community and ICT sector in building and supporting locally relevant applications.
- Establish and enforce policies and regulations that protect against human rights abuses consistent with the UN Guiding Principles on Business and Human Rights.
- Advance policies to encourage efficient use of energy and water in the manufacturing and use of mobile devices.

Technology providers should:

- Consider the use of machine learning and machine translation techniques to create local content for developing communities.
- Uphold the corporate responsibility to protect human rights wherever they operate, consistent with the UN Guiding Principles on Business and Human Rights.
- Continue to develop innovations that reduce negative impacts of mobile devices on the environment.

Development organizations should:

- Embed ICT in their programming.
- Include activities that enhance digital skills of women, ensure they have access to relevant information and services, and educate men on how empowering women through access to ICT can have a positive impact on family life and prosperity.





Technology Building Blocks

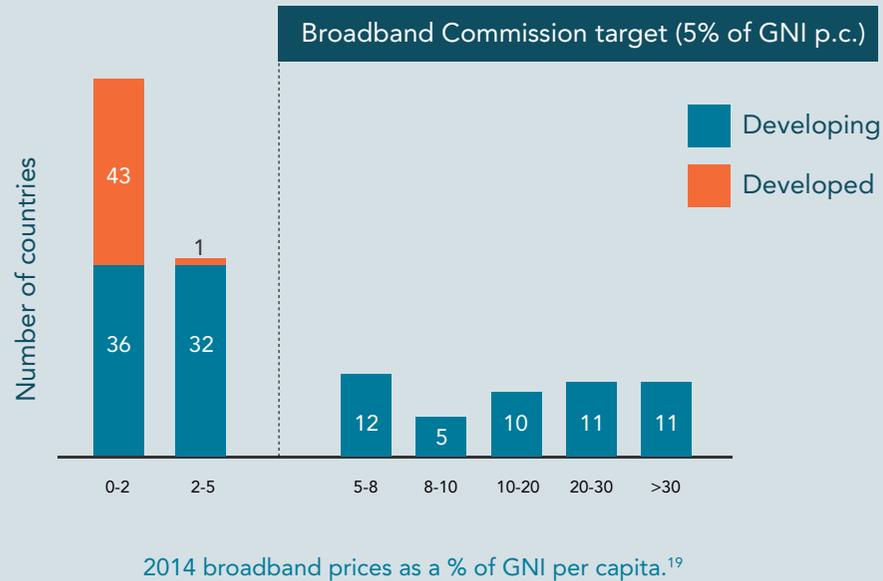
Connectivity

- POWER
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- 3D PRINTING

★ Benefits

Connectivity provides unprecedented opportunities to improve livelihoods as it connects people to markets, lowers market entry and trade barriers, and facilitates online commerce (for every 10% increase in Internet access, low and middle-income countries see a 1.38% increase in GDP).²⁰ Connectivity:

- Empowers people and provides social benefits in the form of access to healthcare, education and public services.
- Improves productivity as it connects people to information and tools that improve their efficiency and decision-making.
- Offers opportunities for individuals to interact with and influence the institutions that impact their lives.



🌐 Trends

Penetration and coverage are expanding.

- The fastest growing segment of the connectivity market is mobile broadband, as it is faster and less expensive than fixed broadband in developing areas (coverage has increased 12-fold since 2007).²¹
- Internet penetration has increased 7-fold since 2000 from 6.5% to 43%.²²
- Broadband is growing more affordable with prices for basic broadband service in 111 countries now less than 5% of gross national income (GNI).²³





Technology Building Blocks

Connectivity

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Trends (continued)

The majority of developing countries now have **national broadband plans**.

- While their governments are planning for Internet access, they are only beginning to look at demand aggregation across government agencies to reduce the cost of solutions that enable improvements specific to sectors such as health and agriculture.

Technology innovations are rapidly emerging to expand affordable Internet coverage (including last mile coverage):

- New satellite technologies (KU/KA Band) and low-orbiting satellite access devices improve affordability.
- UAVs provide Internet access in disconnected areas.
- Wi-Fi mesh* and long distance Wi-Fi technologies extend Internet reach within local communities.
- Use of unused broadcasting frequencies in the wireless spectrum extends broadband access to hard-to-reach rural areas.
- Portable storage and Wi-Fi devices bridge connectivity gaps when traveling in and out of disconnected areas.

Challenges

People who **lack Internet access** today include those who:

- **Live in areas that have Internet coverage.** These users either do not perceive a value in Internet connectivity or live in areas where technology providers are not offering affordable services or locally-relevant content.
- **Live in areas that don't have coverage, but where Internet services are economically viable.** These users could gain access to the Internet if an up-front investment is made to extend network infrastructure to these areas.
- **Live in areas where Internet services are not economically viable today.** These users are not likely to gain access to the Internet until further technology innovations make such access economically viable.

*A wireless **mesh** network (WMN) is a communications network made up of radio nodes organized in a **mesh** topology.





Technology Building Blocks

Connectivity

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✓ Recommendations

Local governments should:

- Increase affordable Internet access through regulatory reforms that foster market competition, establish an independent regulator, reduce tariffs, encourage shared use of passive network infrastructure*, incentivize network operators to expand coverage and make open, transparent frequency spectrum allocations that favor innovations designed to close the Internet gap.
- Offer e-services to catalyze the development of locally-relevant content.
- Aggregate ICT demand and business needs across government agencies to reduce service costs.

Technology providers should evaluate whether:

- Current services can be adapted to be viable in low density settings through use of connectivity innovations.
- Strategies such as Internet caching† can be used to reduce connectivity costs.
- Low-cost “pay as you go” schemes can increase affordability for low-end consumers.
- Region-wide managed connectivity services can be offered to reduce an organization’s connectivity costs and its need to build in-house network expertise.

All organizations should adopt strategies to extend the benefits of existing networks in advance of universal Internet access by investing in:

- Occasionally-connected applications and portable storage/Wi-Fi devices that can be used by individuals traveling in and out of unconnected environments.
- Government sponsored telecenters‡ that are run like a business to achieve sustainability.
- Connectivity services built around institutions (schools, clinics, etc.) and extended to surrounding populations.
- Use of second generation network mobile applications as an interim measure for users who do not have third generation network and smartphone access.²⁴

*Passive infrastructure sharing refers to sharing of physical sites, buildings, shelters, towers, power supply and battery backup.

†Internet caching is the temporary storage of web documents, such as HTML pages and images, to reduce bandwidth usage, server load and perceived lag.

‡A telecenter is a public place where people can access computers, the Internet and other digital technologies that enable them to gather information, create, learn and communicate with others while they develop essential digital skills.





Technology Building Blocks

Internet of Things

POWER

MOBILE DEVICES

CONNECTIVITY

INTERNET OF THINGS

CLOUD COMPUTING

ANALYTICS

SOCIAL MEDIA

DIGITAL SERVICES

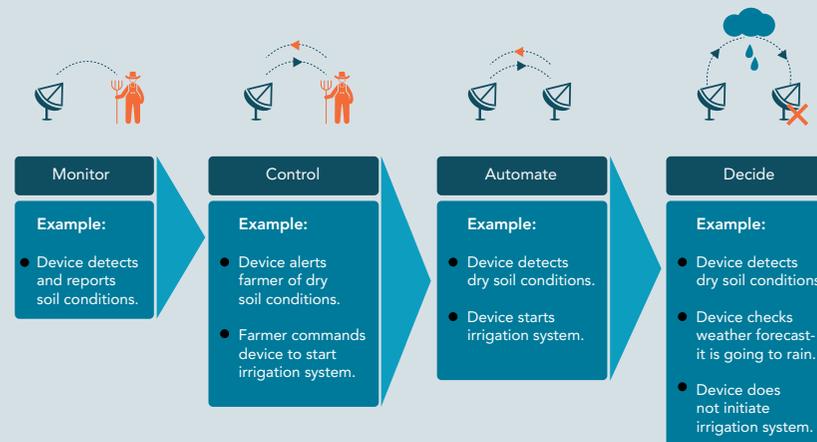
SMART SYSTEMS

3D PRINTING

★ Benefits

The IoT:

- Allows organizations to better understand their environments by collecting vast amounts of useful data with regularity and precision that has not been humanly possible in the past.
- Enables digital services that allow individuals to monitor events and trends important to their well-being.
- Enriches the data that analytics tools use to develop insights needed to guide development programs and improve their impact.
- Provides the data and controllers that allow smart systems to automate labor-intensive tasks, optimize use of resources and respond to day-to-day operational issues.



