UN Commission on Science and Technology for Development
2013-2014 Inter-sessional Panel
2-4 December 2013
Washington D.C, United States of America

Issues Paper on

ICTs for Inclusive Social and Economic Development

ADVANCED UNEDITED VERSION

ICTs FOR INCLUSIVE SOCIAL AND ECONOMIC DEVELOPMENT

Issues Paper for the CSTD 2013-2014 Intersessional Panel, Washington DC, December 2013

Prepared by the UNCTAD Secretariat[1]

Table of contents

Foreword

The Commission on Science and Technology for Development (CSTD), in its 16th session held in June 2013, selected "ICTs for Inclusive Social and Economic Development" as one of its priority themes for the 2013-2014 inter-sessional period. The CSTD Secretariat will hold a panel meeting in Washington DC, USA, from 2 to 4 December 2013 in order to facilitate, *inter alia*, an exchange of views on this theme.

This draft Issues Paper has been prepared by the UNCTAD Secretariat,[1] as a contribution to the work of the Commission in its inter-sessional panel, in order to identify, analyse and present for discussion key issues concerning the role of ICTs in inclusive social and economic development for policymakers in developing countries. A revised Issues Paper will be prepared following the inter-sessional panel.

The Paper is structured in four sections.

- The first provides background context concerning intergovernmental engagement and key themes in ICTs for social and economic development, and briefly summarises current trends in ICT technology and markets.

[1] In collaboration with Dr David Souter, Managing Director of *ict* Development Associates and Visiting Senior Fellow in the Department of Media and Communications, London School of Economics and Political Science.

- The second identifies five emergent trends in ICTs (datafication, big data analysis, cloud computing, the Internet of Things and smart systems), which are beginning to influence the course of ICTs in development over the next decade.
- The third assesses the implications of these trends for social and economic development, and reviews public policy challenges arising from them.
- The final section considers implications of these trends for the post-2015 development agenda.

1 – Background

Intergovernmental engagement with ICTs for social and economic development

The significance of ICTs for social and economic development has been recognised for the past two decades. Emphasis was placed on the role of information and knowledge for development in the late 1990s by intergovernmental agencies including the World Bank, whose 1998 *World Development Report* identified knowledge, rather than capital, as the critical driver of economic growth and social welfare for the coming century.[2] That same year, CSTD published an influential report from Professor Robin Mansell and Dr Ute Wehn, entitled *Knowledge Societies: Information Technology for Sustainable Development*, which examined evidence for the relationship between ICTs, economic and social development and the potential for building innovative 'Knowledge Societies'.[3]

The concept of Knowledge Societies – in which knowledge becomes the principal driver of development – has also been adopted by UNESCO.[4] It reaches beyond an Information Society by emphasising the human development processes which transform information into knowledge and thereby enable governments, people and organisations to effect lasting change in economy and society.

The highpoints of intergovernmental engagement with ICT4D were the two sessions of the World Summit on the Information Society (WSIS), held in 2003 and 2005. These summits and their outcome documents:[5]

- affirmed the international community's commitment to 'a people-centred, inclusive and development-oriented Information Society;'[6]
- enthused about the potential of ICTs for enabling economic growth and social welfare;
- raised awareness of that potential, especially within developing country governments; and
- established targets and assessment mechanisms for the deployment and exploitation of ICTs up to 2015.

CSTD was given responsibility, through ECOSOC, for monitoring and assessing implementation of WSIS outcomes.

The emergence of interest in ICTs for development (ICT4D) did not take place in isolation, but in a context of long-term international concern about the challenges facing developing countries, particularly Least Developed Countries (LDCs). The Millennium Declaration of 2000 focused the attention of governments and development agencies on the Millennium Development Goals

(MDGs): eight goals concerned primarily with poverty reduction and basic needs, with eighteen targets to be achieved by 2015. These have provided the framework for international development policy within which thinking about ICT4D has evolved since 2000. ICTs were briefly included in the final MDG, but without a quantified target for achievement.

The next two years will be a critical period in the international community's assessment of both development and ICT4D. In 2015, the United Nations General Assembly will review the outcomes of the MDGs and set the framework for a new post-2015 development agenda. This will include the adoption of Sustainable Development Goals (SDGs), refocusing international and national strategies on broader societal objectives designed to meet the three core themes of sustainable development: economic prosperity, social equity and environmental viability. Alongside this general review and adoption of future development strategies, the Assembly will also review implementation of WSIS outcomes and the relationship between ICTs and other development sectors.

Although ICTs have had a substantial and pervasive impact on many aspects of economic and social life over the past two decades, the sense of their importance which is held within the ICT and ICT4D sectors is not yet shared throughout the development community. The outcome document from the Rio+20 Earth Summit, *The Future We Want*,[7] included few references to ICTs and none to their systemic impact on economy and society. Likewise, although it commends developmental uses of big data (see below), the report of the UN Secretary-General's High Level Panel of Eminent Persons on the Post-2015 Development Agenda, *A New Global Partnership*,[8] has little to say about the potential of ICTs and the Internet for enabling systemic developmental change. Unless this gap in understanding of the role of ICTs is addressed, there is a risk that the post-2015 development agenda will fail adequately to address their potential or integrate them in the next phase of international development activity. We consider this challenge in the final section of this Issues Paper.

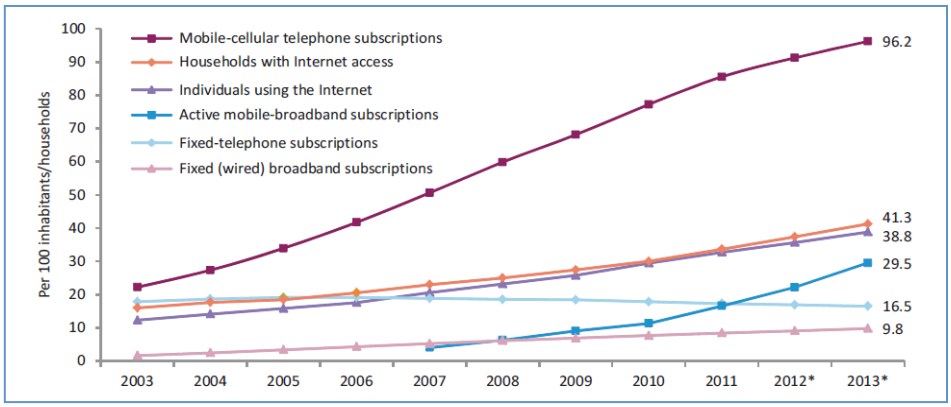
The changing ICT sector

The ICT sector is highly dynamic. Decades of very rapid growth in the capabilities of ICT components and networks have driven equally rapid innovation in technology and services. The rate of adoption of ICTs within societies, including developing countries, over the past two decades has exceeded that of any previous technology. The opportunities and challenges presented by ICTs, including the potential of ICT4D, are therefore also subject to rapid change.

The growth in ICT adoption and use is well-known, and need only be summarised briefly. Since WSIS ended in 2005, the number of mobile phone subscriptions worldwide has grown from 2.2 to 6.8 billion, just under one for every person on the planet.[9] Telephone access, which was rare in developing countries twenty years ago, is now approaching ubiquity. Internet access and use continue to grow strongly but are less ubiquitous, with only two-fifths of individuals using the Internet worldwide and only two-fifths of households having Internet access. The majority of households in developed countries now have domestic broadband access, but this remains rare in developing countries where mobile handsets have become prevalent for Internet access.[10] Overall, the ITU estimates that 77% of individuals in developed countries use the Internet, but only 31% in developing counties and only 16% in sub-Saharan Africa.[11]

The upward trend in ICT access is illustrated in Figure 1, below, which is taken from the 2013 edition of the ITU report *Measuring the Information Society.*

Figure 1: Developments in global ICT access, 2003-2013



Source: ITU, Measuring the Information Society*, 2013* (* = estimate)

The changing nature of ICT access and use was recognised in CSTD's five-year review of WSIS outcomes, published in 2011.[12] Two developments since WSIS are particularly noteworthy.

- The advent of **online social networks** has been a strong driver of Internet adoption and use in all countries, including developing countries. The most popular network, Facebook, stands with Google as one of the two most popular websites worldwide, with an estimated 1.25 billion users, accessed by around 40% of those who use the Internet each day. YouTube and Twitter also feature in the top ten websites globally and in many individual countries, including developing countries.[13] The popularity of these and other interactive 'Web 2.0' services has changed the Internet experience for many users from primarily passive (accessing information) to primarily active (posting content).

- High levels of investment are being made in **broadband networks** in most world regions, greatly increasing the capacity of connectivity. Submarine cables now provide the principal means of international connectivity for developing as well as developed countries (though there is still dependence on more expensive, lower-bandwidth international connectivity in some landlocked and small island states). International and national backbone investment is taking place alongside investment in local access networks. Mobile broadband has been the fastest growing market segment worldwide, with subscriptions in developing countries doubling in the two years to 2013.[14]

These developments contribute to very rapid growth in the volume of data transmitted over Internet and international communications. Cisco has estimated that global IP[15] traffic quadrupled in the five years to 2012, and will treble again by 2017, when the majority of data will be accessed on wireless devices.[16] Other factors driving growth in data traffic include migration of data and applications to cloud computing which has greater storage capacity (see below), and the emergence of mobile apps which facilitate data access on smartphones. Bandwidth usage is already reported to be doubling every eighteen months.[17] The 'Internet of Things' (see below) will further drive up data volumes.

The prospect of a 'data tsunami' is raising concerns among policymakers about the adequacy of legacy infrastructure and potential spectrum shortages.

Key themes in ICTs for inclusive social and economic development

As indicated in the first part of this introduction, there are different views concerning the impact of these changes in the adoption and use of ICTs on social and economic development. The enthusiasm and belief in the development potential of ICTs which has been widely shared by ICT/ICT4D specialists, and was strongly expressed in WSIS, has not become pervasive within the wider development community. The remainder of this section of the paper summarises views of the impact which ICTs have had to date on development policy and practice, and outlines eight themes in debates about that impact.

ICTs are general purpose technologies, *i.e.* technologies whose value and impact arise primarily from their use in other economic and social sectors. Three capabilities are especially important for economic and social development. ICTs:

- enable greater **efficiency** in economic and social processes;
- enhance the effectiveness of **cooperation** between different stakeholders; and
- increase the volume and range of **information** available to people, businesses and governments.

Realisation of these capabilities depends not on technology alone but on the interface between technology and other factors in development, particularly the human capabilities that are needed to take advantage of technology. Achieving an Information Society is as much about human development as technological development.

Two broad, complementary, approaches to ICTs in social and economic development can be discerned.

One focuses on the systemic impacts which ICTs have had on the development of economies, societies and culture, which are already substantial and will continue to grow in significance over time. These systemic impacts were summarised in a recent study by the International Institute for Sustainable Development.[18]

- Economic impacts include the globalisation of production in goods and services, changes in international trade and distribution networks, changes in patterns of consumption, the virtualisation of some products and behaviours, and the growing importance of the ICT sector within the world and national economies.
- Social impacts include mass market access to an enormously increased range of information resources, enhanced freedom of expression and association, the ability of citizens to bypass national regulation of markets and behaviour, new patterns of work and human settlement, changes in the relationships between government, citizen and the state, and between citizens, and associated challenges to traditional ideas of privacy and individuality.
- Environmental impacts include higher levels of waste and carbon generation, and potential mitigation of environmental impacts from other sectors.

