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Digital Development

Issues Paper for the CSTD 2014-15 Inter-sessional Panel, Geneva, November 26th -28th, 2014

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Introduction

The Commission on Science and Technology for Development (CSTD) at its 17th session, that took place in May 2014, selected 'Digital Development' as one of its priority themes for the 2014-15 inter-sessional period. This draft Issues paper has been prepared to facilitate discussion at the inter-sessional panel which will take place in Geneva during November 26-28th, 2014.

ECOSOC resolution E/RES/2014/28 calls on CSTD to act as a forum of horizon scanning and strategic planning. In response to this request, this paper conducts a horizon scanning of the relationship between digital ICT and development, with a special focus on 'millennials'[2], emerging technology applications such as rural wifi though whitespace and next generation satellites. The paper begins by describing the changing landscape of digital development in terms of emerging technologies, changing demographics and development priorities. It discusses the transformative impacts rendered by these changes in two sectors of the society, namely, economy and politics. The paper concludes by discussing the implications of these changes for development and policy-making.

A. Changing Landscape of ICT4D

Since early 2000, the ICT for development (ICT4D) or the digital development landscape has changed in three significant and foundational ways in terms of: digital technologies, demographics, and development priorities. This section examines these changes in turn.

A1. Changing Digital Technologies

ICTs itself have changed dramatically during the 21st century. For example, key ICT trends in developing countries are summarised in Figure 1 below. These figures smooth over many inequalities which will be discussed later but the overall change is clear: in ten years, digital ICTs have moved from a peripheral to a core role in developing countries. They have increased in terms of:

- Reach: digital technologies were largely the preserve of urban elite in developing countries. With the significant geographic and demographic expansion of ICTs, they now reach most low-income communities; both urban and rural.
- Scope: ICTs tended to cluster around a few focal development issues and applications. Now, ICTs are active in almost all development issues and sectors.
- Depth: ICTs tended to skate across the surface of development processes, adding a shallow input of email or perhaps a static website. Now, ICTs are increasingly part of all aspects of development processes: gathering the data, supporting or making the decision, underpinning the actions, and communicating the results.

[2] 'Millenials' refer to those who are born after 1980, the first generation to come of age in the new millennium. See Box 2 for a detailed discussion on 'millennials' and the need for harnessing their potential for development.