In the Internet of Things (IoT), physical objects are seamlessly integrated into the Internet and can exchange data with other connected objects, systems and individuals.

Using IoT devices, soil conditions can be monitored to inform farmers of the best time to plant, delivery of electricity can be optimized, movement of goods can be tracked across supply chains, health workers can perform remote diagnostics, health clinics can manage vaccine cold chain storage and villagers can receive early warnings of impending disasters.

Internet of Things

🌐 Trends

- Between 20 and 50 billion **devices** and more than half the world's population will be connected to the Internet over the next 5 years²⁵ as the application of the IoT expands.
- **Internet protocol** (IPV6) has evolved to support this expansion, enabling trillions of possible IP addresses.²⁶
- With the aid of **IoT devices** and **intelligent** networking, a diversity of processes will migrate online ranging from business transactions to environmental monitoring to government interactions.





Technology Building Blocks

Internet of Things

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MOBILE DEVICES

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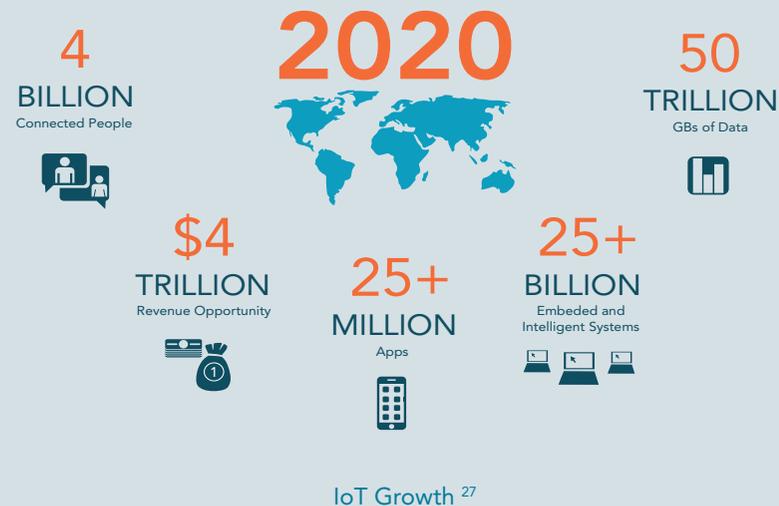
3D PRINTING

Trends (continued)

- IoT devices will become increasingly more **intelligent and prevalent**. Devices used solely for monitoring will evolve to trigger actions based on data.
- Several large technology providers are collaborating on a **framework** for IoT technology adoption that emphasizes open standards and embeds robust security and privacy controls to accelerate organizations' abilities to realize IoT benefits.

Challenges

- The **IoT ecosystem** is complex and immature. IoT solutions tend to be domain specific and employ proprietary data formats, devices and networks. IoT devices connect to the cloud today using at least 115 different protocols, and integration with legacy systems adds an additional dimension of complexity. Many efforts to evolve IoT standards are underway, but are not coordinated.
- The current **Internet architecture** will need to be continually improved to intelligently manage increased volume and frequency of traffic stemming from a growing number of IoT devices – devices with heterogeneous bandwidth, latency and priority requirements.
- The IoT will require **complex policy formulation** by governments to develop a balanced approach to issues of cross-border traffic, privacy and security, spectrum allocations and bandwidth constraints – one that facilitates data sharing at the same time that it fosters the ethical use of data. These policies will need to vary by sector and will require significant changes to legacy policies that shape current business models.





Technology Building Blocks

Internet of Things

POWER MOBILE DEVICES CONNECTIVITY INTERNET OF THINGS CLOUD COMPUTING ANALYTICS SOCIAL MEDIA DIGITAL SERVICES SMART SYSTEMS 3D PRINTING

✓ Recommendations

A broad coalition of **governments, businesses, researchers and consumers** must work together to mature the IoT ecosystem by:

- Forming a learning alliance to share plans and experience moving forward.
- Gaining commitment to IoT standards and a policy framework supported by a broad coalition of industry, academia and governments.
- Establishing goals for the use of IoT solutions that address a wide range of sectors and track progress against those goals.
- Fostering dialogue among IoT-related standards bodies.
- Encouraging the development of IoT solutions based on building blocks and an open architecture – one that is secure, scalable, interoperable and reusable across deployments, vendors and sectors.



UAVs

UAVs are another area of rapidly evolving technology that has many potential uses in development programs.

In emergency response, UAVs are powerful tools for making situation assessments which are often dangerous, costly, time-consuming and difficult to carry out with other means. UAVs can fly over areas where roads are impassable. They can be outfitted with night vision technology or infrared cameras that mitigate low-visibility conditions. They can pick up heat signatures of bodies, pinpointing locations of survivors. They can operate in circumstances that are too dangerous for responders, even pilots. UAVs can also be used in emergencies to deliver critical supplies and tools and track the location of ground shipments and responder vehicles through the use of RFID tags.

Innovative uses of UAVs are emerging in large-scale agriculture where the convenience, flexibility and cost effectiveness of UAVs have made them attractive as a vehicle for checking on the health and hydration of crops and dispensing pesticides. UAVs are also one of the innovations being used to extend Internet connectivity in rural areas.

Regulations regarding the use of UAVs are still being formulated in many parts of the world and UAVs also raise new challenges concerning privacy and the protection of personal data.

Similar to the IoT, reaping the benefits of UAV technology will require a concerted effort and partnership between governmental, civil society and private sector organizations.





Technology Building Blocks

Cloud Computing

- POWER
- MOBILE DEVICES
- CONNECTIVITY
- INTERNET OF THINGS
- CLOUD COMPUTING**
- ANALYTICS
- SOCIAL MEDIA
- DIGITAL SERVICES
- SMART SYSTEMS
- 3D PRINTING

★ Benefits

Cloud computing and storage is the practice of using a network of remote servers hosted on the Internet to store, manage and process data. Cloud computing:

- Facilitates data sharing, providing people with access to information anytime and anywhere.
- Allows organizations to share infrastructure to reduce costs.
- Facilitates prototyping, experimentation and adoption of new systems by reducing upfront capital investment in infrastructure.
- Reduces the need to recruit in-house operations and maintenance staff with adequate training to manage complex security, privacy, backup and recovery issues.
- Enables “pay as you go” cost models that improve ICT affordability.
- Facilitates transition of service ownership from one entity to another (e.g., from a development organization that introduces an ICT service to a government agency that will use it long term).



Gisli Olafsson,
Emergency Response Director,
NetHope

“Rapid access to the data needed to make the right decisions in the humanitarian relief area is often the difference between life and death.”

🌐 Trends

- **Innovations** continue to drive down infrastructure costs, making cloud services increasingly affordable to business and governments and lowering the barrier for start-ups to enter the ICT market without significant capital or technical resources.
- Cloud technology is evolving to support new services that take advantage of the **IoT**.
- Advances in **‘hybrid cloud’** computing* are facilitating the unification of traditional, on-premise ‘systems of record’ with new cloud applications and easing an organization’s ability to transition to cloud services.

* **Hybrid cloud computing** is the integration of traditional private system services (dedicated to a single organization) with public cloud services, each addressing a portion of an organization’s needs.





Technology Building Blocks

Cloud Computing

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Trends (continued)

- Cloud computing **platforms** are rapidly emerging that reduce the costs associated with building new applications and stimulate innovation within developing country local ICT sectors.
- Cloud service providers increasingly view developing markets as a **growth opportunity** and are aligning their product roadmaps with the needs of developing communities.

Challenges

- While some cloud services are designed to operate in low-bandwidth settings with intermittent connectivity, many cloud services require a **persistent connection** to fast, high-quality network services that are not yet universal.
- As organizations adopt cloud services, they have the capability to connect with a significantly **broader range of stakeholder groups**. They need to establish guidance for their staff concerning how to share and protect information intended only for specific stakeholder groups.
- **Data residency** (or sovereignty) policies, requiring data collected in a country to be stored within that country, could have a stifling effect on the use of cloud computing services, or make it infinitely more expensive and complex to build them.