These impacts have been more profound in developed countries than developing countries, but are increasingly visible worldwide. It should be noted that they are not all benign. Automation and

computerisation reduce employment in some sectors, while increasing it in others. The enabling power of ICTs is exploited by criminals as well as by legitimate businesses, and raises new challenges of data protection and cybersecurity. Citizens in many countries are concerned about government surveillance. And the ICT sector has become the fastest growing source of both physical waste and greenhouse gas emissions.[19]

The second perspective focuses on the potential for governments and other stakeholders to use ICTs as agents of social and economic development. It emphasises the role of technology as a driver of development which can be accelerated through investment in infrastructure, stimulation of demand for ICT devices and applications, and active intervention in the form of ICT4D programmes and projects. It is particularly evident in recent work from the World Bank's GICT division, the ITU and the Broadband Commission for Digital Development.[20] It underpins development strategies in countries like Rwanda,[21] which explicitly focus on knowledge-led development, and is at the root of many programme interventions by governments and international agencies, from the promotion of telecentres in the early years of the century, through the One Laptop Per Child programme launched at WSIS,[22] to the current focus on mobile-led applications for public health and education.

The relationship between these two perspectives is evident in a number of key debates about ICT4D which have continued during the past two decades. The following paragraphs identify eight key themes in these debates, which will continue to resonate as new forms of ICT, such as those described later in this paper, come onstream.

1. The **'digital divide'**, at international and national levels, has been a central concern in ICT4D since the ITU's Maitland Commission first explored the relationship between ICTs and development in the 1980s.[23] Developed countries have better ICT infrastructure, secure earlier ICT investment, enjoy more pervasive ICT usage, and gain earlier access to ICT innovations than developing countries. Urban areas and wealthier social groups in developing countries are similarly advantaged over rural areas and poorer communities. The use of ICTs is also significantly affected by complementary factors, such as literacy and other human skills and the availability of relevant content, which are more prevalent in more prosperous communities. These digital divides are seen as potentially more significant than comparable divides concerning other development assets because ICTs, as general purpose technologies, have an impact on other social and economic sectors: they could, therefore, potentially exacerbate economic and social inequalities.

   The digital divide has been changing over time. Ten years ago, the primary concern was basic telephone access. Rapid growth in mobile networks and devices since then means that this gap in basic access is rapidly diminishing, though concerns remain about affordability. For the last five years, concern has been growing about the growing divide at higher levels of ICTs, particularly broadband, which has come to be seen as a crucial driver of future economic growth (see below). Although there has been substantial growth in broadband networks in developing countries, it has not matched the very high rates of growth achieved in developed countries, resulting in a widening broadband gap. There is particular concern that, while middle income countries are likely to make up this difference in the short to medium term, it will be much more difficult for LDCs to do so.

2. Substantial claims have been made about the possible **macroeconomic impact** of ICTs in developing countries. Two are widely cited. Waverman *et al.* suggested in 2002 that mobile phone penetration has a strong positive impact on macroeconomic growth, and that this will be greater in developing countries where telephony was previously under-provided.[24] Qiang et al., for the World Bank, argued in 2009 that a 10% increase in broadband density is associated with a 1.38% premium in GDP growth in developing countries, higher than the 1.21% rate reported for industrial countries.[25] However, the methodology used in both studies is controversial: it includes data from years when relevant ICT density levels were very low. Different findings might result from more recent years, when broadband investment has accompanied recession. There are significant questions about reverse causality – the likelihood that GDP growth leads to investment rather than *vice versa* – and about whether late adopters of a technology like broadband will experience the same outcomes as early adopters.[26] Nevertheless, there is a general perception that improved ICT provision is likely to encourage inward investment and promote economic growth while poor provision will deter investment and inhibit growth.

3. The centrality of the MDGs in international development policy has encouraged ICT4D advocates and practitioners to identify ways in which ICTs can contribute to **MDG delivery**, particularly in social welfare areas such as health and education.[27] However, the MDGs are primarily concerned with basic needs and poverty reduction. While ICTs can make a significant contribution where basic needs are concerned, more traditional development inputs are likely to have greater impact. The principal factors in reducing maternal mortality, for example, will be improvements in maternal health and nutrition, more and better qualified midwives, and cleaner environments for mothers giving birth. In practice, more significant outcomes of ICTs may be felt where individuals and businesses have greater financial and human capacity to exploit them in order to achieve social and economic goals. Not all development activity needs to be justified as addressing poverty reduction and basic needs – as recognised in the transition from MDGs to SDGs which is at the heart of thinking about the post-2015 development agenda.

4. Experience in the past decade has shown that it is important to consider the **developmental context** for the delivery of ICT4D. Much ICT4D literature focuses on what ICTs can achieve in relatively ideal conditions. Conditions in developing countries, however, are often far from ideal, limiting what can be achieved with ICT networks, services and devices. ICT infrastructure is often inadequate or, in some districts, absent. Where it is available, it is often expensive, limiting the use of services by organisations and individuals. (Development finance may cover capital but not operational costs.) ICT equipment requires reliable power supplies, while these are often unreliable, or absent in some districts. Human resources are also critical. Many ICT projects require literacy and other human skills for effective use, while equipment also requires maintenance, upgrades, security protection and other ICT support services. These skills are often absent, particularly in rural areas.

   The net result of these constraints is that many ICT4D projects have under-performed against objectives, undermining the confidence of non-ICT development professionals. In some cases, projects have proved more valuable to wealthier and more educated community members than to the poorer groups that were their target beneficiaries. The most successful ICT4D interventions have tended to be those that have been most carefully tailored to their

development contexts, designed in partnership with target beneficiaries, implemented through accessible technologies (for example mobile phones), and incorporated operational funding from the outset.

5. Experience has likewise demonstrated the importance of the **communications context**. This is not simply a matter of infrastructure. The past twenty years have seen an almost ubiquitous restructuring of the telecommunications sector, from state monopoly to competitive, predominantly private sector, markets. Experience has shown that competition increases investment and reduces prices for telecommunications services, including Internet, resulting in more widespread access and greater social and economic gains. This requires an appropriate legal framework for the ICT sector, including pro-competitive regulation.[28]

   Communications markets are now converging with one another and with adjacent markets such as financial services. ICT policies need to be responsive to these rapid changes in technology and markets. This requires rethinking of the legal and regulatory frameworks involved. (The development of mobile money markets, for example, requires consistency between communications and financial regulation.) Many of the new services that unlock value from ICTs, such as e-commerce and e-government, require a wider range of enabling legislation concerned with electronic transactions, data protection and cybersecurity. There is therefore a strong connection between government policies concerned with the ICT sector itself and the potential for successful ICT4D.

6. Encouraged by development agencies, the governments of many developing countries have adopted **national strategies for ICT4D**. Analysis of those in Africa suggests that there are five main ways in which governments have sought to exploit ICTs' potential:[29]

   - as a driver of macroeconomic growth through improved general economic efficiency and attraction of investment (see above);
   - as a stimulant to new economic sectors such as business process outsourcing (BPO);
   - as a means of improving government administration;
   - as a means of improving public services and social welfare, for example in the health and education sectors; and
   - as a means of enhancing citizen engagement in public life.

   National strategies are generally considered effective, but have not always delivered as well as expected. Some have been over-ambitious, under-funded or under-estimated the constraints on ICT4D discussed in point 4 above. Others have been poorly integrated with overall national development strategies, or failed to respond quickly to the rapid changes in technology and markets that are taking place. Many e-government strategies have failed or disappointed because of weaknesses in planning, management and procurement, or because organisational changes required to make them work have not been incorporated in design and delivery.[30]

7. A number of different **approaches to the implementation of ICT4D** have been adopted in different countries over the past twenty years. Initially, emphasis was placed on stand-alone programmes and projects which sought to leverage the potential for ICTs in particular areas of

development. Examples have included telecentre programmes in many countries early in the century, the introduction of ICT-enabled Common Service Centres providing access to public services in India, and the One Laptop Per Child programme to offer basic computers to schoolchildren in developing countries. While programmes such as these continue to be important, there has been a growing emphasis on mainstreaming ICTs in development, *i.e.* incorporating ICTs as a matter of course in the design and implementation of all development activities in order to capture their value in improving efficiency and cooperation. This requires more attention to be paid to the balance between investment, efficiency and cost-effectiveness of ICT and non-ICT development initiatives.

A more recent discussion focuses attention on the adoption of ICTs which is taking place within society. In an influential paper entitled *ICT4D 2.0*, published in 2009, Richard Heeks argued that ICT4D policy and practice should move away from top-down programmes and projects designed to leverage ICTs in the interests of the poor and instead develop bottom-up approaches based on the widespread appropriation of ICTs by the poor in pursuit of their own social and economic welfare.[31] This 'per poor' approach resonates with emphasis on 'bottom of the pyramid' markets in the work of C.K. Prahalad and others,[32] and with renewed focus on empowerment in thinking about social development. It also reflects the emergence of interactive 'Web 2.0' services on the Internet, such as microblogs and online social networks, which have shifted the experience of connectivity from information-gathering to information-sharing.

8. Finally, the **rapid pace of change in ICT technology and markets** poses a critical challenge for ICT4D. The reach and nature of ICTs are evolving more rapidly than those of any previous technology. The growth of mobile telephony after 2005, for example, rendered some key assumptions of ICT4D at WSIS obsolete within five years, leading the ITU and the Partnership for Measuring ICT for Development to rethink indicators of progress towards an Information Society.[33] In its five-year review of WSIS outcomes, CSTD noted five 'new themes in changing times' which have emerged since WSIS – the approaching ubiquity of mobile connectivity, high levels of broadband investment, the introduction of cloud computing, the development of mobile apps and mobile-enabled services, and the advent of online social networking.[34]

   Policymakers, legislators and users of ICTs have difficulty in adapting to such rapid change in the capabilities of ICTs, including their potential as agents for development. The pace of change makes evidence-based policymaking particularly difficult as, by the time an ICT4D programme (or even pilot project) has been properly evaluated, the technology and market context has moved on. ICT4D specialists need to find ways of learning from past experience of ICT4D in ways that accommodate this extraordinary pace of change, and try to anticipate the directions which the use of ICTs within economy and society will take in future. As suggested by point 7, this may be better achieved by looking at those impacts in societal rather than in programme terms.

Much more could be said about the current state of ICTs in developing countries and the current state of ICT4D. However, the intention of this section has been to establish a context and starting point for considering the development potential of emerging trends in ICTs. We will return to the themes described above in section 3.

2 – Emerging trends in ICTs and ICT4D

As noted above, CSTD's five-year review of WSIS outcomes identified five areas in which the ICT/ICT4D context has changed substantially since 2005. This section of the paper identifies and briefly describes five emerging trends in ICTs which have the potential to drive further substantial changes in the relationship between ICTs, society and development in the five years after the WSIS review in 2015. These trends concern:

- the *datafication* of business and government organisation and practice;
- the emergence of *big data* and *big data analysis* as new resources and tools for understanding social and economic processes;
- the development and adoption of *cloud computing*;
- the extension of networks beyond people to the *Internet of Things*; and
- the deployment of ICTs in *smart systems* designed to improve the efficiency and productivity of other sectors.