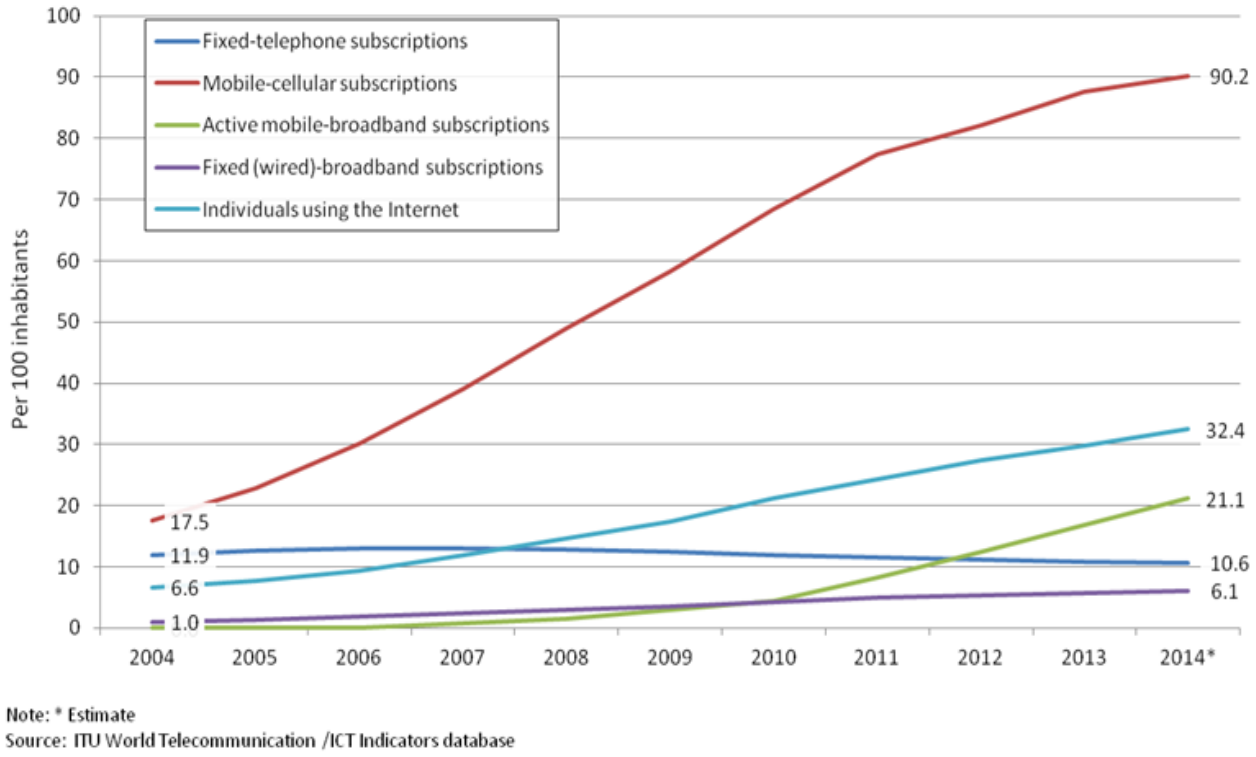


Figure 1: Key ICT Indicators for Developing Countries (2004-2014)

As a result, we already start to feel the existence of a digital "nervous system" for development: a pervasive digital infrastructure in which most development organisations from international agencies through government departments to small community-based organisations have internet access and in which a large proportion of individuals in developing countries have digital mobile phone access.

As Figure 2 shows, we already have enough data to know that mobile, broadband, and mobile broadband (hence smartphones and tablets) will be a key driving force of future technology trends in ICTs. Social media is also a racing certainty: by 2014 North America and Europe made up just 27% of global social network users, with 54% in Asia (including Oceania), 14% in Central/South America, and 8% in the Middle East and Africa, and with growth rates faster in the global South than the global North[1].

The CSTD during its 2013-14 inter-sessional period, had highlighted the five big emerging trends in digital technology, namely, 'datafication', big data, cloud computing, 'the internet of things' and smart systems. These five emerging trends are profoundly changing the digital development landscape.

Of these five big trends, the big data and 'datafication' could be characterised by the following 5Vs of data[2]:

- Volume: increasing amounts of data being produced.
- Velocity: decreasing time between any process and the widespread availability of data about it.
- Variety: data from an increasing diversity of sources in an increasing variety of forms (including less-structured forms such as audio and video).

- Veracity: increasing objectivity of data as humans are disintermediated from the data capture and processing chain.
- Visibility: greater awareness and availability of data.

It is very likely that cloud technologies – "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"[3] – will have a significant impact in developing countries. Most social media users use cloud and "the highest growth rates in the next few years are expected in the Middle East and Africa"[4]. Cloud will reduce financial and time costs and increase flexibility and digital accessibility for organisations in developing countries while simultaneously increasing their dependency and vulnerabilities to cybercrime and surveillance[5].

"Internet of things" denotes the Internet connectivity of increasing numbers of objects. This has already happened in familiar ways with the growing connectivity of mobile phones, tablets, laptops, PCs – 13 billion devices were Internet-connected in 2013[6]. But the main growth area – 50 billion devices predicted by 2020 – is seen to be two types of connection. First, stand-alone sensors – for example providing agricultural readings from fields, or medical readings from health centres[7]. Second, sensors integrated into mainstream objects from cars and refrigerators to toilets and shoes[8]. All these applications become smart when they move from a passive ability to collect and transmit data to an active ability to take a decision and action on the basis of that data: smart irrigation systems that automatically water dry crops; smart electricity grids that automatically isolate and re-route around transmission failures[9]. In future, smart systems could bring significant potential to increase efficiency and effectiveness of infrastructure and business while, again, potentially increasing dependency and vulnerabilities to cybercrime and surveillance[10].