Recommendations

Technology providers should:

- Assist their clients in adopting cloud hosting strategies that reduce network and storage costs (e.g., local caching, shared computing resources).
- Invest in intelligent IoT gateways that reduce IoT-generated traffic by filtering and analyzing data at its source to reduce the cost of transmitting large amounts of data to a central location for analysis.
- Assist data owners in taking advantage of tools to monitor access to their data and to rescind access as necessary.





Technology Building Blocks

Cloud Computing

- POWER
- MOBILE DEVICES
- CONNECTIVITY
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- 3D PRINTING

✓ Recommendations (continued)

- Build applications that allow cloud services to be used in low-bandwidth settings: occasionally-connected applications, applications that enable use of Wi-Fi devices with temporary storage capabilities to mitigate network outages, and applications that can receive SMS messages/alerts.

Entrepreneurs, particularly those from developing country ICT sectors who have adequate access to the Internet, should take advantage of cloud computing platforms to lower the barriers to building new, locally relevant applications.

Governments should work with private sector and civil society organizations to develop a balanced approach to issues of data sovereignty - one that facilitates inclusive access to digital services and data sharing at the same time that it fosters the ethical use of data.

All **organizations** investing in cloud solutions should:

- Plan for the changes cloud computing brings to the way ICT is funded, procured and operated within an organization.
- Invest in end-to-end monitoring capabilities to provide the insight needed to manage cloud service providers effectively.
- Develop an architecture for data storage that facilitates discovery of information and reduces redundancies.
- Develop security and privacy guidelines and educate users on their application.
- Assist technology providers in incorporating requirements for low-bandwidth settings into their product roadmap.

Fair Information Practice Principles

Legal Requirements differ around the world, however, they generally use the following Fair Information Practice Principles (FIPPs):

- 1. Collection Limitation:** Limit the amount of personal data collected.
- 2. Data Quality:** Ensure the data is accurate and kept up to date.
- 3. Purpose Specification:** Explain how the data will be used at the time the data is collected and use the data only for that purpose.
- 4. Use Limitation:** Use data with the consent of the individual or under authority of law.
- 5. Security Safeguards:** Protect personal data by using reasonable security safeguards.
- 6. Openness:** Be willing to disclose data practices.
- 7. Individual Participation:** Allow individuals to obtain information that has been collected about them.
- 8. Accountability:** Be accountable for complying with measures which give effect to the principles stated above.





Technology Building Blocks

Analytics

POWER

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DEVICES

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SOCIAL
MEDIA

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★ Benefits

The combination of vast amounts of accessible high-quality, real-time data and today's data visualization and analytics technology:

- Opens up countless opportunities to improve the planning of development efforts, to understand what is working and what is not, and to monitor progress towards the SDGs.
- Facilitates better decision-making by making all relevant data accessible in forms that are easy to understand and interpret, such as graphs, charts, maps and dashboards.
- Provides insights needed to improve the effectiveness of government and development services, such as which interventions have the greatest impact and whether they vary by geography.
- Forms the basis for development of smart systems such as irrigation systems, electrical grid systems and transportation systems that optimize the use of scarce natural resources and reduce harmful emissions.

🌐 Trends

- The **exponential growth** of digital data is fueling the need for analytics to make sound decisions. 90% of the data in the world has been created in the last two years²⁹ and by 2020, 44 zettabytes (4 billion terabytes) will be created annually.³⁰
- The emergence of **new technologies** such as smartphones, IoT devices and UAVs is providing opportunities to improve decision-making through access to disaggregated and more granular data.
- Leading providers of geospatial and big data technology are focusing on **interoperability** to facilitate data sharing and allow users to take full advantage of the entire range of structured and unstructured data analytics.

The Data Revolution

"An explosion in the volume of data, the speed with which data are produced, the number of producers of data, the dissemination of data and the range of things on which there is data, coming from new technologies such as mobile phones and the Internet of things... coupled with a growing demand for data from all parts of society."

A World that Counts: Mobilising the Data Revolution for Sustainable Development, UN Secretary General²⁸





Technology Building Blocks

Analytics

POWER

MOBILE
DEVICES

CONNECTIVITY

INTERNET
OF THINGS

CLOUD
COMPUTING

ANALYTICS

SOCIAL
MEDIA

DIGITAL
SERVICES

SMART
SYSTEMS

3D
PRINTING

Trends (continued)

- While geospatial visualization and analytic technology has matured, data platforms needed to analyze large volumes of variable, high-velocity data are in their infancy and will become more **affordable** as the result of rapid innovation in such areas as infrastructure and in-memory analytics.
- Improvements in **user interfaces** continue to reduce learning curves associated with the use of visualization and analytic tools.
- In the **short run**, development programs will use data visualization and analytics tools for planning, monitoring and assessment of impact. In the **longer term**, analyses will aid the development of smart systems that optimize resources and reduce manpower needs.
- **Geo-referenced data** will be used increasingly to improve decision-making, facilitate transparency and mitigate fraud.

Challenges

- **Poor data literacy** (a lack of experience, technical understanding of data needs and intended use, and appropriate analytical tools) can reduce the usefulness of the data that is collected and the information products that result from its analysis.
- Lack of **standards**, data sharing strategies and structures impedes the ability to share data. Many groups are working on data standards, but a path to convergence is not apparent. Where standards have been defined, they are not universally applied.
- Availability of **baselines and base maps** for country infrastructure is not uniform. Developing countries often do not have the resources necessary to address this gap, leaving them disadvantaged compared to those with more robust and complete data.
- In many developing countries, valuable paper-based records are prevalent and need to be **digitized** to improve the quality of data available for analytics.

“Data are the lifeblood of decision-making. Without data, we cannot know how many people are born and at what age they die; how many children need educating; how many doctors to train, how many schools to build, how public money is being spent and to what effect; whether greenhouse gas emissions are increasing or the fish stocks in the ocean are dangerously low; how many people are in what kinds of work, what companies are trading and whether economic activity is expanding.”

A World that Counts: Mobilising the Data Revolution for Sustainable Development, UN Secretary General^{B1}





Technology Building Blocks

Analytics

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SYSTEMS

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PRINTING

Challenges (continued)

- Guidelines for addressing **security and privacy** issues are not well established and understood, particularly within development organizations. Privacy laws are in a state of flux. Passive collection of data through sensors and people's digital footprints raises concerns about the ability to protect privacy rights.
- Commitments to **sharing** data often don't translate into action due to competition and lack of cross-sector collaboration.
- Security breaches and poor-quality data erode **trust** between data providers and users.

Recommendations

- **Governments, multilateral organizations and foundations** should collaborate on a strategy and roadmap for the adoption of data management principles and legal, technical, geospatial and statistical data standards. This roadmap should include incentives for institutions to engage in the development and use of shared data sources and lead to the development and open publishing of accurate and authoritative base maps for all developing countries.
- **Technology providers** should continue to make improvements in the usability, interoperability and affordability of tools, and offer managed services and capacity-building support.
- **Governments** should develop strategies for use of analytics to improve government services, aggregate demand to drive down the costs of information products such as imagery, and build local ICT capacity with the support of technology providers. They should take advantage of participatory mapping and investments in ongoing aid programs to facilitate the development of base country infrastructure information.
- **Development organizations** should embed guidelines for integration of analytics into the planning, monitoring and evaluation of their field projects. They should ensure that data quality, accuracy, security and privacy risks are understood and risk analysis processes are routinely applied.
- **All organizations** should invest in data literacy training and capacity building for technologists, practitioners and information managers.





Technology Building Blocks

Social Media

POWER

MOBILE
DEVICES

CONNECTIVITY

INTERNET
OF THINGS

CLOUD
COMPUTING

ANALYTICS

SOCIAL
MEDIA

DIGITAL
SERVICES

SMART
SYSTEMS

3D
PRINTING

★ Benefits

Use of crowdsourcing and social networking technologies in development has:

- Engendered a new level of transparency and accountability within the systems and structures that affect the lives of even the most vulnerable populations.
- Revolutionized the use of information within disaster relief areas by enabling impacted populations to rapidly communicate their needs and the situation on the ground. This enables thousands of people around the world to collaborate in addressing those needs.
- Created new and faster ways to communicate and share information.
- Given a voice to people in low resource settings that has increased their confidence and ability to influence decisions and structures that impact their communities and families.
- Magnified the voices of individuals advocating for the changes needed to improve the human condition and engaged people in advocating for those changes.
- Enabled women and girls to participate in online support networks designed to further their education and livelihoods.
- Facilitated the ability of local entrepreneurs to link to global customer groups.