The third section of the paper explores some of the implications of these trends for development, including their potential impact on the 'digital divides' between countries at different levels of development. The final section considers their implications for the post-2015 development agenda.

The context for these five trends is the continued rapid development of ICT technology and markets. For the past fifty years, the processing speed and capacity of computer processes, and many components, has doubled every two years or so, the trend known as 'Moore's Law.' As a result, even short periods of time have seen very large increases in capabilities – 32-fold, for example, in the decade since WSIS. The implications of this can be seen at three levels:

- in the capabilities of **computing**, ICT devices and resources, which are able to manipulate much larger volumes of data at much greater speeds year-on-year;
- in the volume of **data** which can therefore be usefully stored and meaningfully analysed; and
- in the capabilities of **communications** networks to transmit data between users and computer devices irrespective of their location.

The combination of greatly increased capabilities in both computation and communications has particular transformative power, enabling entirely new types of ICT service, driving innovation in the production and consumption of other goods and services, and extending the scope and scale of data analysis and information exchange in ways that impact on relationships between governments, businesses and citizens. Those that have access to these increased computational and communications capabilities have more opportunities to exploit ICTs for social and economic gain that those that do not – though these new technologies and services also pose additional challenges to them.

Datafication

Datafication is an overarching conceptual term which describes many of the changes taking place in ICT technology and markets. It is used in this paper to mean the process by which data have become

(or are becoming) the critical resource in business and government activity, not just within the ICT sector but across whole economies.

Most businesses of scale in developed countries now depend on data storage and analysis to maintain performance and gain competitive edge. To a significant degree, data and IT resources are displacing labour, and even capital, as the most important factors determining the success or profitability of business activity. While this process is less advanced in developing countries, it is nevertheless already apparent, especially in sectors with a high degree of globalisation such as financial services and telecommunications. It can be expected to spread along supply chains, requiring the engagement of small businesses as well as corporations.

Datafication is also occurring in government activity, particularly in developed and emerging market countries. Relationships between government and other stakeholders (businesses and citizens), including transactional relationships such as taxation and social welfare, are increasingly managed through centralised databases and conducted online. Governments believe the digitalisation of these relationships improves the efficiency and cost-effectiveness of service delivery (particularly where labour costs are high), and simplifies access for end-users. Datafication of government services is much less widespread in developing countries, but, as with businesses, can be expected to spread over the next decade. E-government initiatives which exploit ICTs are supported by the World Bank and other development partners.[35]

Unlocking the advantages of datafication depends on more than technology. As long ago as the 1980s, economists recognised that productivity gains do not automatically arise from ICT investments.[36] Other factors are necessary to leverage these gains, particularly organisational change that enables firms (and supply chains) to achieve the efficiency improvements which ICT investment makes possible.[37] Firms, and government departments, which fail to invest in organisational change such as management delayering, the retraining of personnel and the restructuring of supply chain and customer relations management, will fail to reap the benefits. The same is true today of datafication: organisational restructuring is essential if firms and governments are to take advantage of the analytical potential which data-led business processes make possible.

Concerns are raised about some of the consequences of datafication. The automation of administrative functions causes job losses and can make interfaces between government, business and the citizen less as well as more transparent and accountable. Computerisation of core business management functions means that a degree of control is handed over from human management to algorithms, an outcome which many find uncomfortable and some feel poses risks, especially in areas like international finance.[38] Nevertheless, the savings made and efficiencies gained by larger businesses make it clear that datafication will continue to grow in all environments over the coming period, including developing countries.

Big data and data analysis

The terms ***big data*** and ***big data analysis*** describe the accumulation and analysis of greatly increased information resources, beyond the storage and analytical capacity of conventional hardware and software tools. The market analysis form Gartner defines big data as 'high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization.'[39]

Big data have great commercial value. The business models of free online services – including search engines such as Google and online social networks such as Facebook – are built around ***data mining***, the detailed computational analysis of information supplied by users (its raw material). The information resources and analytical power of big data enable businesses to market goods and services more effectively than conventional advertising. Large retail and other businesses likewise acquire, store and mine data on their customers.

Big data and big data analysis are exploited by governments as well as commercial interests. All governments accumulate extensive databases on citizens, businesses and other organisations, through established interfaces such as national identity schemes and censuses, taxation and licencing procedures, and the education, health, social welfare and criminal justice systems. Large-scale datasets of this kind are powerful in themselves, enabling governments to identify and target financial resources on critical opportunities and challenges. They become more powerful still when they are conjoined, enabling correlations and associations to be established between them, for example between health and education outcomes, occupations and longevity. Commercial data such as those derived from social media analytics (see below) can add further to the scope, scale and robustness of such findings.

Large-scale correlations that bring together many different data sets are complex computational tasks, which require sophisticated IT applications, and are particularly suitable for cloud computing. They do not obviate the need for sample surveys or qualitative market research, but place these in a context of reliable quantitative information, particularly about whole populations, major population groups and the social and economic challenges they face, which was not previously available.

Four further points should be made about big data.

- Big data analysis can be used at both macro and micro levels. Data can be aggregated to discern trends relating to whole populations, and disaggregated to focus on specific geographical, social or economic groups, with finer granularity than previously possible. Data derived from multiple sources can be combined to give a much more detailed picture of both individual and collective needs and behaviour. As well as adding value, this raises concerns about surveillance, privacy and data protection.

- Both data and metadata ('data-about-data', such as subject headers or messaging locations) have value for analysis. The gathering and use of metadata are less intrusive and raise fewer issues of privacy than the harvesting of content.

- Distinctions between causation, correlation and association are critical to the analysis of big data. The direction of causality is often difficult to determine where development outcomes are concerned. Mistaking association for causation can lead to expensive mistakes in public policy and expenditure. Big data analysis must be undertaken with statistical expertise if it is to be of value.

- The capabilities of businesses and governments to undertake big data analysis vary greatly, depending on both access to computational capacity and human skills. Businesses such as Google and Facebook have developed highly sophisticated analytical tools and algorithms to

mine user data in order to maximise advertising revenue (and add value to users). Most developing country governments are constrained by lack of analytical capacity.

Three other forms of data gathering and analysis, which have potential value (and risks) for social and economic development, should also be considered.

Social media analytics *(SMA)* applies approaches used in big data analysis to data and metadata posted on online social networks such as Facebook, blogs, and microblogs such as Twitter and Sina Weibo. It thereby gathers and analyses information about the behaviour and sentiments of groups of users, which can be disaggregated according to geographic and other demographic criteria. This allows businesses or government departments to learn more about the uptake and salience of commercial offerings or public services. SMA advocates emphasise its potential for identifying incipient problems – for example, a heightened level of references to influenza or malaria could give early warning of an epidemic and enable early intervention in a particular geographic area. Critics argue that repressive governments could use SMA techniques to identify and target political dissidents or social minorities.

The term ***open data*** refers to the publication or public availability of data owned or financed by governments. It includes:

- publication of data, including statistics and research materials, which are the result of government commissions and/or public expenditure;
- publication of analytical materials resulting from these statistics and research materials, for example online maps illustrating pollutant levels; and
- public availability of raw data, including that resulting from big data gathering, which can then by independent as well as official analysts.

Open data policies are associated with ***freedom of information*** legislation, enacted in a growing number of countries, and accord with international agreements such as Principle 10 of the 1992 Rio Declaration on Environment and Development, which urges governments to open up information and participation on environmental issues.[40] The Internet is a highly appropriate medium for open data publication. Open data commitments are also associated by some with broader 'open systems' principles, such as open technological standards and open educational resources.

Some countries have seen the development of ***crowdsourcing***, ***citizen science****,* and similar data collection methods by governments and independent agencies. These use mass market mobile phone and Internet connections to solicit information from the general population, extending the range, diversity and scope of data collection. Examples include the collection of air, soil and water pollution data, which can be uploaded by individuals to official websites. The Kenya-based non-profit company Ushahidi has pioneered crowdsourcing techniques in non-official and semi-official contexts, such as monitoring and mapping election participation and violence, and mapping emergency needs following natural disasters. The adoption of crowdsourcing by governments and development agencies is commended by the Secretary-General's High-Level Panel on the post-2015 development agenda.[41]

Cloud computing

Cloud computing is regarded by many in the ICT industry as the next main phase of Internet development. It is a model of computing in which both data *and applications* are held in large data centres (or groups of data centres) which are remote from users' own terminal devices. Instead of locating data and applications on their own hardware, users rent access to them online as and when required. In some respects, this is similar to the client/server computing model that preceded widespread personal computing. Rather than relying on corporate servers, however, it takes advantage of the greatly increased computational *and communications* capacity now offered by global IT and telecommunications businesses.

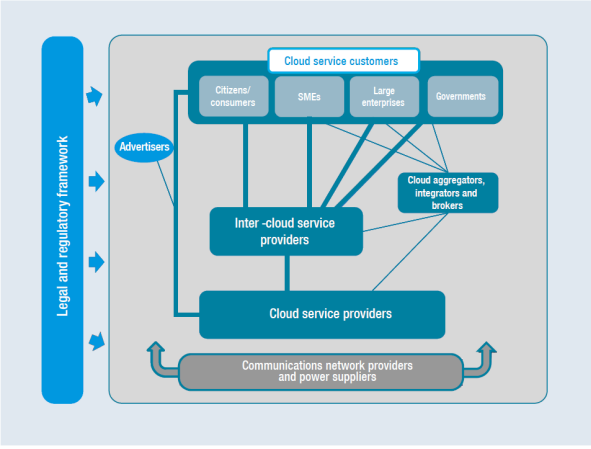
Cloud computing has numerous advantages for business and other users. Instead of spending scarce resources on hardware, software and IT management, cloud users can procure these more flexibly, as and when required, from cloud providers, increasing and reducing capacity as needed and realising immediate benefits from upgrades. Cloud-based services can also be accessed from multiple locations, using mobile as well as PC platforms. Resulting savings have been estimated at up to 40% of IT costs, though this varies substantially according to individual business requirements.[42]

Cloud computing is therefore increasingly used in business and government. Estimates of the global cloud market by media analyst Gartner suggest that this will treble in size from 2010 to 2015, rising to US$ 43.3 billion. Its competitor Forester, suggests a higher outcome, of US$ 94.1 billion in 2015.[43] These variations indicate the uncertainty attached to projections of new ICT trends such as those discussed in this paper.

As well as businesses, individuals in all countries make extensive, usually unwitting, use of cloud-based services. Google, Facebook, YouTube and Twitter all provide access to users' own and others' content from data centres in the cloud.

The potential of cloud computing for developing countries is assessed in UNCTAD's 2013 *Information Economy Report*, to be published in December 2013.[44] The cloud ecosystem which this describes is illustrated in Figure 2.

Figure 2: The cloud economy ecosystem



Source: UNCTAD, Information Economy Report 2013: The Cloud Ecosystem and Developing Countries

Key participants in this ecosystem include cloud service providers, which own and manage networks of data centres and supply cloud-based software applications; inter-cloud service providers, which exploit cloud infrastructure and programmes to develop and deliver their own services to users; and cloud-service customers, the diverse community of governments, businesses and individuals that use cloud and cloud-based services for a variety of purposes.