Also likely to have an impact is an emerging set of telecommunications technologies that are helping to fill gaps in network coverage to rural areas. These derive from various technological directions but all have an aim of addressing digital inclusion (see below). Examples include:

- Local-scale wireless networking using the television white space spectrum: those frequencies within the TV broadcast ranges that are unused in a particular region[11].
- Wider-scale networking via use of small satellites [12].
- Local-scale cellular networks, typically serving a few hundred or thousand users and using mesh or WiFi-based long distance networks[13].

All of these technologies are pushing the digital development paradigm towards universality, and further details of the same are provided in Box 1.

Thanks to telecommunications advances, we are slowly erasing the blank spaces on the digital map and moving towards 'everywhere' being connected at any time. In terms of nodes, pretty well anyone and anything could now be connected thanks to ubiquitous computing. There is a still a very long way to go but within a generation almost everyone will be connected, and we will be steadily moving closer to everything being connected. ICTs are therefore moving from the exotic to the mundane in developed and developing countries alike.

Box 1

Case Study: Enabling Rural Wifi Through Whitespace and Next generation Satellites

To circumvent the problem of access to internet in rural areas, diverse solutions are proposed relying on radiocommunication and efficient use of radio spectrum. One such promising technology is using Whitespace for rural wifi. National and international bodies assign different frequencies for specific uses and in most cases license the rights to provide services over these frequencies. This frequency allocation process creates a band-plan, which for technical reasons assigns whitespace between used radio bands or channels to avoid interference[14]. In addition to white space assigned for technical reasons, there is also unused radio spectrum which is becoming free as a result of technical changes. In particular, the switchover to digital television frees up large areas of the spectrum. Experiments are currently being carried out to use white space for broadband Internet, especially in rural areas[15] [16]. For instance, Indigo Telecom/Microsoft and the Kenyan government is reportedly delivering bandwidth speeds of up to 16 Mbit/s to three rural communities[17]. In Namibia "Citizen Connect" project, a collaboration between the Microsoft 4Afrika Initiative, the MyDigitalBridge Foundation, and the MCA-N (Millennium Challenge Account Namibia), has been started to deliver broadband Internet to twenty-seven schools and seven circuit offices of the Ministry of Education using whitespace technology[18][19][20].Rural areas are often inhibited from wireless access because they are inaccessible and off the local power grid. Cell towers are difficult to install and cannot connect either. To meet these specific challenges of rural areas, White Space power stations are set up to be charged with solar panels and their frequency is largely unaffected by weather and terrain[21].

Similarly, communication satellites too can be used to provide internet connectivity in rural areas. High altitude platforms (HAPs) such as drones or balloons that hover or circulate in the stratosphere could be used in a larger scale to provide internet access in rural areas. For example, Google Project Loon uses high-altitude balloons placed in the stratosphere at an altitude of about 32 km to create an aerial wireless network with up to 3G-like speeds[22]. There are several such promising initiatives on this front. These technologies hold great promises for more inclusive development particularly for rural areas.

Another emerging space technology is that of next generation satellites, such as nanosatellites and picosatellites, which are relatively fast to develop, cheap to build and launch. These satellites are of 1-10kg have an edge length of less than 30 cm and a typical mission lifespan of less than 3 years. These satellites are bringing space into everyday life: they offer greater possibilities of individualized satellite access for entertainment, education, and a myriad of practical applications such as weather forecasting, earth observation, climate change adaptation and mitigation, forest fire detection and monitoring, remote sensing and communication [23]. Millennials are playing a key role in adopting and popularizing these new satellite technologies. For example, University Space Engineering Consortiums (UNISEC) are currently being formed to facilitate greater participation of university students in practical space projects using nanosatellites; In India, a group of under-graduate students, collaborating with the national space research organization, designed and successfully launched a picosatellite (STUDSAT-1) into the earth orbit in 2010 and is in the process of designing their second satellite with enhanced capabilities[24]. More governmental commitment and funding would contribute towards

raising awareness and capacity building in these emerging satellite applications and to make full use of the potential of these next generation small satellites. These satellite technology applications can play a crucial role in promoting internet access in rural areas, as well as in 'digital sustainability' aspects, that are discussed in later section of this paper.
Source: see Appendix 1.