🌐 Trends

As individuals have increased their use of social media to communicate with their personal networks, so have organizations increased efforts to take advantage of their online presence by:

- Gathering information on people's needs, the state of their economic, social and physical environment, and feedback on the services they receive through the use of SMS or Internet-based surveys (**crowdsourcing**).
- Engaging a team of trusted reporters in gathering and communicating information from their surrounding communities and reporting results through the use of SMS or Internet-based applications (**crowd seeding**).

Examples of Social Media Use

- Monitor elections in Nigeria.
- Mobilize youth in Uganda.
- Organize protests in Egypt.
- Report Russian presence in Ukraine.
- Share health information with Ebola-affected communities.
- Evaluate food security in Sierra Leone.
- Warn villages of impending floods in India.
- Translate earthquake victim requests for help from Haitian Kreyol to English in Haiti.
- Provide Typhoon Haiyan crisis map in the Philippines.
- Provide new microtasking livelihoods to disadvantaged women and youth in India.
- Communicate status to family and friends when in a disaster area.





Technology Building Blocks

Social Media

POWER

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DEVICES

CONNECTIVITY

INTERNET
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CLOUD
COMPUTING

ANALYTICS

SOCIAL
MEDIA

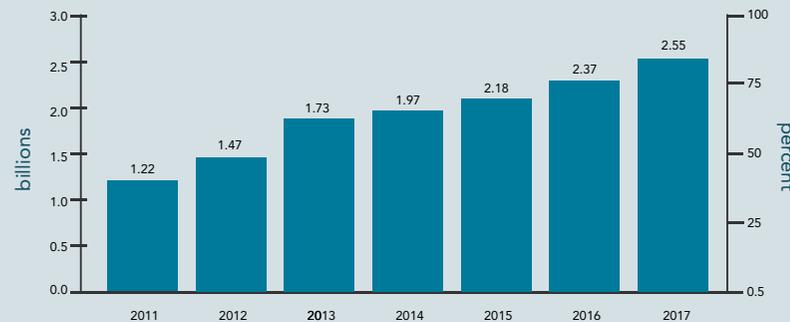
DIGITAL
SERVICES

SMART
SYSTEMS

3D
PRINTING

Trends (continued)

- Engaging volunteers or businesses in analyzing high-volume, high-velocity data and incorporating the results in information products that support decision-making (**micro-tasking**).
- Analyzing patterns in social media traffic to create valuable, accurate and useful insights (**data analytics**).
- Engaging people in augmenting maps of their community (**participatory mapping**).
- Extending their **reach** by integrating mobile devices and networks with Internet-based social media sites.



Social media users worldwide (2011-2017)³²

Challenges

- Development organizations frequently do not have **mature practices** for handling personal and sensitive data and the owners of that data may not fully understand who will access it and how it might be used, leading to compromises in the protection and ethical use of data.
- Use of social media and crowdsourcing may inadvertently **bias** the data on which key decisions are based, leaving behind the voices of those who are not online.
- Governments may **shut down** Internet services to control the flow of anti-government social media in an effort to thwart terrorism, simultaneously interfering with the ability of their citizens to communicate.
- The amount of time spent in **authenticating information** may compromise its value if it is not timely enough to support decision-making and, in the case of emergencies, save lives.





Technology Building Blocks

Social Media

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Challenges (continued)

- Relevant data at the right **level of disaggregation** and detail is not always available. For example, weather data and soil conditions are needed at a very high level of resolution if they are to benefit smallholder farmers.
- When people use social media to express their needs, their entire network is aware and may be expecting **immediate action** which is not always feasible.

Recommendations

Governments should ensure free and open access to social networking tools while having safeguards in place to protect their citizens' privacy and security.

Technology providers should:

- Collaborate on the development of interoperable technologies that bridge the capabilities of telecommunication networks, Internet services and a full range of visualization and analytics tools.
- Consider investing in products that incorporate machine learning techniques to automate authentication of crowd-sourced information.

Development organizations, multilateral organizations, volunteer networks of technical experts and governments should:

- Carefully plan and coordinate use of social media in joint development programs by establishing clear goals, roles and responsibilities.
- Develop an understanding of what information is needed and how it will be used.
- Agree on methods for mitigating potential bias in data that will be used for decision-making.
- Create agreements on how data will be analyzed, verified and shared.
- Analyze security vulnerabilities and their potential impact on individuals.
- Use best practices to manage those vulnerabilities.

“Together, the increased reach of communications networks and the growing network of people willing and able to help, are defining a new age – a network age – for humanitarian assistance.”

*Humanitarianism in the Network Age
UN Office for the Coordination of
Humanitarian Affairs (OCHA)³³*





Technology Building Blocks

Digital Services

POWER	MOBILE DEVICES	CONNECTIVITY	INTERNET OF THINGS	CLOUD COMPUTING	ANALYTICS	SOCIAL MEDIA	DIGITAL SERVICES	SMART SYSTEMS	3D PRINTING
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★ Benefits

The convergence of mobile technologies and Internet services has opened up endless possibilities for providing digital services that are relevant and valuable to communities. Some examples include: market and weather information services needed by smallholder farmers; disease outbreak alerts and stock level reports required by health providers to manage availability of medicine; e-courses and online certification needed by students to improve their livelihood opportunities; and mobile money, savings, lending and insurance services needed by families to engage in markets and manage their finances in a sustainable way. Some of the most impactful digital services today are financial services, as they open up new livelihood opportunities, reduce corruption, increase safety and provide timely access to funds.

🌐 Trends

- The use of mobile applications is **growing rapidly**. Analysts predict that annual mobile application downloads will exceed 200 billion worldwide by 2017.³⁵
- Mobile applications have become increasingly affordable as technology providers implement “**pay as you go**” models and as the cost of Internet services and handsets decreases.
- Entrepreneurs across the world are making use of cloud-based platforms to design **locally-relevant applications**.
- Private sector businesses are developing new low cost **financial inclusion tools** that extend financial services to previously hard to reach populations, even when connectivity is lacking.
- Private sector businesses, such as mobile network operators and agricultural input providers, are **bundling digital services** with their standard product and service offerings as a means to distinguish themselves from their competitors.

“In developed countries today, and in pockets in developing countries, electronic payments are widely accepted. In most cases, consumers can choose how they make and receive payments, balancing a range of attributes such as convenience, security, speed as well as cost. While people in developed countries still use cash for small transactions, they could barely imagine the inconvenience and risk of paying large bills or buying large household items such as furniture, or even a vehicle, in cash. It is all too easy to overlook or underestimate the value that even poor and rural household electronic payments can bring compared to cash. While cash may seem a benevolent ruler in a land of choice, it can be a tyrant in a place with few or no other options.”

*The Journey toward ‘Cash Lite’
commissioned by the Better than Cash
Alliance³⁴*





Technology Building Blocks

Digital Services

POWER

MOBILE DEVICES

CONNECTIVITY

INTERNET OF THINGS

CLOUD COMPUTING

ANALYTICS

SOCIAL MEDIA

DIGITAL SERVICES

SMART SYSTEMS

3D PRINTING

Trends (continued)

- **Digital identities** are increasingly being used as a means to control and facilitate individual access to services, both on and off-line, and to track their service usage.
- Low cost mobile payment networks are growing rapidly in developing countries and will likely **disrupt current development programming** as they reduce reliance on more costly in-kind transfers and provide greater flexibility to beneficiaries in meeting their needs. Eighty-five developing countries now have at least one mobile money service.³⁶

Challenges

Challenges to the adoption of digital services mirror the same challenges we see in ensuring that Internet access is inclusive, affordable and provides value to local populations:

- To be effective, mobile applications must be **relevant** to the local context in which they will be used – taking into consideration the users’ language, literacy, cultural norms, disabilities and familiarity with mobile devices.
- Mobile applications must be **affordable** for the target population. Local regulations must be aligned with and favor their use.
- Business models for providing digital services must be **sustainable** over time. Development projects frequently introduce services without paying adequate attention to the need to sustain those services following project end.
- Methods of identifying individuals who participate in a service must be rationalized. To access modern financial services and take advantage of e-commerce, users need to be able to establish a **digital identity** that is recognized among service providers.