The economies of scope and scale associated with the cloud – large-scale data centres can cost as much as $1billion to deploy – mean that global cloud provision is dominated by very large IT companies, such as Google, Amazon, Microsoft and Apple, the majority of which are based in the United States.

There is widespread expectation that the cloud will become increasingly prevalent as a resource for both business and government, not just for data storage but also data management and analysis. Many businesses in developed countries manage their customer relations through cloud services such as those provided by Salesforce, while others make use of the increasingly varied range of cloud-based tools for development and service provision offered by cloud providers such as Amazon Web Services.[45] As the *IER* reports, use of these services is spreading in developing countries, particularly among larger businesses, while some are exploring ways of establishing a stake in the evolving cloud economy (see below).

The cost savings that can be made from the cloud are attractive to governments which have limited resources and face pressures on public expenditure. Service delivery can also be brought closer to end-users where the majority have appropriate facilities (PCs or smartphones) and reliable access to sufficient bandwidth. These factors will continue to drive the use of cloud computing, in developing as well as developed countries. At the same time, governments have concerns about loss of sovereignty over data and applications that are outsourced to global cloud providers, concerns which have intensified as a result of recent publicity concerning surveillance of Internet traffic. As reported in the *IER*, reservations over sovereignty have an inhibiting effect on cloud adoption, and provide incentives for local, rather than global cloud provision. This issue is discussed further in the next section of this paper.

The Internet of Things

The Internet of Things refers to the extension of connectedness beyond people and organisations to include objects and devices used in government, business and daily life. Businesses and administrative systems already make use of connected objects and devices, for example through radio-frequency identification (RFID) tags and the GPS systems that identify and track them. The Internet of Things takes this further by enabling communication with and between any objects or devices to which an IP address can be attached. It will enable everyday devices – 'everything from tires to tootbrushes,' according to the ITU[46] – to be connected, responding to instructions sent to them digitally, and gathering data which can be used by their owners or by others that have access.

The Internet of Things requires increased availability of IP addresses. The most current version of the Internet Protocol, IPv4, allows a maximum of 4.3 billion addresses to be allocated, slightly more than one for every two people on the planet. There is already a shortage of Internet address space in most world regions, and the Internet is migrating to a new version of the Protocol, IPv6, which enables enormous expansion in the number of addresses (to 3.4×10^{38}). This transition is taking

place more slowly than had been hoped, with only some 3.75% of websites worldwide using IPv6 in November 2013,[47] but is expected to accelerate.

Advocates of the Internet of Things expect it to enable improvements across the range of administrative and commercial activities undertaken by governments and businesses, from inventory management to distributed computing. In 2005, the ITU envisaged it leading to 'a plethora of innovative applications and services, which will enhance quality of life and reduce inequalities whilst providing new revenue opportunities for a host of enterprising businesses,' including 'tangible applications in … medical diagnosis and treatment, cleaner water, improved sanitation, energy production, the export of commodities and food security,' for developing as well as developed countries.[48]

Many of these predicted applications have yet to appear in practice. However, Internet-connected sensors are now widely used to monitor weather patterns, pollution levels, traffic management and other public policy indicators, increasing the capacity of governments to intervene in short-term crises and to develop better informed and more effective long-term policy responses. The city of Porto in Portugal, for example, has been the subject of a number of experimental initiatives to exploit the connectedness of vehicles and sensory devices to improve civic management.[49] Sensor-derived data can also be made publicly available through open data channels, reinforcing public participation in areas such as environmental monitoring and enabling people to respond more appropriately to changing circumstances.

Alongside these beneficial outcomes, however, the Internet of Things also intensifies concerns over privacy that have emerged in discussions of datafication, big data and cloud computing. The volume of data that will be generated by devices will enormously increase the data footprint which can be used by businesses and governments to track individuals' movements and behaviour. Most of these data will be invisible to those who generate them. Similar challenges are presented, and questions raised, by innovations such as the wearable computer Google Glass. For some, these innovations provide new opportunities for governments and businesses to respond to changing social and economic behaviour and needs, and to nudge behaviour towards more socially and economically beneficial outcomes. Others fear the emergence of the 'total surveillance society' envisaged in dystopian fiction.

Smart systems

Smart systems are industrial and other processes which use the capabilities of ICTs to enable more efficient production, distribution and consumption of goods and services. An early example was the adoption of 'just-in-time' production techniques to minimise inventory costs in the 1980s. Outcomes from improved efficiency should include lower costs, reductions in the environmental footprint of industrial processes (including waste of natural resources, waste generation and carbon emissions), and increased availability and affordability of goods and services across communities.

The potential for smart systems has been explored by the business-led Global e-Sustainability Initiative (GeSI). In an influential report in 2008,[50] it identified four sectors in which it anticipated that high levels of both financial and carbon savings could be made as a result of ICT deployment. These were:

- smart motor systems – the automation and monitoring of production processes in manufacturing;
- smart logistics – improvements in the management of transport and storage;
- smart buildings – improvements in building design, management and automation, including sensor systems and remote control of building devices through the Internet of Things; and
- smart grids – better monitoring and management of electricity generation and distribution.

The potential of smart systems, and their interaction with the other trends discussed above, can be illustrated through two examples.

International trade in goods occurs along lengthy supply chains which include many different transactions and stakeholders. As well as those producing, despatching and receiving a consignment, it is handled by transport and other intermediaries in countries of origin, transit and destination, shipping and airfreight businesses in ports and airports, and government agencies concerned with customs, immigration, quarantine and security. Every interaction between these causes delay, raising transaction costs and the final price of goods. Interactions at checkpoints and border crossings increase opportunities for corruption and fraud. These inefficiencies are particularly problematic in Africa, where checkpoints are frequent, delays lasting several days are common at border crossings, and ports and airports are often under-equipped to meet demand.

ICTs are increasingly used to reduce inefficiencies in international trade in goods. RFID and GPS technologies track consignments along transit routes, in order to minimise the need for checkpoints. Automation of data sharing and recording substantially improves cost-effectiveness and fraud prevention. 'Single window' data-sharing systems, which allow data to be entered once and then used throughout supply chains, have considerable potential for reducing costs and are beginning to be installed at developing country ports and border crossings.[51]

GeSI defines a smart grid as 'a set of software and hardware tools that enable generators to route [electrical] power more efficiently, reducing the need for excess capacity and allowing two-way, real time information exchange with … customers for real time demand side management.' This, it claims, 'improves efficiency, energy monitoring and data capture across the power generation and [transport and distribution] network.' ICT resources involved include sensors, smart meters (providing real-time monitoring of usage), grid management systems and power load analysis, and advanced communications to enable energy providers to pool resources and manage fluctuations in demand. GeSI estimates that smart grids could reduce losses in power transport and distribution in a country such as India by 30%, achieving substantial financial and carbon savings.[52]

The scope for innovations such as these is, naturally, greatest in societies with high levels of power usage. They also require substantial capital investment, and are best-suited to communications networks in more developed countries, where they can exploit datafication, cloud computing and broadband connectivity. However, their value in developing countries should not be under-estimated – particularly those with high rates of economic growth and demand for electric power, such as China.

Looking ahead

The five emerging trends in ICT technology and application discussed in this section of the paper are already influencing government policy, business practice and economic and social outcomes in developed countries. Their potential for doing so in developing countries is assessed in the following section.

The emergence of these trends since WSIS illustrates the pace of change in ICTs and ICT4D. Like previous waves of innovation in the ICT sector over the past twenty years, these trends are stages in an ongoing process of rapid development in technology and markets. There is nothing to suggest that the capabilities of hardware, software and communications networks will not continue to double every two years or so, further increasing the scope for services such as those described above and opening up the potential for others which are currently in development. Within the next ten years, there will undoubtedly be other innovations whose evolution we cannot reliably predict today, though glimpses of them may already be apparent. New kinds of interface between people and devices, such as Google Glass, speech-based computing and automated translation suggest some of the directions in which consumer technology and applications may move. At a more fundamental level, the World Wide Web Consortium advocates development of the 'semantic Web', which would (or will) enable automated agents to access the Web and perform tasks on behalf of users, without their direct intervention. The development of self-regulating algorithms, research into artificial intelligence and the concept of organic computing are other areas at the boundaries of the evolution of ICTs which future intersessional panels of CSTD may wish to discuss – in terms of their ethical as well as their developmental implications.

Policymakers and business users of technology need to recognise, therefore, that the opportunities and challenges presented by datafication, cloud computing and the Internet of Things are not final destinations for policymaking or investment. The potential of these trends will evolve with continued growth in the capacity of the computing and communications technology on which they depend, and will be joined by opportunities and challenges arising from further waves of innovation in ICT technology and markets. Government policies and business practice need to be continuously adaptive if they are to take advantage of the opportunities and keep abreast of the challenges that arise as these technological advances impact on economy, society and culture. This poses real difficulties for governance institutions which are designed to operate at the pace of human rather than digital decision-making.

3 – The social and economic potential of emerging trends

The third section of this paper explores the implications of the emerging trends described in the previous section for developing countries and their social and economic development. The first part of this section summarises the potential developmental implications and likely significance for development of the five trends described in section 2. This is followed by discussion of their potential impact on the digital divide, and of communications and public policy requirements for maximising their value for development.

It should be emphasised that, as these trends are still emerging, the evidence base concerning their application is very limited, and there has been insufficient time to date for substantive impacts to be measured. A significant amount of advocacy literature has been published, much of it by ICT suppliers and market analysts, which focuses on potential expansion in trends such as cloud computing. Some projections of potential benefits have also been made by ICT4D-focused agencies such as ITU and the Broadband Commission.[53] However, there is little independent analysis so far that relates trends such as big data and cloud computing to the constraints facing developing country governments in deploying them. Much of the assessment of implications for development that is available infers likely outcomes from early experience in the more propitious environments of developed countries. Systematic research into these new trends, as they increase their significance in developing countries, will be essential to building a better understanding of the opportunities and risks they pose for development.

Development implications of emerging trends

The opening section of this paper suggested that ICTs have already had profound impacts on economy, society and culture. The adoption and use of ICTs throughout society has had systemic impacts across the range of human activity: in patterns of economic production, distribution and consumption; in access to information and knowledge; in the dynamics of social relationships; in the relationships between government, business and citizens; in patterns of work, leisure and human settlement. Government and donor programmes designed to exploit the potential of ICTs have sought to intensify these outcomes in critical aspects of social and economic development. While the impact of ICTs has been greatest in developed countries, it has also been substantial in developing countries, including LDCs, and even – thanks to the widespread availability of mobile phones – in very poor communities within those countries.

The five trends described above are emerging, therefore, in a developmental context which has already been profoundly affected by ICTs. The previous section of this paper outlined broad characteristics of each of these five trends, summarising some of their potential advantages and disadvantages, and including brief illustrative examples of their application. The following paragraphs build on this earlier discussion, summarising the potential scope of each in turn for social and economic development.