A2. Changing Digital Demographics

The technology changes outlined above have been accompanied by changes in demographics of ICT usage. The geographic composition of internet users has changed indicating the bridging of global digital access divide[25]. Geographically, in terms of number of users, the 'new Internet world' (emerging nations of the global East and South) have already surpassed the 'old Internet world' (the US and Europe)[26]. The changing share of global Internet users is summarised in Table 1: there are now twice as many Chinese citizens online as there are US citizens in total; the Middle East and Africa have more users than Western Europe[27]. Some argue that these 'new internet world' users are more sociable online, produce more online content, and source more of their audio-visual content online and ICTs are more central to their lives [28]

Table 1: Regional Share of Global Internet Users (2001, 2014)

Region	***% Share in 2001***	***% Share in 2014***
RISING SHARE		
Africa	1%	9%
Middle East	1%	4%
Latin America/Caribbean	5%	11%
Asia	32%	45%
FALLING SHARE		
North America	30%	11%
Oceania	2%	1%
Europe	29%	20%

A large share of the newer internet users falls to the generation, who are "growing up digital"[29]. 'Digital natives' can be defined as those 15-24 year olds with five or more years of online experience[30]. They are more likely than others to both consume and produce online content, they perceive themselves as more innovative and creative, and ICTs are changing the way they think and learn (though what exactly those changes are is still a matter of debate)[31]. What can be said is that while only around one-fifth of the youth cohort in developing countries are digital natives (compared to four-fifths in the global North), youth in the global South are twice as likely to be digital natives as the total population, and so they have a disproportionate role which might be worth specific encouragement[32]. A further discussion on the related notion of harnessing the power of the "millennials" is provided below in Box 2.

Further, the current ICT users, especially the 'millennials' or 'digital natives', are experiencing changes that include[33]:

- Time-space compression: breaking down traditional barriers of time and physical space.

- Public to private: moving from shared-use to individual-use models of ICT interaction. Voice communication is moving from public payphones to shared mobile phones to individually-owned mobile phones. Internet access is moving from public access telecentres and cybercafés to semi-public home or work computers to personal mobile devices. The digital experience thus becomes increasingly private and personal.
- Fixed to mobile: as mobile devices become the dominant means of access to digital infrastructure and content.
- Text/audio to audio-visual: while it may be premature to call the emergence of a post-literate society, increasing bandwidth and technical capabilities mean digital experiences can increasingly resemble natural real-life experiences rather than the artificial restrictions of just text or just audio.

One can argue that all four cases represent an increasing presence of the digital, as its mediation merges more seamlessly into everyday life and activities[34]. As a result of this pervasive nature of digitisation, everyone can be assigned a role within a digital "role ladder"[35]. In simple terms, climbing the ladder represents a greater engagement with digital technology, moving from no direct use (people who don't use ICT) to direct use (active users of email and internet applications) to sufficient use to be classified as falling within the ICT sector (ICT sector workers, producers, entrepreneurs and innovators). It is also a ladder of technological capability; each step reflecting higher-level capabilities (skills, knowledge and perhaps also attitudes) that are required for this type of ICT use but which are also created by this type of ICT use. For example, though there is a surge in number of 'millennials' from developing countries who are active users of internet, very low proportion of them currently end up climbing up the role ladder to become producers, entrepreneurs or innovators, as they lack the necessary digital capabilities and enabling opportunities.

Box 2

Case Study: Harnessing the power of the 'Millennials'

'Millennials' is the terminology used to refer to those who are born after 1980, the first generation to come of age in the new millennium[36]. This is the generation to follow the generation X and according to recent estimations would comprise 75% of the global work force by 2025[37]. A distinguishing feature of this generation is that, they are the first 'growing up digital' generation. The majority of their activity including peer-to-peer communication and knowledge management are mediated by digital technologies[38].