Mobile solutions, especially in financial services, require **ubiquitous and affordable connectivity** which will take a number of years to achieve in many parts of the world. Until then, the development ecosystem needs solutions that can operate effectively without connectivity.





Technology Building Blocks

Digital Services

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SERVICES

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SYSTEMS

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✓ Recommendations

Technology providers building products and organizations seeking to adapt them for local use should:

- Adhere to best practices for building, deploying and maintaining products.*
- Build products that comply with system interoperability and data standards.
- Focus on user-centered design methods to ensure that these products will address local needs.

Development organizations should:

- Leverage the potential of mobile applications to decrease the gender gap by meeting women’s needs for privacy, security and time flexibility.
- Engage governments early in the process to ensure sponsorship of the changes the use of these products will bring about, particularly if these products are related to the services that the government provides.
- Identify sustainable business models early in the design process and secure the support of stakeholders who will provide resources for ongoing operation and maintenance.

Governments, private sector and civil society organizations should collaborate on development and deployment of digital identification systems in the context of a global market.

*The [Organizational Guide to ICT4D](#) provides guidance for applying the [Principles for Digital Development](#) to deliver ICT solutions.





Technology Building Blocks

Smart Systems

POWER

MOBILE
DEVICES

CONNECTIVITY

INTERNET
OF THINGS

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COMPUTING

ANALYTICS

SOCIAL
MEDIA

DIGITAL
SERVICES

SMART
SYSTEMS

3D
PRINTING

★ Benefits

Modern analytics, coupled with the volume and velocity of data now available from remote sensors, aerial and satellite imagery, lays the foundation for smart systems that use the results of analyses to initiate and prescribe action. Some examples of how such systems contribute to the SDGs include:

- **Precision agriculture:** Smart systems analyze weather and soil information and use that information to control irrigation and the application of fertilizer and pesticides – conserving water, reducing weather-related crop losses by up to 25% and avoiding the environmental damage caused by pesticides runoff.³⁷
- **Transportation:** Smart systems analyze highly precise street maps and real-time information about delivery commitments and traffic conditions to prescribe routes for drivers, leading to reductions in operational costs, optimization of fuel usage, and reduction of CO₂ emissions that help sustain our ecosystem and combat climate change.
- **Smart cities:** Smart systems make use of imagery, sensors, digital reports and social media to provide the information needed to automate city services, optimize their level of quality and minimize their use of resources - from public utilities, building, transportation, public safety, to social services.

The most advanced smart systems make decisions based not only on insights developed using advanced analytics and data from sources such as IoT devices, digital services, social media and human-facilitated data collection systems, but also on the results of past decisions – sometimes referred to as machine-learning.

What is a Smart System: An Example from Agriculture

“Imagine you are a farmer riding along in your 50,000-acre wheat field early in the growing season. You push a button on your tractor to turn on its Global Positioning System (GPS) monitor, which pinpoints your exact location to within one meter. Touching another button, you display a series of Geographical Information System (GIS) maps that show where the soil in your field is moist, where the soil eroded over the winter and where there are factors within the soil that limit crop growth. Next, you upload remote sensing data, collected just yesterday, that shows where your budding new crop is already thriving and the areas where it isn’t. You hit SEND to upload these data into an onboard machine that automatically regulates the application of fertilizer and pesticides – just the right amount and exactly where the chemicals are needed. You sit back and enjoy the ride, saving money as the machines do most of the work. Congratulations, you are among a new generation of growers called “precision farmers.”

David Harrington, NASA Earth Observatory³⁸





Technology Building Blocks

Smart Systems

POWER

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Trends

Smart systems will increasingly be used to make improvements in large-scale, complex operations that would otherwise be impossible using traditional means, because of the volume and velocity of data needed to manage those operations, the complexity of the decision-making that is needed to optimize those operations and the amount of labor that would be required to perform them.

Their adoption is driven in part by some of the most urgent development issues:

- The urgent need to **increase global food production** by 70% over the next 35 years to feed a growing population³⁹ is fueling the growth of precision agriculture, which relies on smart systems to improve yields and profitability and reduce energy consumption and cost of farm operations. The precision agriculture market is growing at a rate of 13.4% per year worldwide and 25.2% in Asia-Pacific.⁴⁰ New business models and mobile technology solutions to bring precision agriculture to consortia of small-scale farmers in Africa, Asia and South America are being actively explored.
- The rapid growth of urban areas is inspiring cities of all sizes to leverage smart systems to address an already urgent need to **provide adequate services** to their citizens (by 2050, 66% of the world population will live in urban areas, an increase of 3 billion since 2010).⁴¹ The market for smart systems for city management is growing at a rate of 22.5% per year.⁴²
- Private businesses are becoming increasingly aware of their impact on the environment and are using smart systems to improve their profitability in a **socially responsible** way. For example, UPS' smart transportation system is saving them 10 million gallons of fuel annually (\$300 million in costs) while realizing annual reductions of 100,000 metric tons of CO₂ emissions.⁴³





Technology Building Blocks

Smart Systems

- POWER
- MOBILE DEVICES
- CONNECTIVITY
- INTERNET OF THINGS
- CLOUD COMPUTING
- ANALYTICS
- SOCIAL MEDIA
- DIGITAL SERVICES
- SMART SYSTEMS
- 3D PRINTING

Challenges

Major challenges to the deployment of smart systems include the need to:

- Adopt **new business models** to make investment in smart systems attractive despite the disruption to current patterns of revenue generation across the value chains they support.
- Develop **cross-industry architecture** and standards that will allow for interoperability, ease of deployment and alignment of smart system services with those of IT infrastructure and network providers.
- Build development community **capacity** to manage smart systems implementation.⁴⁴

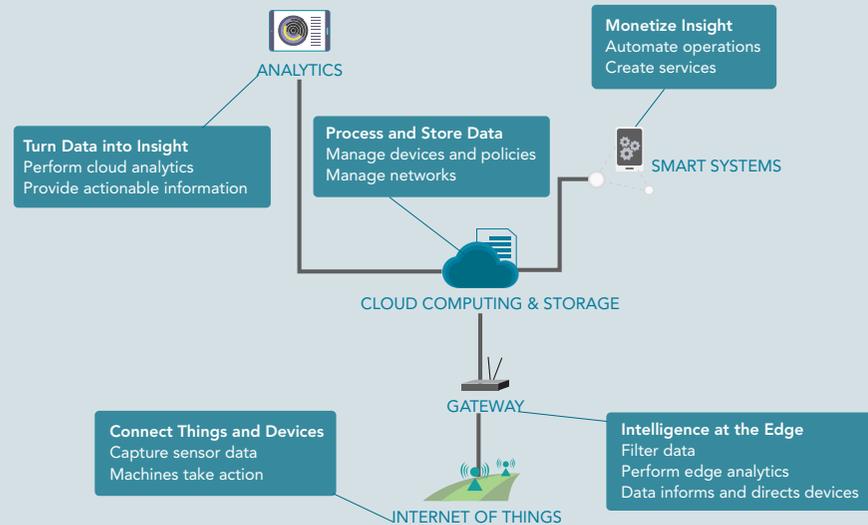
Recommendations

Technology providers should:

- Collaborate to align IoT, connectivity, analytics and cloud technologies, and to produce platforms that can accelerate smart system development.
- Assist organizations in using these platforms to shorten deployment cycles and reduce their smart system costs.
- Provide the training and services needed by governments, local businesses and development organizations to identify opportunities that would benefit from the use of smart systems and to manage their deployment.

Governments should incorporate smart systems into their e-government strategies where they offer improvements in efficiency and effectiveness of government services.

All organizations committed to achieving the SDGs should share their experience data in deploying smart systems to improve their operations and learn from each other.