The processes of ***datafication***, which put information and knowledge at the heart of government and business decision-making, reflect some of the aspirations which have underpinned discussions of an Information Society or Knowledge Societies over the past twenty years. These discussions have anticipated that more information will lead to better decision-making, including more appropriate policymaking, more efficient deployment of land, labour and capital, more innovation in social and economic activity, and more empowerment of individuals (including the poor) to take control of their own lives and livelihoods.

This acquisition and analysis of data on a scale which was not previously available provides a platform for better-informed policymaking and better targeting of services by governments. Other things being equal, this should increase the prospects of social and economic development interventions achieving their objectives. Whether they do so in practice, however, will depend on a number of complementary factors – the quality of data-gathering, which has historically been poor

in developing countries; the availability of analytical expertise which can draw appropriate conclusions from available data; the political will to implement inclusive development policies that emerge from better information; and the financial resources and implementation capacity to deliver developmental outcomes in the challenging social, economic and geographical contexts concerned.

Datafication, therefore, provides a platform for improvements in development policy and practice, but is insufficient in itself to bring about positive developmental outcomes. The concentration of data gathering and ownership in large business and governmental institutions can also be problematic. Both Information Society and Knowledge Society concepts anticipated the democratisation rather than concentration of information, empowering individuals to take more control of their lives rather than becoming more dependent on decisions from above. At the same time as datafication increases the amount of information available to decision-makers, the expansion of mobile phones, the Internet and online social networking are increasing information access and sharing amongst ordinary citizens. The interface between these two levels of information gathering and use will be crucial to the inclusiveness and effectiveness of future development interventions.

Much of this analysis of datafication affects the other trends discussed in this paper. The value of ***big data* and *big data analysis***, compared with previous information sources, is that they enable policy decisions to be made on the basis of data covering whole populations rather than samples, and that they allow the combination of multiple data sets in ways that can identify meaningful associations between different aspects of social and economic development which would not otherwise be apparent. This in turn allows more granularity in analysis, policy and practice: data concerning whole populations can be more precisely disaggregated according to geographical location, gender, age and other social categories, allowing interventions to be more effectively targeted on the needs and circumstances of communities at both national and local (*e.g.* urban) levels.

This should improve the effectiveness of developmental interventions. The UN Secretary-General's High Level Panel on the Post-2015 Development Agenda recognised the potential of big data in its report, *A New Global Partnership*, which called for 'a data revolution for sustainable development, with a new international initiative to improve the quality of statistics and information available to citizens.' Better data, both aggregated and disaggregated, the Panel argued, 'will help governments track progress and make sure their decisions are evidence-based,' as well as enhancing public accountability.[54] However, its value can only be unlocked if other developmental factors are addressed – if data gathered are accurate, reliable and up-to-date; if national statistical offices are capable of analysing them effectively; if decision-makers are prepared to engage with development needs suggested by analysis; if financial and logistical resources are available to target resources as required.

Other ICT-enabled data gathering methodologies, including ***social media analytics*, *crowdsourcing* and *citizen science***, likewise add to the scope and range of data available for analysis, policymaking and the design of interventions. Social media analytics enables data on attitudes and behaviour to complement other data sets, though it should be remembered that social media users are not representative of communities in general. Crowdsourcing and citizen science enable data to be collected from locations where this might not otherwise be possible, complementing sensor and

other data sources. Ushahidi's experience has demonstrated the potential value of crowdsourcing in diverse contexts, notably in facilitating disaster recovery – it was instrumental, for example, in targeting support for victims of the 2010 earthquake in Haiti[55] – though all crowdsourcing initiatives are vulnerable to challenges of data quality and manipulation.

One important value of crowdsourcing is that it engages the wider public in data gathering, thereby increasing public participation in decision-making processes. The publication of ***open data*** is often seen as likewise enabling wider public participation because it allows anyone who can access information to analyse it on their own behalf or that of local communities. Open data are seen as having particular value, for example, in enabling citizens and civil society organisations to track public expenditure, increasing transparency and accountability and thereby inhibiting corruption.[56] Publication of pollution data enables citizens to protect their own health as well as to coordinate protest. Open data also encourage academics, civil society organisations and other interested parties to scrutinise public policy decisions in greater depth, leading (if politicians take notice) to better quality decision-making which is more relevant to local communities.

While open data legislation has been enacted in many jurisdictions, there have been problems in implementation. The Kenyan government's Open Data Initiative, sponsored by the World Bank, has been widely praised, but has encountered resistance from government officials schooled in earlier, less inclusive governance traditions.[57] Open data is also not a free facility. Significant expenditure is incurred by governments in establishing and maintaining websites and in preparing data for publication. Some commentators have questioned whether governments should forgo potential revenue streams by offering data freely when the most substantial users may be commercial businesses using it for market research and segmentation, who would be willing to pay for access.[58]

There are risks in over-extending ICT-enabled data gathering and publication resources. Big data and especially social media analytics can be used to exclude communities from developmental benefits, as well as to include them, while SMA in particular can be used to target political dissidents. The combination of multiple data sets has enormous potential for targeting resources, but also raises privacy concerns and data protection challenges – a dilemma, for example, for India's unique identity programme.[59] More data are not always more useful than less, and can lead to less efficient use of resources. Intelligence-led customs inspections, for example, tend to achieve higher detection rates than inspections of all travellers, because they focus limited resources where they are most relevant. Too many data can overwhelm the capacity of individuals or community organisations to analyse and use them for their own purposes. It is important, therefore, for governments and their development partners to think through the implications of trends concerned with data analysis, to identify where they are most likely to add value to national development and focus resources accordingly. Nevertheless, data initiatives have allowed new analytical and participative mechanisms to be developed by both governments and independent agencies, and helped to broaden participation in policymaking, trends that will continue into the future.

Some of the same points apply to the ***Internet of Things***, which promises to extend enormously the volume of information which can be incorporated in big data, allowing even more detailed analysis of individual and collective behaviour. While these data sources may improve the results obtained by both governments and commercial businesses, the prospect of living in an environment of

interconnected devices, each of which records and retains data relating to individual behaviour, is beginning to raise significant concerns about privacy and surveillance in developed countries.

In developing countries, in the short term at least, the principal impact of the Internet of Things is likely to be more narrowly focused on specific developmental applications, some of which have already been mentioned in this paper. RFID tags and GPS, which can facilitate the monitoring of trade consignments along supply chains, can be used to improve efficiency in many other ways, for example in maintaining adequate supplies of educational materials and drugs in schools and clinics. Similar devices can be attached to selected vehicles, such as buses or taxis, enabling real-time information to be gathered about traffic flows and thereby better traffic management to be effected – a major challenge in large, complex urban environments with poor infrastructure. Sensors are increasingly widely used to monitor weather, pollution levels and soil fertility, helping to protect communities against environmental risks and enable them to improve their productivity. In the longer term, they will play an important part in monitoring the effects of climate change, enabling more appropriate adaptation. There are many other aspects of social and economic development in which such applications can have value.

Smart systems have some similarities to the Internet of Things. Though they operate at a much larger scale, and incorporate a wider range of ICT technologies and applications, they often rely on the monitoring of individual devices (such as smart electricity meters) to gather data and maximise service efficiency. The introduction of smart systems will be most effective where there is already a high level of technology within industries and utilities, and is most likely to take place where investment will yield relatively early financial returns (for example where it displaces high labour costs). For these reasons, deployment of smart systems is more likely in developed and in emerging market countries than in developing countries which have less widely distributed utilities and lower labour costs. There is, nevertheless, a strong case for developing country governments incorporating smart systems into modernisation and expansion programmes for utilities such as electricity, in order to improve resource efficiency, save costs, and reduce the incidence of power outages.

Cloud computing provides important resources for the other trends discussed above. The computational resources required for big data analysis and managing smart systems can be made available most efficiently in large-scale data centres and agglomerations of data centres, whose capacity exceeds that available within individual companies or to the governments of most developing countries. Sharing access to such large resources with other users enables clients, including governments, to benefit from the large economies of scale available. Being able to access resources flexibly, increasing and decreasing operational expenditure as required without incurring one-off capital investment costs, is attractive to financially-pressed developing country governments. Renting data storage and access to applications located in the cloud can therefore yield substantial savings in hardware, software and IT management, as well as enabling levels of data analysis that would not otherwise be achievable.

These benefits arise for public institutions, such as universities, as well as for governments in general. National Research and Education Networks (NRENs), for example, are natural beneficiaries of the cloud, which facilitates joint working with academic and research institutions in other countries. Universities can exploit the cloud to make a much wider range of educational materials,

books and journals available to their students than can be provided in physical libraries. Clinicians, likewise, can access medical journals which would otherwise be unavailable to them, improving standards of health practice. There is an ever-increasing range of information and interactive services, provided by intermediary cloud-based service providers and available through smartphones as well as through computers – including services designed by developing country businesses for users in their own countries.

There are, however, downsides to cloud computing that concern many governments and some businesses. Recent revelations concerning international surveillance have intensified anxieties over data sovereignty, making governments (and some businesses) less willing to locate data outside national territory. The economies of scale in cloud service provision are such that the market in cloud services is dominated by a small number of global IT corporations, mostly located in the United States. Lack of standardisation in cloud-based systems means that it can be difficult for users, such as governments, to migrate data and applications, raising fears that they will become locked into uncompetitive contracts. Reliance on cloud-based services also depends on the quality of national communications and power infrastructures. Affordable and reliable broadband infrastructure, with sufficient capacity, is essential. Government departments and other users cannot afford to lose access to their data because of communications network failures or power outages.

The implications of the cloud economy for developing countries have been comprehensively assessed in the 2013 edition of UNCTAD's *Information Economy Report*, which will be published in December. This report recognises that the cloud economy offers significant potential benefits which are already being realised by some businesses and government departments in most developing countries. It recommends that governments should welcome these and seek to facilitate access to the cloud from national communications environments, by addressing infrastructure, legal and other constraints which currently discourage it (see the final part of this section of the report, below). It also identifies a number of potential business models through which developing countries may be able to take advantage of the cloud.

- In some countries, it may be possible to establish national data centre markets, meeting the expressed need of some governments and businesses to retain data in-country while still accessing applications offered by global cloud providers. The Government of Kenya has commissioned data centres to provide facilities not just for government departments but also for national/regional businesses concerned about data sovereignty.
- In many countries, there is scope for the development of cloud aggregation or brokerage services, which can offer businesses and government departments a single point of access to a variety of services offered by different cloud providers. This would help to overcome the reluctance of many potential users to manage a variety of complex agreements with such providers.
- Most developing countries have businesses with the potential to establish cloud-based services, including information and/or interactive services, targeting national or regional user groups, including local businesses. Many of these can be built around software programmes available from cloud providers such as Amazon Web Services. Others can make use of software development platforms offered by providers.

Cloud computing is still evolving and its future development is difficult to predict. Many in the ICT sector believe that it will become the predominant mode for data and applications access in the medium term. For users in developed countries, with fast, cheap international connectivity, economies of scale give global cloud providers a substantial competitive advantage over local alternatives. As the *IER* points out, this advantage may be less significant in developing countries, where slower and more costly international connectivity increases the proportion of the cost of cloud computing which results from communicating with the cloud. Along with concerns about data sovereignty, this may encourage the establishment of local data centres. However, the capital costs required to establish data centres are very high. As with other ICT investments, therefore, they are most likely to be established in larger developing countries or countries which are more prosperous and have established ICT resources. Cloud provision also requires high levels of expertise in cybersecurity, which is available in relatively few developing countries.