A recent survey among millennials from 28 countries reveals that millennials are eager to make a difference. 63% of the millennials contribute towards charity, 43% actively volunteered or were a member of a community organization, 52% signed petitions for different causes, and hence is eager to participate in 'public life'[39]. Another survey among millennials of 100 hundred countries finds that their key role models are entrepreneurs and millennials rate passion as the most desired trait in leaders[40]. This idealism and passion of the millennials for addressing development issues when channelled through appropriate global collaborations could emerge as the 'single most powerful new asset in the 21st century development sphere'[41].

Certainly, ICT has a major role to play in facilitating such collaborations and partnerships between the millennials of the global north and the global south and also among the

millennials within these regions. Millennials see ICTs as more important and more beneficial than others do. Given they make proportionately greater use of digital technologies and of social networks, then engagement of these digital natives – for example in education or politics – may be enhanced by ensuring there are effective digital channels in these sectors. Hence, ICT need to be given a more prominent role in our development approach, in order to effectively harness the power of these millennials and also to deal with some of the new challenges posed by an increasingly digitised generation.

A3. Changing Development Priorities

The current ICT4D discourse, including the two World Summits on the Information Society in 2003 and 2005, were significantly shaped by the Millennium Development Goals. The MDG approach focused largely on mitigating social deprivation. The WSIS *Geneva Declaration* proclaimed that 'our challenge is to harness the potential of ICT to promote development goals of the millennium declaration' and recognised ICTs as 'tools' to achieve development goals.

The development landscape that shaped the current ICT4D discussion itself has also evolved since early 2000. The Rio+20 summit of 2012 called for a set of sustainable development goals (SDGs) which encompasses three dimensions -- economic, social and environmental of development.[42] These SDGs will be part of a post-2015 development agenda which is envisaged to be strong, ambitious, inclusive, and people-centred.[43] Three core themes in development can be identified from the emerging post-2015 development agenda discussions: [44]

- Transformation: The UN secretary General's High Level Panel of eminent persons on the post-2015 agenda in its report in 2013, highlighted that business as usual would deliver neither eradication of poverty nor environmental sustainability. The report called for a paradigm shift in development approach which is transformative[45]. While the MDGs focused on mitigating of certain specific social deprivations,[46]such as poverty and gender inequality, the post-2015 development agenda is expected to deal with broader issues of sustainable economic and structural transformations.
- Inclusion: the development process need to ensure equal opportunities - that everyone, regardless of their background, can achieve their full potential in life. Such efforts include policies and actions that promote equal access to (public) services as well as enable citizen's participation in the decision-making processes that affect their lives[47].
- Sustainability: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs"[48].

Currently, ICT is playing a crucial role in shaping up of the post-2015 development agenda, in terms of providing space and opportunity for wider consultations. The statement of the United Nations Group on the Information Society (UNGIS) on the Post-2015 Development Agenda in 2013, underlined that fact that during the conception of MDGs the international community was only beginning to understand the 'catalytic potential of ICTs to advance development agendas and priorities'. The statement called for recognizing ICTs as 'cross-cutting enablers for the achievement of all three pillars of sustainable development'[49].

Hence, there is a need to re-evaluate the role of ICTs in development in light of these emerging development priorities.

B. Transformative Impacts on Society

The emerging changes in the ICT4D or the digital development landscape, discussed in the first section, are already creating transformative impacts on many facets of society. This section discusses some of the key transformative impacts of these changes on two important sectors of the society, namely, economy and politics.

B1. Digital Economy

There are attempts to measure the size of the ICT sector or the Internet economy[50]. These sources suggest that these elements of the digital economy typically represent less than 10% of GDP, even in the more developed economies of the world. These sectors are growing faster than the general economy but the majority of ICT gains are captured by the "traditional" economy. Looking at the changes associated with ICTs in the economic sphere, we can identify two types of change: incremental transformations which take existing models and improve their coverage or performance; and disruptive transformations that truly harness the power of ICTs to create fundamentally new business models. Each of these will be described in turn.