Technology Building Blocks

3D Printing

POWER

MOBILE
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CLOUD
COMPUTING

ANALYTICS

SOCIAL
MEDIA

DIGITAL
SERVICES

SMART
SYSTEMS

3D
PRINTING

★ Benefits

3D Printing allows production of physical objects (such as vehicle spare parts, prosthetics, hearing aids, dental implants, pharmaceuticals and food) from a design using any of a number of different materials. 3D printing:

- Aids in rapid prototyping and reduces the cost of product development.
- Allows a product to be manufactured at multiple locations anywhere in the world, eliminating many traditional supply chain costs.
- Avoids many of the production setup costs associated with traditional manufacturing, making 3D printing particularly cost-effective when manufacturing products that need to be customized (such as prosthetics) or products that are needed in low volume.
- Reduces waste associated with traditional manufacturing processes.
- Allows non-traditional raw materials to be combined with mainstream materials as a means to mitigate raw material shortages and reduce environmental impact (such as the use of non-traditional but nutritious ingredients in foodstuffs, or recycled construction materials in building components).
- Provides new opportunities to address critical shortages in low resource settings, such as spare parts for smallholder farm vehicles.

🌐 Trends

Some trends that favor the use of 3D printing to address development challenges include:

- As 3D printed objects are becoming more functional, 3D printers are moving from being a prototyping tool to being a **manufacturing tool**.
- Technology providers are providing **solar-powered** 3D printers to extend their reach to low-resource settings.
- The variety of 3D **printing materials** for the manufacturing of objects is increasing and materials are now stronger.
- While providers are experimenting with different kinds of materials, such as metal, **low-cost polymers** will dominate the market for some time to come.
- 3D printer **open source object designs** and schematics are being hosted in the cloud.





Technology Building Blocks

3D Printing

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3D
PRINTING

Challenges

- 3D printing still needs refinement in the areas of **materials, durability, cost and speed** before it becomes widely accepted.
- 3D printing will challenge existing **intellectual property laws** as the industry struggles to address issues such as ownership of 3D printed work, what is and is not considered proprietary or a trade secret, and what does or does not constitute infringement. For example, who owns the intellectual property rights to a 3D printed product: the party who conceived the product, the party that specified the product in a 3D printable format, the party that manufactured the 3D printer, or the party who printed the 3D product?⁴⁵
- The **size** of objects and the **pace** with which they can be manufactured with 3D printers has been limited, although recently China is reported to have used a 6.6x10x150 meter 3D printer to produce components that are then assembled into buildings from a combination of steel, cement, glass fiber and recycled construction materials.⁴⁶

Recommendations

Organizations throughout the development community should:

- Engage now to influence the formulation of 3D printing intellectual property laws, as they could have major impacts on the value of 3D printing in addressing development issues such as the affordability and availability of medicines and medical supplies in developing areas.
- Prepare now to take advantage of what will be a very rapid onset of 3D printing capability to enable new livelihoods, eliminate traditional production setup and supply chain costs, reduce waste, and mitigate lack of timely access to critical tools and supplies, such as prosthetics in war torn areas or meals in refugee camps that incorporate available, nutrient-rich ingredients such as algae or milled mealworm into familiar dishes.





Technology Uses by Sector

Technology use in livelihoods: end poverty, promote inclusive and sustainable economic growth, employment and decent work for all (G1, G8).

LIVELIHOODS

AGRICULTURE

HEALTH

EDUCATION

WASH & POWER

INFRASTRUCTURE

DISASTER RELIEF

GOVERNANCE

ENVIRONMENTAL PROTECTION

ANALYTICS

provide the visualization and analytic tools needed: by businesses to understand market trends and make decisions concerning product/service offerings; by governments to evaluate the health of the local economy and formulate policies that strengthen it; and by civil society organizations to make livelihood programming decisions.



SOCIAL MEDIA

allow individuals to participate in professional networks and take advantage of their support in securing new livelihood opportunities. Social media also: assist businesses and entrepreneurs in connecting to a global customer base and providing new digital services such as microtasking; provide new means for individuals to participate in government initiatives; and enable citizens to hold governments accountable for policies that favor both fair and open competition and provide inclusive access to economic resources.



DIGITAL SERVICES

such as mobile money, micro-insurance, savings and loans, job placement and market information: foster financial inclusion; assist people in identifying and securing employment opportunities; provide governments a cost-effective means of identifying citizens and providing citizen services; and provide businesses and entrepreneurs with market information to improve their profitability, facilitate their market transactions to reduce costs and connect them to new market opportunities.



CLOUD COMPUTING

allows the implementation of trading, tendering and bartering platforms that facilitate electronic commerce. Cloud computing also fosters innovation by eliminating the upfront costs in infrastructure that entrepreneurs would otherwise need to launch their businesses.



SMART SYSTEMS

allow governments to improve public services, and businesses to optimize their use of resources in the interest of a vibrant local economy.



3D PRINTING

fosters innovation by allowing entrepreneurs to prototype new products and by establishing businesses that manufacture and offer locally relevant products.



MOBILE DEVICES

allow individuals and businesses to establish a digital identity and take advantage of digital information and services that improve their livelihoods and profitability.



CONNECTIVITY

facilitates electronic commerce and connects people and businesses to information and services relevant to new and existing livelihoods.



SATELLITES, UAVs & THE INTERNET OF THINGS

provide governments, businesses and individuals with a better understanding of their world – such as the location of human settlements, markets, citizens and customers, and existing public infrastructure and transportation routes – information needed for planning.



POWER

and the innovative approaches for providing it ease deployment of technology and create livelihood opportunities for entrepreneurs selling off-grid services.





Technology Uses by Sector

Technology use in agriculture: end hunger, achieve food security and improved nutrition and promote sustainable agriculture (G2).

LIVELIHOODS

AGRICULTURE

HEALTH

EDUCATION

WASH & POWER

INFRASTRUCTURE

DISASTER RELIEF

GOVERNANCE

ENVIRONMENTAL PROTECTION

ANALYTICS

provide capabilities needed to produce snapshots, analyze trends and make projections about weather, soil conditions, land use, diseases, markets and food security. This is done within time frames critical to the development and implementation of farm business plans, agriculture research and extension services, and agriculture development programming.



SOCIAL MEDIA

connect farmers to an online social network that can provide insight about changing conditions, provide advice and support, and share best practices. Social media also allow governments and research organizations to collaborate on agriculture sector improvements.



DIGITAL SERVICES

such as mobile money, micro-insurance, market information, weather information, advisory services and distance learning programs both help farmers to improve their livelihoods and allow governments to build extension agents' capacity, monitor their performance, and reduce the cost of extension and land management services. These may be delivered through ICT-enabled extension services, call centers, or directly to farmers' mobile devices.



CLOUD COMPUTING

provides the capability to build trading, tendering and bartering platforms. Cloud computing also brings together and delivers high quality, timely information and services needed to improve farm businesses – anytime, anywhere.



SMART SYSTEMS

are emerging that automate and control key farming operations such as irrigation, fertilization, and pest control and optimize agriculture supply chains.



3D PRINTING

offers opportunities to produce tools farmers require such as farm vehicle spare parts at a fraction of the cost and time required in the past.



MOBILE DEVICES

allow farmers to access the information they need to improve farm business plans, acquire financial resources, manage production, link to markets and meet supply chain information requirements. Mobile devices also allow extension agents to access learning programs and information to improve their services and to record their interaction with farmers.



CONNECTIVITY

connects farmers to information and services and allows farmers to form support networks and communicate with agriculture value chain buyers and suppliers. Connectivity also allows governments to monitor extension workers and deliver services.



SATELLITES, UAVs & THE INTERNET OF THINGS

such as remote sensors, weather stations and RFID tags, generate rich sets of highly accurate georeferenced digital data about weather, soil conditions, crop conditions, land use, market locations, transport routes and even the location of vehicles carrying farm produce. Collectively, these form the basis of farmer information services.



POWER

solutions provide the energy needed to power ICT equipment.





Technology Uses by Sector

Technology use in health: ensure healthy lives and promote well-being for all at all ages (G3).