Emerging ICT trends and the digital divide

The trends considered in this paper have the potential to enhance the impact of ICTs on social and economic development, described in its first section, moving society closer to the Information and Knowledge Society models first envisaged in the late 1990s and at WSIS. Very rapid growth in data availability enables much greater analysis of society as a whole, as well as even wider access to information and knowledge for citizens and non-governmental actors – though the impact of these depends substantially on the availability of statistical and analytical skills within government and population. Cloud computing is likely to have profound effects on business costs and the ability of small firms to innovate, as well as on global patterns of production, distribution and consumption – though it may also concentrate ICT infrastructure and resources in a relatively small number of global businesses. The Internet of Things, as it develops, will reshape the relationship between people and the devices on which they depend. Smart systems, if they can be effectively enabled, could have substantial impacts on the costs and environmental consequences of non-ICT infrastructure, stimulating development and affecting global policies on sustainability and climate change.

While the five trends discussed in this paper can be distinguished from one another, it is also clear that they are closely inter-related. All five are enabled by the extraordinary growth in capabilities of computing and communications technologies which has occurred over the past decade. As a result, they have the potential to improve the efficiency, coordination and cost-effectiveness of established business and government practice, *and* to enable business and government activities which were previously unfeasible. In order to achieve this, however, they require access to reliable, high-quality infrastructure, which is not yet fully available in developing countries. The implementation of outputs from these processes, and their translation into practical outcomes such as new business models and government programmes, also depends on the quality of governance, human capabilities and financial resources available for development. This has significant implications for the digital divide.

As discussed earlier, there has been a shift in international concern about the digital divide in the past five years as a result of approaching ubiquity in basic mobile telephone access. While the gap between developed and developing countries in basic access has narrowed, the gap in broadband networks and services has been growing. Very high levels of investment in developed countries

have enabled them to establish near-ubiquity in broadband access and are driving continual upgrades in the quality and speed of networks. Even though most developing regions are seeing significant investment, broadband access remains limited in most and rare in some developing countries. Projections suggest that, while middle-income and emerging market economies are likely to reduce the broadband gap between them and developed countries in the medium term, Least Developed Countries are likely to be more disadvantaged, with the result that the digital divide between emerging market economies and LDCs may widen.

The growing broadband gap causes concern because broadband communications networks are essential for enabling developing countries to make use of more sophisticated ICT services and applications. This is particularly so where the new trends discussed in this paper are concerned. To be effective, these all require reliable, high-quality broadband networks capable of consistently transmitting very large volumes of data at low prices both nationally and internationally. Reliability in this context includes redundancy (alternate routings in the event of network failure) and adequate power supplies to maintain equipment at full operating levels.

As general purpose technologies, ICTs have impacts on the efficiency and effectiveness of all development sectors. Better, more affordable connectivity enables greater efficiencies to be achieved and new services to be deployed. Where these efficiencies and services improve outcomes in other sectors, then digital divides are likely to exacerbate the gaps in development outcomes between more and less well-provisioned countries (and districts within countries). The high reliance of trends such as cloud computing and smart systems on broadband infrastructure means that their positive impacts are likely to be felt more intensively in developed than in developing countries, and more intensively in middle-income countries than in LDCs. A growing broadband digital divide could therefore exacerbate other development divides.

At the same time, it should be remembered that not all economic sectors are equally affected by ICTs. LDCs in general are more dependent on raw material extraction and agriculture, and less dependent on manufacturing and services, than developed countries. These dominant sectors are less susceptible to ICTs. There are still substantial gains to be made in LDCs from the wider deployment and application of basic ICTs, which have already been harvested in developed and middle-income countries. While these factors may mitigate the impact of later broadband deployment in lower-income countries, they do not obviate the importance of broadband investment for unlocking the benefits of the new trends discussed in this paper, not least for economic diversification and social welfare.

It should be remembered, also, that the digital divide results substantially from the pace of innovation in ICT technology and markets. New infrastructure will always be deployed first where it is most likely to secure a rapid return on investment, and new services will always be bought first by those that can most readily afford them. It is important, therefore, to focus not just on absolute levels of access to broadband and other ICT resources, but also on *trends* in access development. Developing countries which exhibit strong positive growth in ICT capabilities are better placed to take advantage of ICTs, including the emerging trends discussed in this paper, than countries which lack that positive growth trajectory.

Public policy requirements for maximising the value of emerging trends

Two conclusions can be drawn from the above discussion from the perspective of overall government policy.

The first concerns the value of governments taking an holistic view of the relationship between ICTs and development. ICTs have already had profound effects on economy, society and culture, and the depth of those impacts will grow with the increasing pervasiveness of ICTs and the continuing emergence of new applications and services such as those described in this paper. These effects, however, do not take place in isolation, but in a context of other important changes in world society, including the shift in global economic power from West to East and North to South, continued growth in population and the impact of scientific advances in medicine and food security, and the threats posed by climate change, environmental pollution and the depletion of natural resources. Governments need both to acknowledge the increased and increasing importance of ICTs and to recognise that their impact is integral to the complex dynamics of political, economic, social and environmental change that are occurring and will continue to occur as the present century proceeds.

Secondly, if they are to equip their societies to secure maximum value from the trends described in this paper, governments need to pay attention to the enabling environment for ICTs and ICT4D. Businesses and government departments which wish to place datafication at the centre of their operations must have computing and communications resources capable of handling the scale of data analysis and complex business operations that arise. Big data analysis can only be undertaken with high levels of computational capacity and appropriate human skills in designing algorithms and interpreting results. Reliance on cloud computing, beyond basic services like search and social networks, depends on the availability of high-quality, reliable broadband communications networks. The Internet of Things will greatly increase bandwidth and spectrum requirements. Smart systems can only be implemented in a context of high-performance infrastructure, as well as capital investment in new technology and high levels of professional management expertise.

Infrastructural investment is therefore crucial to developing countries' capacity to engage fully with these trends. The bulk of this investment will come from the private sector, as with most telecommunications infrastructure for the past twenty years. However, the scale of capital investment required for broadband upgrading is very substantial. Private sector communications businesses focus on countries where they expect to achieve high short-term returns on investment, and on urban and industrial areas within them. There has therefore been a trend towards renewed investment in infrastructure by governments, with the support of International Financial Institutions and/or equipment/network vendors. The World Bank, for example, has invested in the development of a regional backbone network for the under-resourced and under-connected Central African region.[60] The government of Tanzania has developed its national backbone with the support of a Chinese network equipment vendor.[61]

Network access also needs to be affordable and reliable, not merely available. Developing country networks and services are typically more costly than those in developed countries, inhibiting adoption of services such as cloud computing. There is also less competition in broadband provision in developing countries. Regulatory mechanisms such as open access to backbone infrastructure, infrastructure sharing and requirements for cost-based interconnection can play an important part in enhancing competition and reducing prices.

Businesses that rely on data communications and cloud computing also need infrastructure to be reliably available. Sufficient redundancy needs to be built into networks to ensure that infrastructure failure at one point does not cut off all connectivity. Low levels of latency – the time delay between parties to a connection – are also important in maximising the value of broadband connectivity for cloud computing. These can be lowered by the introduction of country-level Internet Exchange Points.

Infrastructure alone is insufficient to enable the effective deployment of the new ICTs discussed in this paper. Experience in developed and developing countries shows that appropriate **legal and regulatory environments** need to be established that enable government agencies and businesses to take advantage of trends like cloud computing. There are four main components to this.

- Legislation and regulations are required that enable ***digital transactions and exchanges*** to take place effectively. Although there are international models for such legislation,[62] it has still not been enacted in many developing countries, inhibiting the spread of electronic commerce. Banking and other business cultures also need to adapt to the requirements of business digitalisation.

- A positive enabling environment is also needed for ***business development and innovation***. Many developing countries rank poorly in the World Bank's *Doing Business* index which measures the flexibility of business regulation. In even neighbouring countries in Africa, the time required to launch a new business can vary from a few days to almost a hundred.[63] Governments need to reduce bureaucratic constraints on business innovation in order to encourage adoption of ICT-enabled opportunities. Businesses need to respond by making the organisational changes required to take advantage of them.

- Legislation concerning ***data protection, data sovereignty and cybersecurity*** is also crucial. Datafication results in much more information being recorded and retained about business and personal behaviour than previously. Data subjects need confidence that these data will be used for their benefit rather than intrusion, and that they are not susceptible to hacking and criminal activity. Governments are concerned about data sovereignty, particularly following revelations of international surveillance and about the risks to national online environments from cyber-attacks.

- ***Open standards*** play an important part in encouraging innovation, through interoperability between ICT hardware, software (both proprietary and open source) and business systems. United Nations agencies such as UNESCO have advocated openness as a more general principle, for example by encouraging open educational resources.[64]

Governments need to have a thorough understanding of their national communications and development environments, when designing policies and programmes to take advantage of ICT4D. International experience can also be valuable, but needs to be treated cautiously. Later adopters of new technology can often learn from the experience of early adopters, both positive and negative, but should remember that policies and programmes need to be tailored to their national circumstances and needs, which may differ considerably from those that they consider potential models. Particular attention needs to be paid to the constraints affecting the deployment of ICTs, including limited infrastructure, power, financial and human resources. Just as important is the pace

of change in ICT technology and services. What can be done today in one country is different from what could be done, in the same or any other country, two years previously, and different again from what might be achieved in two years' time, when the capabilities of computing and communications equipment will have doubled yet again.

4 – ICTs and the post-2015 development agenda

As indicated at the start of this paper, and not just for this reason, the next two years will be a critical period in the evolution of international cooperation on social and economic development, including the role of ICTs. In 2015, the United Nations General Assembly will review the achievements and failures of the Millennium Development Goals (MDGs), which have guided global policy on development with a strong focus on poverty reduction and basic social welfare, since 2000.[65] The Assembly will adopt a new post-2015 development agenda, drawing on its analysis of the MDGs, other evidence such as that provided by the Secretary-General's High Level Panel of Eminent Persons on the Post-2015 Development Agenda,[66] and input from other UN processes, particularly the Rio+20 Earth Summit. As agreed in Rio, Sustainable Development Goals will form a central part of the post-2015 agenda, and work is already underway to develop proposals for those Goals.[67]

The WSIS+10 review of ICT-related goals and outcomes will take place within this context, and is already underway. The first WSIS+10 event was organised by UNESCO in February 2013,[68] and a High Level Event is being organised by the ITU in association with its World Telecommunication Development Conference in April 2014.[69] A statistical assessment of WSIS outcomes will be published during 2014 by the Partnership on Measuring ICT for Development. Final arrangements for the review of WSIS outcomes will be agreed by the General Assembly.

The confluence of these reviews provides an opportunity for the significance of ICTs to be incorporated more realistically and systematically in the global development agenda than has been the case to date. Existing literature and commitments, including those within the UN system, show something of a paradigm gap between advocates of ICT4D and mainstream development thinking. ICT and ICT4D organisations, including the ITU, the Broadband Commission, the Global ICT division of the World Bank and agencies such as *info*Dev, have placed high emphasis on the potential agency of ICTs in achieving social and economic development gains, including the Millennium Development Goals. Their enthusiasm has been reflected in more long-term visions of ICT-enabled development, such as the Knowledge Societies concept pioneered by CSTD and by UNESCO.