Incremental Transformation

A key problem for the poor in developing countries is that they can be excluded from economic opportunities by lack of access to information. ICTs can help overcome such barriers. For example, in many low-income communities, waged work is hard to find and the opportunities that do exist flow to only a few people via informal connections and word-of-mouth. Through ICTs, a market for jobs can be created – employers submit job details to a database that can be viewed by those looking for work; would-be workers submit their details for employers to view; contact between the two is facilitated by mobile (SMS/call) or email. Faster filling of vacancies, better employee-job match, and improved wages are the result[51].

As well as improving economic opportunities for marginalised groups, ICTs can also improve the functioning of existing businesses. They can cut operational costs and expand market reach for all scales of firms, helping them improve their sustainability and profitability. For example, use of mobile phones by microenterprises in developing countries has been shown to reduce the costs of inputs, increase the range of customers that can be reached, improve the amount of repeat business, and thus improve overall revenues and growth[52]. Further, ICTs enable consumers to be part of the production process. For example, a survey among the 'millennials' in South Africa revealed that 74% of them are connected with various companies and brands online and they expect their feedbacks of various products to be reflected in future product design[53].

ICTs can even change the performance of groups of businesses. Small and medium enterprises have often struggled to grow, but ICTs enable networks of SMEs to collaborate together at relatively low cost. For example, they can be organised so that each contribute one part of an overall production process; a complexity that can only be managed thanks to digital technology[54]. This can allow SMEs in low-income locations to compete when otherwise they might be driven out of business by large firms.

Disruptive Transformation

Incremental transformation tends to just amplify or improve existing activities, but digital technologies can go beyond this to create much greater change that may challenge existing ways of doing business.

ICT has enabled creation of 'digitally enabled products' through two primary ways. Firstly, through the creation of new digital products that did not previously exist. An obvious example would be software. Secondly, digitisation of existing products; that is, their conversion from a physical to a virtual product. This is occurring in almost all sectors and examples include the conversion of books into e-books; conversion of newspapers into news websites, and conversion of classroom education into e-learning

ICT application in businesses has led to emergence of digital business models. Most digital business models are traditional ways of doing things but with the overlayering of ICTs. We can sum up four features that some of these digital business models reflect[55]:

- Virtual: the untying of business models from physical restrictions, therefore enabling value chain activities (sourcing inputs, processing inputs into outputs, distributing outputs, managing the value chain, etc) to locate anywhere with a digital connection.
- Open: the breaking open of traditional value chain activities to enable much greater transparency and involvement of a wider range of external stakeholders including models of co-sourcing, co-production, co-distribution and co-consumption.
- Crowd: the opening of value chain activities to a large group of not-pre-identified individuals which may including sourcing inputs (e.g. crowdfunding), processing inputs into outputs (e.g. crowdsourcing completion of digital tasks), and distributing outputs (e.g. crowdsharing).
- Shared: the sharing of the value of any resource beyond a single individual (e.g. owner) relating to any value chain activity though typically related to final consumption of the resource.

Some of these new digital business models are potentially highly profitable. For example, organisations such as oDesk and Mechanical Turk operate on a fully-digital model. They take digital tasks (web development, search engine optimisation, data entry, etc) and outsource them via a web portal to a "human cloud" of individuals who can be based anywhere around the world. This epitomises the idea of a global free market that in theory could break through all manner of barriers and exclusions – thus many human cloud contractors come from developing countries. The evidence is that these models lead to worldwide convergence of payment with contractors in the global North paying less than their typical rates but contractors in the global South paying more[56].

Further, ICTs have led to highly-profitable “info-monopolies". Because of network effects (the more people that join a network, the greater the value of joining that network) there is a natural tendency towards monopoly in the provision of some digital services. While the network effects mean using these services could be beneficial for the consumer, monopoly effects mean that significant power and control is vested in these firms vis-a-vis their consumers and vis-a-vis nation states[57]. At the same time, in some countries, popular ICT applications make certain services, such as hospitality and transportation, more competitive and disrupt the current market dynamics in these sectors[58].