ANALYTICS

provide capabilities needed to produce snapshots, analyze trends and make projections that governments, research institutions, health service providers and civil society organizations need to know about: disease outbreaks; health service usage and inclusiveness; and patient knowledge, attitudes and practices regarding their health. This is done within time frames critical to eradicating disease and reducing mortality rates.



SOCIAL MEDIA

connect health workers, researchers and patients alike to social networks that: alert them to disease outbreaks and to the availability of health services; provide advice and support; and share best practices.



DIGITAL SERVICES

such as mobile money, micro-insurance, stock level monitors, patient reminders, health advisory services and distance learning programs, provide access to the resources and information needed by: governments to monitor health service delivery; hospitals and clinics to manage patient records, stock levels, and health care delivery; community health workers to improve their services; and patients to improve their health. These may be delivered through delivered through ICT-enabled community health workers, call centers, or directly to patients via mobile devices.



CLOUD COMPUTING

provides the capability of governments and health care providers to bring together and deliver high-quality, timely information and services needed to understand patient histories and improve health services - anytime, anywhere.



SMART SYSTEMS

are emerging that optimize medical supply chain operations; improve pharmaceuticals cold storage management; generate warnings of imminent disease outbreaks; and recommend the placement of health facilities and personnel.



SATELLITES, UAVs & THE INTERNET OF THINGS

such as ingestible sensors, patient monitors and RFID tags, generate rich sets of highly accurate georeferenced data about: hospitals, clinics, and patients; the location of human settlements, health facilities, transport routes and vehicles carrying medical supplies; as well as changing environmental, political and social conditions that are likely to lead to health issues.



3D PRINTING

offers opportunities to produce low-cost medical devices such as prosthetics.

POWER

solutions provide the energy needed to power ICT equipment.



MOBILE DEVICES

allow community health workers to learn about and prepare for disease outbreaks, identify patient symptoms, follow established treatment protocols, perform remote diagnostics, access expert support, refer patients to clinics, send patient reminders, record delivery of health services and receive mobile payments for those services.



CONNECTIVITY

connects health workers to information and diagnostic services, allows them to form support networks, facilitates communication with doctors and nurses within clinics and hospitals, and allows medical professionals to interact remotely with patients.





Technology Uses by Sector

Technology use in education: ensure inclusive and equitable quality education and promote lifelong learning opportunities for all (G4).



ANALYTICS

provide capabilities that governments, educational institutions and civil society organizations need to produce snapshots, analyze trends and make projections about: the inclusiveness of a nation's education system; its ability to foster innovation; and its ability to build the types of skills at levels that are needed to maintain a strong, vibrant economy.



SOCIAL MEDIA

support the development of support networks for teachers and for students, most essentially for women and girls attempting to further their education and for youth seeking new livelihood opportunities.



DIGITAL SERVICES

such as e-learning programs (self-paced and instructor-led), e-books and journals, online certification programs, online competitions, online labs and student advisory services: open up a whole new world of learning assets to students that can lead to new livelihood opportunities; allow governments to build teacher capacity through providing online teacher training and to monitor learning results; and reduce the cost of public education services.



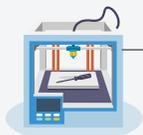
CLOUD COMPUTING

provides the capability to establish online classrooms and labs, and to bring together and deliver a rich set of learning assets that can be accessed anytime, anywhere.



SMART SYSTEMS

analyze patterns of student learning and prescribe individual learning plans to improve results.



3D PRINTING

fuels limitless creativity when students get to see, hold and test their ideas in real space, and exposes learners to the same cutting-edge technologies they'll encounter in their careers.

POWER

solutions provide the energy needed to power ICT equipment.



MOBILE DEVICES

allow: students to access learning assets; teachers to prepare for classes and record their delivery; and governments and educational institutions to monitor learning results, anytime and anywhere.



CONNECTIVITY

connects governments, teachers and students alike to a wealth of learning resources and online information relevant to strengthening public education systems, building teacher capacity and improving student learning results.



SATELLITES, UAVs & THE INTERNET OF THINGS

generate rich sets of highly accurate georeferenced digital data about the location of schools, the communities they serve, and school transportation routes. These tools provide students with different mechanisms to explore and learn about their world.





Technology Uses by Sector

Technology use in water and sanitation (WASH) and power: ensure availability and sustainable management of water, sanitation and energy for all (G6, G7).

LIVELIHOODS

AGRICULTURE

HEALTH

EDUCATION

WASH & POWER

INFRASTRUCTURE

DISASTER RELIEF

GOVERNANCE

ENVIRONMENTAL PROTECTION

ANALYTICS

provide capabilities that governments, research institutions, civil society organizations and utility companies need to produce snapshots, analyze trends and make projections about: access to and usage of water, sanitation and various forms of energy services; the impact of such services on the environment; and the state of the infrastructure needed to manage them.



SOCIAL MEDIA

support the development of collaborative research networks and public forums for sharing information and learning about water, sanitation, proper hygiene, and energy issues and innovations.



DIGITAL SERVICES

such as e-learning, energy usage monitoring, water pathogen detection, and infrastructure fault reporting applications, support efforts to educate consumers and businesses on responsible water, sanitation, and energy management practices. Digital services also enable governments and utility companies to build capacity to manage utilities at a local level and to streamline delivery.



CLOUD COMPUTING

provides the capability for governments and utility companies to establish online platforms for ordering and managing utility service delivery that reduce costs and facilitate provision of affordable services.



SMART SYSTEMS

provide governments and utility companies with the automation and expert decision-making needed to optimize delivery of water, sanitation and energy services, maximize their use of renewable energy sources and minimize environmental impacts.



SATELLITES, UAVs & THE INTERNET OF THINGS

generate rich sets of highly accurate georeferenced digital data about: the status of water, sanitation and power infrastructure; water, sanitation service and energy usage; and the environmental impact of that usage - information that governments, research institutions and utility companies need to improve the quality and reduce the cost and negative environmental impact of services.



3D PRINTING

supports prototyping of new devices to improve access to clean water, sanitation, and energy such as water filtration and energy storage systems.

POWER

solution innovation and use of renewable energy sources facilitate universal access to affordable modern energy services.



MOBILE DEVICES

allow governments and utility companies to manage a mobile workforce and interact with consumers remotely to reduce utility costs.



CONNECTIVITY

connects governments, utility companies, health workers, and citizens and facilitates the education and collaboration needed to provide universal access to clean water and modern sanitation and energy services and practices.





Technology Uses by Sector

Technology use in infrastructure: build resilient infrastructure, make cities and human settlements inclusive, safe, resilient and sustainable (G9, G11).



LIVELIHOODS



AGRICULTURE



HEALTH



EDUCATION



WASH & POWER



INFRASTRUCTURE



DISASTER RELIEF



GOVERNANCE



ENVIRONMENTAL PROTECTION

ANALYTICS

provide capabilities that governments and their partners need to produce snapshots, analyze trends and make projections about population growth, migration patterns, urbanization and commerce. These projections are necessary for development planning and facilitate industrial growth that leads to strong economies and safe, resilient, and sustainable human settlements.



SOCIAL MEDIA

support the development of collaborative research networks and innovation forums; facilitate global market participation; and foster public participation in government planning and development efforts.



DIGITAL SERVICES

provide the means for governments to establish digital identities for their citizens and digitize government services to improve access, create efficiency and reduce costs. Digital services also prove the capability to enhance the local economy and raise revenue.



SMART SYSTEMS

provide governments with sophisticated tools for: planning government services; managing and automating the delivery of public services to reduce resource consumption; and providing oversight of the industries that make up local economies. They provide local businesses with tools to automate business processes and reduce costs in ways that contribute to the local economy and protect the environment.



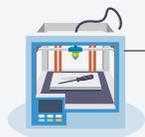
CLOUD COMPUTING

provides the capability: for governments to establish online delivery of government services; for businesses to develop an online market presence and reduce transaction costs through the use of e-commerce; and for entrepreneurs to establish new businesses while minimizing upfront investment costs.



SATELLITES, UAVs & THE INTERNET OF THINGS

generate rich sets of highly accurate georeferenced digital data about: the status of human settlements; the public infrastructure that supports delivery and the usage of public services; and the industries that make up local economies and their economic, social, and environmental footprint. Governments and their partners need this information to feed the analytics and systems that support safe settlements and vibrant local economies.