Although ICT and ICT4D organisations have paid substantial attention to the WSIS+10 review, however, this has not been reflected in other inputs to the post-2015 development agenda. Very little attention was paid to the systemic impact of ICTs on economy, society and culture in the Rio+20 report, *The Future We Want*,[70] or in the report of the Secretary-General's High-Level Panel, *A New Global Partnership*,[71] though the latter does commend the value of datafication and big data analysis. ICTs receive only limited recognition, as useful technologies, in the *Action Agenda for Sustainable Development* published by the UN Sustainable Development Solutions Network.[72]

This final section of the paper suggests two ways in which ICT and ICT4D specialists can address this paradigm gap, which is growing in importance as a result of the trends discussed earlier in the paper.

- The first is to tackle the lack of emphasis on ICTs in global processes concerned with social and economic development, increasing the visibility of their impact on economy, society and culture, and thereby on development in general.

- The second is to focus the attention of ICT and ICT4D specialists on the emerging priorities of the post-2015 development agenda.

Recent work by the International Institute for Sustainable Development, discussed earlier in this paper, has drawn attention to the systemic impact of ICTs on economy, society and culture – particularly on patterns of economic production, distribution and consumption; the availability of information and opportunities for expression at all levels of society; and relationships amongst citizens and between citizens, their governments and the businesses and other organisations with which they interact. This systemic impact represents, in many ways, the advent of the Information Society that was envisaged at the time of WSIS and of progress towards the kind of Knowledge Societies, in which information, information technology and the knowledge that they generate play a leading role in social and economic development, which were anticipated by CSTD as long ago as 1998.

The fact that ICTs have only recently gained developmental significance may account, to some extent, for their subdued profile in discussions about the post-2015 development agenda. These discussions build on earlier formulations of development policy. The Rio+20 Summit, for example, took as its starting point the conclusions of the original Rio Summit in 1992, while the principal reference point for the Secretary-General's High-Level Panel was the MDGs that were agreed in 2000. Both of these reference points pre-date the WSIS Summits, and neither anticipated the scope or scale of change which has taken place in ICTs since then, let alone the further wave of new developments discussed above. Where documents such as the UN Sustainable Development Solutions Network's *Action Agenda for Sustainable Development* do recognise the significance of emerging ICTs, they do so as exemplars of the value of technology rather than relating them to longer-term processes of social and economic change.[73]

It has proved challenging to establish a clear narrative concerning the relationship between ICTs and the MDGs, which have been the foremost drivers of international development activity this century. The MDGs were and are primarily concerned with basic needs – reducing the numbers of people experiencing absolute poverty and hunger; securing universality (including gender equality) in access to basic resources such as education, healthcare, water and sanitation; reducing infant and maternal mortality and the incidence of HIV/AIDS, malaria and other diseases. The most important impacts on these Goals were always likely to come from basic interventions using familiar development resources – improved hygiene and nutrition, for example, the supply of condoms and mosquito bed-nets, or financial support to enable free primary education – rather than from new technology.

This is not to deny the significance of ICTs for basic needs. Mobile phones have had demonstrable value in reducing vulnerability, by making it easier for individuals to seek financial and other support and to maintain family relationships at a distance.[74] ICTs can and have played an increasingly

significant supportive role in facilitating MDG delivery through applications including logistics management, health promotion and clinical support. Much has been made of that role by agencies concerned with ICT4D.[75] However, the emphasis of development discourse on the MDGs and poverty reduction may have obscured the greater significance which ICTs have had on those at higher income levels and on society more generally. ICTs are inherently likely to offer greater opportunities to those with the income, literacy and other skills to maximise their value – from farmers using mobile phones to improve the cost-effectiveness of their supply chains to young entrepreneurs setting up cybercafés in urban markets.

The Millennium Declaration did include a passing, generic reference to ICTs in its eighth and final goal, which reached beyond basic needs towards a 'global partnership for development'. This goal's sixth and final target (8F) called on governments and the international community, 'in cooperation with the private sector, [to] make available benefits of new technologies, especially information and communications.'[76] Target 8F has provided a locus within the MDGs for international cooperation on ICTs in development, which can be viewed alongside the targets that were agreed at WSIS and the wider WSIS objectives that have been monitored by CSTD.[77] A variety of international fora for cooperation on ICT4D have been established, bringing together international actors from public and private sectors and from civil society, including the explicitly multistakeholder annual WSIS Forum and Internet Governance Forum (IGF).[78] Cooperation between international agencies and the private sector has been most prominent in the Broadband Commission for Digital Development, established in 2010 by the ITU and UNESCO with a high level of participation from very senior figures in the ICT sector.[79]

The challenge for this and other ICT4D advocacy bodies has been to bridge the gap between their concern with ICT4D and the broader social and economic development objectives which will determine the post-2015 development agenda. The following paragraphs suggest two broad themes which may have the potential to bridge this gap – the Sustainable Development framework which emerged from the Rio Summit in 1992; and the Knowledge Societies concept which was initially identified by CSTD and subsequently developed by UNESCO.

The Sustainable Development framework asserts that sustainable development can only be achieved if it brings together three distinct but inter-related objectives – economic prosperity, social equity and environmental sustainability. The challenge of enabling all three objectives simultaneously has proved difficult, particularly balancing economic prosperity with environmental sustainability. However, the systemic changes in economy, society and culture described in the IISD report, which can be encapsulated as an emerging Information Society, have substantially affected all three of them. They have altered processes of economic production, distribution and consumption; changed social relationships, including those between government and citizen, enabling new social dynamics to emerge; granted greater information access at all levels of society; and offered potential new ways of mitigating environmental harms. It is this systemic significance of ICTs, and their potential contribution to sustainability, that have not been prominent to date in discussion towards the post-2015 social and economic development agenda.

The second conceptual framework which may have resonance in this context is that of Knowledge Societies, meaning societies in which the exploitation of information and knowledge becomes the principal driving force of social and economic development. That this is already happening can be

seen not just in high-tech innovation or exploitation of the trends described in this paper, but also in the adoption of basic ICTs by ordinary citizens, including the poor. It is important, in assessing this evolution towards Knowledge Societies, to place it firmly within the realities of the present development agenda. ICTs and ICT4D reflect an important direction in which societies across the world are moving, and aspirations towards one way in which more sustainable development might be achieved. They cannot solve all the development challenges of today, nor offer a comprehensive solution to the development challenges of tomorrow, but they are increasingly important factors in establishing routes towards solutions.

These two focal points – Sustainable Development and Knowledge Societies – are both rooted in human development approaches. They locate the importance of technology not in technology itself, but in the interaction between technology and society. They recognise that ICTs are valuable instruments for development, but do not mistake them for development itself. They see the Information Society which is emerging as one in which governments, businesses and people make use of ICTs to pursue broader development objectives. Experience shows that, in this context, it is *more appropriate* ICTs, rather than more ICTs, that have developmental value in delivering public services.

This brings us to the paper's second suggested way in which ICT and ICT specialists might address the post-2015 development agenda: by aligning ICT4D, including the potential of trends discussed in this paper, with those objectives which are emerging from discussions about Sustainable Development Goals and other instruments for the post-2015 agenda. Whatever form they take, these instruments will represent something of a generational shift within international development policy. Although the detail of the future Sustainable Development Goals is yet to be agreed, by the General Assembly, some idea of thinking towards them within the development community can be found in two of the reports referenced above, the Secretary-General's High Level Panel report *A New Global Partnership* and the UN SDSN's *Action Agenda for Sustainable Development*. Each of these has proposed provisional goals for the post-2015 agenda, which are set out in Table 1 below. In both cases these reach beyond the basic needs emphasised in the MDGs towards the tripartite objectives of sustainable development (economic prosperity, social equity and environmental sustainability). Exploring the potential of ICTs for these, including the emerging trends described in this paper, offers a way of reframing the relationship between ICTs, ICT4D and wider development policy and practice.

Table 1: Suggested goals in recent international development reports

	A New Global Partnership	*Action Agenda for Sustainable Development*
	UN Secretary-General's High-Level Panel	UN Sustainable Development Solutions Network
1	End poverty	End extreme poverty and hunger
2	Empower girls and women and achieve gender equality	Achieve development within planetary boundaries
3	Provide quality education and lifelong learning	Ensure effective learning for all children and youth for life and livelihood
4	Ensure healthy lives	Achieve gender equality, social inclusion and human rights for all
5	Ensure food security and good nutrition	Achieve health and wellbeing at all ages
6	Achieve universal access to water and sanitation	Improve agricultural systems and raise rural prosperity

7	Secure sustainable energy	Empower inclusive, productive and resilient cities
8	Create jobs, sustainable livelihoods and equitable growth	Curb human-induced climate change and ensure clean energy for all
9	Manage natural resource assets sustainably	Ensure ecosystem services and biodiversity, and ensure good management of water and other natural resources
10	Ensure good governance and effective institutions	Transform governance for sustainable development
11	Ensure stable and peaceful societies	
12	Create a global enabling environment and catalyse long-term finance	

Conclusion

This paper has tried to set the scene for understanding the changing contribution of ICTs, including emerging trends, to social and economic development. Datafication and big data analysis, cloud computing, the Internet of Things and the emergence of smart systems are all ways by which the impact of ICTs on the evolution of economy, society and culture will grow over the next decade.

- Datafication can enable governments to improve the efficiency and coordination of government administration and the logistics of public service delivery.
- The accumulation of information, enhancements to understanding and analysis of development requirements and better understanding of correlations between different development parameters that emerge from big data analysis and other new data methodologies can improve the quality of both short-term decision-making and long-term development planning.
- Open data and more open means of data gathering and analysis can extend participation in decision-making, enabling people to have more influence on decisions that affect their lives.
- The enhanced data-handling and analytical capacities of cloud computing can contribute to the quality of data analysis, while cloud-based interfaces can provide innovative ways of maximising information access and interaction between governments, citizens and other stakeholders.
- The Internet of Things can extend capabilities to monitor the natural environment (such as weather and climate change), the exploitation of natural and human resources, pollution levels, and behavioural impacts, enabling earlier, more effective and cost-effective intervention by government agencies.
- Smart systems can improve the efficiency of utility and industrial sectors, including power generation and distribution, reducing CO_2 emissions and enabling more efficient exploitation of water and energy resources.

The crucial operative word in each of these points, however, is 'can'. 'Can' does not necessarily mean 'will'. Experience with ICT4D over the past decade has demonstrated a frequent mismatch between the aspirations/expectations of ICT4D initiatives and their outcomes in real conditions. The extent to which ICTs can enable improvements of the kind anticipated by ICT4D is constrained by many factors in development contexts. These include the availability, affordability and reliability of infrastructure; the quality of the enabling legal and regulatory framework for innovation, by government, business and citizens; the human and institutional capabilities required to leverage developmental value from ICTs; and the financial resources for investment in infrastructure, human capacity and (crucially, but oft neglected) operational costs. As things stand, therefore, the impact of ICTs, and these new trends, will continue to be greater in developed than in developing countries,

potentially exacerbating development divides. Analyses of the potential for ICTs in social and economic development need to pay at least as much attention to the limitations imposed by these constraints – and to ways of mitigating them – as they do to the potentialities of ICTs themselves.

Observing, understanding and explaining the development and significance of ICTs within social and economic development will continue be an important element in the work of CSTD as the decade proceeds. The imminent review of MDGs, SDGs and WSIS outcomes provides an opportunity for the international community as a whole to establish that better understanding and to locate ICTs and ICT4D effectively within the next generation of international development policy.

Questions for discussion

The following questions suggest points for discussion at the inter-sessional panel about ways forward for governments, international agencies, including CSTD, and other stakeholders.

1. What changes in international development policy and practice are needed to harness the value of the new trends in ICTs for social and economic development which are discussed in this Issues Paper – datafication, big data and big data analysis, cloud computing, the Internet of Things and smart systems?
2. What are the implications of these trends for the digital divide and developmental inclusiveness?
3. What can national governments to take maximum advantage of the opportunities presented by these trends?
4. Do these trends pose significant threats as well as opportunities to development? What can be done to mitigate these threats?
5. How can these trends contribute to achieving the proposed 'transformative shifts' and Sustainable Development Goals envisaged for the post-2015 development agenda?
6. How can CSTD ensure that the impact of ICTs on social and economic development is most effectively incorporated in the post-2015 development agenda?

[1] The paper draws on material from David Souter, *ICTs in Social and Economic Development*, forthcoming.
[2] World Bank, *World Development Report 1998 – Knowledge for Development*, summary at http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2005/11/04/000011823_20051104124042/Rendered/PDF/18446.pdf.
[3] Mansell, Robin & Wehn, Ute, *Knowledge Societies: Information Technology for Sustainable Development*, Oxford University Press, 1998.
[4] See *e.g.* UNESCO, *Towards Knowledge Societies: UNESCO World Report*, 2005, available at http://www.itu.int/wsis/outcome/booklet.pdf, and the proceedings of its 2013 conference *Towards Knowledge Societies for Peace and Sustainable Development*, reported at http://www.unesco.org/new/en/communication-and-information/flagship-project-activities/unesco-and-wsis/wsis-10-review-meeting/
[5] United Nations and International Telecommunication Union, *WSIS Outcome Documents*, 2005, available at http://www.itu.int/wsis/outcome/booklet.pdf.
[6] 'Geneva Declaration of Principles', article 1, in *ibid.*, p.9.
[7] available at http://www.uncsd2012.org/content/documents/727The%20Future%20We%20Want%2019%20June%201230pm.pdf. A summary of references to ICTs can be found in David Souter and Don MacLean, 'ICTs, the Internet and Sustainability: Where Next?', October 2012, available at http://www.iisd.org/pdf/2012/changing_our_understanding_of_sustainability.pdf.
[8] available at http://www.beyond2015.org/sites/default/files/HLPReport.pdf.
[9] http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2013/ITU_Key_2005-2013_ICT_data.xls. It should be noted, however, that the number of individuals with subscriptions is substantially lower than this because many users have more than one subscription and because it takes time for unused subscriptions to fall out of databases.
[10] Mobile devices are, of course, used for Internet access at home as well as on the move.
[11] ITU statistics available at http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2013/ITU_Key_2005-2013_ICT_data.xls.
[12] *Implementing WSIS Outcomes: Experience to Date and Prospects for the Future*, 2011, available at http://www.umic.pt/images/stories/publicacoes5/dtlstict2011d3_en.pdf.
[13] For data on website access and usage, see www.alexa.com.
[14] ITU, *Measuring the Information Society*, Chapter 1.
[15] Internet Protocol
[16] Cisco, *The Zettabyte Era – Trends and Analysis*, 2013, available at http://www.cisco.com/en/US/solutions/collateral/ns341/ns525/ns537/ns705/ns827/VNI_Hyperconnectivity_WP.pdf.
[17] http://spectrum.ieee.org/telecom/wireless/edholms-law-of-bandwidth.
[18] Souter, David & MacLean, Don, 'Changing our Understanding of Sustainability: The impact of ICTs and the Internet', International Institute for Sustainable Development, 2012, available at http://www.iisd.org/pdf/2012/changing_our_understanding_of_sustainability.pdf.
[19] The rate of growth in greenhouse gas emissions from the sector is some 6% p.a. See The Climate Group for the Global eSustainability Initiative, *SMART 2020: Enabling the low carbon economy in the information age*, 2008, available at http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf.
[20] See *e.g.* Tim Kelly & Carlo Maria Rossotto, eds., *Broadband Strategies Handbook*, World Bank, 2012, available at http://broadbandtoolkit.org/Custom/Core/Documents/Broadband%20Strategies%20Handbook.pdf; and Broadband Commission for Digital Development, *Broadband: a Platform for Progress*, 2011, available at http://www.broadbandcommission.org/Reports/Report_2.pdf.
[21] Rwanda's most recent ICT strategic plan is available at http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf.
[22] See http://laptop.org/en/vision/index.shtml.
[23] *The Missing Link: report of the International Commission for Worldwide Communications Development*, 1984, available at http://www.itu.int/en/history/Pages/MaitlandReport.aspx.
[24] Leonard Waverman et al., 'The Impact of Telecoms on Economic Growth in Developing Countries,' in Coyle, D, ed., *Africa: the Impact of Mobile Phones*, Vodafone Policy Paper Series Vol. 2, 2005, available at http://info.worldbank.org/etools/docs/library/152872/Vodafone%20Survey.pdf

[25] Christine Qiang et al., 'The Economics of Broadband,' in World Bank, *Information and Communications for Development 2009: Extending Reach and Increasing Impact*, available at http://siteresources.worldbank.org/EXTIC4D/Resources/IC4D_Broadband_35_50.pdf.
[26] For a thorough critique of the Waverman and Qiang findings, see Charles Kenny 'Overselling Broadband: a Critique of the Recommendations of the Broadband Commission for Digital Development', 2011, Center for Global Development, available at http://international.cgdev.org/publication/overselling-broadband-critique-recommendation-broadband-commission-digital-development.
[27] The MDGs can be found at http://www.un.org/millenniumgoals/.
[28] The impacts of competition on telecommunications markets are discussed in Colin Blackman & Lara Srivastava, eds., *Telecommunications Regulation Handbook*, 10th anniversary edition, 2010, published by the World Bank, *info*Dev, IFC and ITU, available at http://www.un.org/millenniumgoals/.
[29] Unpublished research by David Souter and Abiodun Jagun for the United Nations Development Programme, 2006/7.
[30] Failures in e-government policy and practice are usefully discussed in Richard Heeks, *Implementing and Managing eGovernment: an international text*, 2006.
[31] Richard Heeks, 'The ICT4D 2.0 Manifesto: where next for ICTs and international development?', University of Manchester Development Informatics Group Working Paper no. 42, 2009, available at http://www.sed.manchester.ac.uk/idpm/research/publications/wp/di/documents/di_wp42.pdf.
[32] C.K. Prahalad, *The Fortune at the Bottom of the Pyramid: Eradicating Poverty through Profits*, 2004.
[33] See ITU, *World Telecommunication/ICT Development Report 2010: Monitoring the WSIS Targets – a mid-term review*, available at http://www.itu.int/pub/D-IND-WTDR-2010.
[34] CSTD, *Implementing WSIS Outcomes*, chapter 6.
[35] For an important World Bank-funded example, see the E-Lanka project described at http://www.worldbank.org/projects/P081771/e-lanka-development?lang=en&tab=overview.
[36] This is sometimes called the Solow paradox, following Robert Solow's 1987 observation that 'You can see the computer age everywhere but in the productivity statistics.' See also Erik Brynjolfsson, 'The productivity paradox of information technology,' *Communications of the ACM* 36 (12): 66–77.
[37] Organisation for Economic Cooperation and Development, *ICT and Economic Growth: Evidence from OECD Countries, Industries and Firms*, 2003; David Souter, 'ICTs and Economic Growth in Developing Countries,' OECD DAC Network on Poverty Reduction, 2003, available at http://unpan1.un.org/intradoc/groups/public/documents/APCITY/UNPAN022641.pdf.
[38] The notion of algorithms taking the international financial system to be verge of destruction is, for example, the plot theme of Robert Harris' 2011 bestselling novel *The Fear Index*.
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[40] http://www.unep.org/Documents.Multilingual/Default.asp?documentid=78&articleid=1163
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[43] cited in Renee Berry & Matthew Reisman, 'Policy Challenges of Cross-Border Cloud Computing,' US International Trade Commission *Journal of International Commerce and Economics*, May 2012, available at http://www.usitc.gov/journals/policy_challenges_of_cross-border_cloud_computing.pdf.
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[46] http://www.itu.int/osg/spu/publications/internetofthings/
[47] http://w3techs.com/technologies/details/ce-ipv6/all/all.
[48] International Telecommunication Union, *The Internet of Things*, 2005, Executive Summary, available at http://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-IR.IT-2005-SUM-PDF-E.pdf.
[49] See presentation by Joao Barros, on innovative ICT applications in Porto, Portugal, at Internet Governance Forum, Bali, 22 October 2013.
[50] The Climate Group for the Global e-Sustainability Initiative, *SMART 2020*, *op. cit.*
[51] The application of ICTs to trade in Africa is described in detail in Lishan Adam, David Souter *et al*., *Transformation-Ready: the strategic application of information and communication technologies in Africa – Regional Trade and Integration Study*, *ict* Development Associates for the African Development Bank and World Bank, 2011, available at

http://siteresources.worldbank.org/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/Resources/282822-1346223280837/RegionalTradeandIntegration_Fullreport.pdf.

[52] *SMART 2020*, pp. 9, 45-46.

[53] *e.g. The Internet of Things*, 2005, available at http://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-IR.IT-2005-SUM-PDF-E.pdf; *The Impact of Broadband on the Economy*, 2012, available at http://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_Impact-of-Broadband-on-the-Economy.pdf.

[54] *A New Global Partnership: Eradicate Poverty and Transform Economies through Sustainable Development*, report of the High-Level Panel of Eminent Persons on the Post-2015 Development Agenda, available at http://www.un.org/sg/management/pdf/HLP_P2015_Report.pdf, pp. 3, 23-24.

[55] Nathan Morrow *et al.*, *Independent Evaluation of the Ushahidi Haiti Project*, 2011, available at http://api.ning.com/files/HX-j3*PqLLSgdkf8w5RVQwTyx-8GN*wEGnr3zb-aZoeXYGoOLSBhU5nFC5-qTSj4C7m7StA0yHmGmHWgdDuDtu48CJRnwW8Q/Ushahidi_Haiti_Eval_final.pdf.

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[64] http://www.unesco.org/new/en/communication-and-information/access-to-knowledge/open-educational-resources/

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[66] *A New Global Partnership*, available at http://www.un.org/sg/management/pdf/HLP_P2015_Report.pdf.

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[78] Websites at http://www.itu.int/wsis/implementation/2013/forum/ and www.intgovforum.org.

[79] The Commission's membership is at http://www.broadbandcommission.org/CommissionerListPage.aspx.