3D PRINTING

supports innovation and the development of new livelihoods through rapid prototyping and manufacturing of products in ways that reduce traditional setup and supply chain costs.

POWER

solutions provide the energy needed to power ICT equipment.



MOBILE DEVICES

allow governments, local businesses, citizens and consumers to interact in ways that reduce service costs and stimulate the local economy.



CONNECTIVITY

connects governments, their partners, and their citizens. Connectivity also facilitates electronic commerce and government services.





Technology Uses by Sector

Technology use in disaster relief: make cities and human settlements inclusive, safe, resilient and sustainable (G11).

LIVELIHOODS

AGRICULTURE

HEALTH

EDUCATION

WASH & POWER

INFRASTRUCTURE

DISASTER RELIEF

GOVERNANCE

ENVIRONMENTAL PROTECTION

ANALYTICS

provide capabilities for networks of technical specialists from around the world to curate incoming data and map disaster relief needs and activities, and for responders to use this information for planning, implementing, monitoring, and evaluating relief efforts and understanding their impact.



SOCIAL MEDIA

connect people, their families and their supporters to a human network that can: take action; alert responders to on-the-ground needs; and provide technical expertise (such as geospatial mapping) to assist in planning, conducting and assessing the effectiveness of relief efforts.



DIGITAL SERVICES

such as mobile money, electronic vouchers, relief information broadcasts, people locators and virtual 9-1-1 services, delivered as part of an emergency response can make relief operations safer and more accessible for all involved. They also can provide early warning of impending natural disasters.



CLOUD COMPUTING

provides the capability to bring together and deliver high-quality, timely information and services needed to save lives and help people recover quickly from disaster situations.



SMART SYSTEMS

open up possibilities for monitoring conflict situations and signs of natural disasters, automatically alerting public institutions of impending events and prescribing action.



3D PRINTING

offers opportunities to produce tools needed to support relief efforts.



MOBILE DEVICES

allow impacted individuals to request help and responders to communicate with them to coordinate relief efforts and to report the situation on the ground.



CONNECTIVITY

connects responders to support networks to coordinate relief efforts. Connectivity also facilitates communication between disaster-affected people and those who are working to support them.



SATELLITES, UAVs & THE INTERNET OF THINGS

such as remote sensors and RFID tags, generate rich sets of highly accurate georeferenced digital data about the evolving situation on the ground, and the location of shelters, transport routes and vehicles carrying relief supplies.



POWER

and the innovative approaches for providing it eases deployment of technology even in disaster areas.





Technology Uses by Sector

Technology use in governance: reduce inequalities and foster peaceful, just and inclusive societies free from fear and violence (G5, G10, G16).

LIVELIHOODS

AGRICULTURE

HEALTH

EDUCATION

WASH & POWER

INFRASTRUCTURE

DISASTER RELIEF

GOVERNANCE

ENVIRONMENTAL PROTECTION

ANALYTICS

provide opportunities to produce snapshots, analyze trends, run simulations and make projections about the need and demand for government services, as well as their effectiveness and inclusiveness with regard to gender, age and urban versus rural residence. They also create transparency and provide the means to hold governments accountable to their citizens and for citizens to be counted.



SOCIAL MEDIA

provide opportunities for governments to engage citizens and for citizens to raise issues, advocate for change and organize to take action.



DIGITAL SERVICES

give governments a whole new way to support their citizens with cost effective electronic services that are more convenient, safer and less prone to fraud - whether used for payment of taxes, salary payments for government employees, recording births, accessing medical records and services, recording sale of land, or arranging for trash disposal.

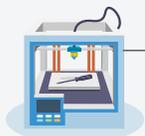
CLOUD COMPUTING

provides the capability to bring together and deliver high-quality, timely information and services needed to improve and take advantage of government services - anytime, anywhere.



3D PRINTING

offers opportunities for the government to incentivize private sector growth in the area of product development and manufacturing.



POWER

solutions provide the energy needed to power ICT equipment.



MOBILE DEVICES

allow individuals to access government services anywhere and at any time and to participate in social networks. They provide governments with the flexibility to interact with and manage field staff, regardless of location.



CONNECTIVITY

connects citizens to government agencies and to the information and services they need to collaborate on improving government service.



SMART SYSTEMS

help governments optimize the use of natural resources and improve the delivery of citizen services. Smart systems can also help governments identify and manage threats.

SATELLITES, UAVs & THE INTERNET OF THINGS

such as remote sensors and RFID tags, generate rich sets of highly accurate georeferenced digital data about the land, waterways, transport routes and settlements that make up a country. These data also contribute to the understanding of environmental trends and activities taking place within and surrounding a country that impact its citizens.





Technology Uses by Sector

Technology use in environmental protection: protect the planet from degradation for present and future generations (G12, G13, G14, G15).



ANALYTICS

provide capabilities needed to produce snapshots, analyze trends and make projections about changes in our environment, their impact and the probability that mitigation plans will be successful. Analytics also inform law enforcement activities focused on environmental protection.



SOCIAL MEDIA

provide opportunities to engage people in discussions concerning environmental protection issues, advocate for change and take collective action.



DIGITAL SERVICES

provide the means for individuals and institutions to engage in commerce electronically (including carbon credit trading), resulting in a reduction of emissions associated with a reduction in transport and warehousing needs. They also can provide early warning of impending natural disasters.



CLOUD COMPUTING

provides the capability to bring together and deliver high-quality, timely information and services needed to protect our environment - anytime, anywhere.



SMART SYSTEMS

such as building, transportation and grid management systems, provide the means to optimize the use of natural resources and reduce environmental impacts.



3D PRINTING

offers opportunities to eliminate much of the cost and the negative environmental impacts of supply chains that move products inefficiently from producer to consumer locations.



MOBILE DEVICES

allow individuals to access information concerning the environment, participate in electronic commerce, take an active role in discussing environmental issues, monitor adherence to conservation targets and alert law enforcement to illegal activity such as poaching or lack of adherence to water rationing.



CONNECTIVITY

connects individuals, conservationists and government agencies to environmental protection information and services.



SATELLITES, UAVs & THE INTERNET OF THINGS

such as remote sensors, weather stations and RFID tags, generate rich sets of highly accurate georeferenced digital data about the earth: soil; vegetation; water bodies and levels; atmosphere; weather; storms; earthquakes and volcanic activity; settlements; transport routes and more.



POWER

solutions provide the energy needed to power ICT equipment.





Call to Action

ICT solutions have tremendous potential to change the way the world works, lives and interacts and thereby accelerate achievement of the Sustainable Development Goals. This potential is being driven by:



The convergence and integration of mobile and cloud technologies.



The emergence of new mainstream technologies for collecting and analyzing vast amounts of real-time data from a myriad of sources, producing high-quality information products to support decision-making.



Growing adoption of these technologies by organizations, communities and individuals worldwide.



The systems and services that utilize these building blocks to optimize the use of natural resources, to amplify the voices of individuals and social networks and to generate new livelihoods.

To realize that potential, leaders within governments, businesses and civil society organizations must be bold and look for every opportunity to foster local innovation, to assist local institutions in becoming part of the digital economy, and to expand local community and citizen access to ICT solutions and the benefits they provide.

The pace of ICT-enabled change will vary from region to region, country to country, community to community and one demographic group to the next. ICT plans must meet communities where they are today, but should not assume that each community will go through the same technology adoption cycle and at the same rate. ICT plans should consider opportunities to bypass or leap-frog older technologies altogether in favor of new, more beneficial ones. ICT plans must also balance investments in basic ICT solutions that provide immediate benefits to developing countries (such as existing power, connectivity, cloud computing, analytics, social media and digital services) with those that are necessary to grapple with access to scarce resources within changing economic, social and physical environments around the world.

Each individual public, private and civil society organization has the responsibility to ensure that their strategic goals align with the SDGs and that their plans to invest in ICT enhance their ability to contribute to the SDGs. They also have the responsibility to identify and build the cross-sector partnerships that strengthen that contribution and to actively seek alignment at national, regional and global levels. This SDG ICT Playbook provides a good starting point from which to build ICT plans and target areas in which to build cross-sector partnerships and align efforts across sectors and geographies.





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