ICT application has also facilitated cooperative, community-based economic models which can be equally disruptive as they challenge mainstream ways of doing business. For example, market forces often lead to exclusion of large numbers of entrepreneurs from access to finance, or lead to very high interest rates for many entrepreneurs. New digital crowdfunding models can disrupt this. In development, true peer-to-peer micro-lending communities have so far been relatively limited but Kiva Zip and Zidisha are examples which allow direct micro-lending to farmers and micro-entrepreneurs in a number of African and Asian countries[59]. These new flows of capital enable income and enterprise growth at the base of the pyramid. Further, these crowdsourcing and crowdfunding platforms, increasingly interconnects the 'millennials' across global North and South, and empowers them to remove binding constraints to development such as access to finance and information.

Likewise proprietary production models and intellectual property rights have been sometimes criticised for reducing technology transfer and competition. To counterbalance this effect, open source models such as open source software production are based on a commitment to sharing and open participation among a community of peers. They are only feasible thanks to the sharing and coordination that ICTs enable. While these were initially restricted to the global North, they are now increasingly used in developing countries with examples of both South-South and North-South collaboration[60]. Such open source initiatives and an 'open internet' at large, have the potential to bring transformative changes to the level of innovation opportunity available especially to the 'millennials' of Africa[61].

Finally, we can see disruptive digital economic models that combine competitive and cooperative instincts. IT outsourcing, for instance, has brought hundreds of thousands of jobs to developing countries. But it has been criticised because those jobs remain entirely restricted to a relatively-wealthy urban elite. On the other hand, IT “impact sourcing” seeks to disrupt this pattern by outsourcing digital work to marginalised communities; a model which has already created tens of thousands of new jobs[62]. By training members of those communities, it enables them to participate in activities such as data entry, digitisation, transcription and call centres. Clients are satisfied with the commercial logic of getting IT contracts delivered at low cost with low staff attrition rates. Impact sourcing also delivers on a welfare logic that sees community members increasing their income earning potential while simultaneously being empowered with new skills[63].

B2. Digital Politics

Just as for the economic realm, we can divide the transformative impacts of ICTs on politics into the incremental and the disruptive.[64] These transformations in the political realm are facilitated by the fact that all types of networks are strengthened by ICT applications. These networks, which include people, devices and organisations, are fast becoming increasingly complex. Also, these network structures will have less of a physical and more of a virtual existence[65]. The 'millennials' and 'digital natives' are playing a key roles in these networks and in turn in ushering in these transformations in politics as they use ICT as the platform for engaging in 'public life'.

Incremental Transformation

In the same way that they are excluded from economic opportunities, many in developing countries are excluded from fair access to public services. They may receive worse or slower access, they may have to pay a bribe they can ill afford in order to get access, or they may simply be denied access. ICTs can help overcome some of these issues by reaching out into low-income communities though e-government and m-government applications. Evidence suggests this can make public services quicker and cheaper to access (e.g. through avoiding the need for journeys to district headquarters), improve consistency and citizen satisfaction, and significantly reduce the necessity for corrupt payments[66]. One of the most successful e-governance caste studies pertaining to e-Estonia is discussed in Box 3 below.

ICTs can also be used to improve government in other ways. Particularly, they can help the voice of the people to be heard in ways they previously were not. For example, e-petitions provide a much easier way than paper petitions for citizens to express their political opinions, and online petitioning sites therefore tend to generate hundreds if not thousands of petitions[67]. They have pushed governments into action – to host their own e-petition sites and to guarantee time in the legislature for e-petitions that achieve a certain minimum number of signatures[68].

Looking more broadly at ICT-enabled political campaigns – which may involve e-petitions but also a broader range of online communication – governments have been pushed to change their legislative programmes, and to get rid of unpopular politicians.

Box 3 **e-Estonia : a success story in e-governance**
e-Estonia is perhaps one of the most cited success stories of national level e-governance. In Estonia, the national id-cards (eID) of citizens act as the gateway for all e-services. This electronic id-card can be used for national health insurance, online voting, e-signatures, accessing government databases and ticket for public transport. At the level of decision making, the e-Cabinet system helps to streamline the government decision making process and it significantly reduced the time spent on meetings and make virtual cabinet-meetings possible. The e-Service portal of the government offers one-stop-shop for the hundreds of e-services offered by various government institutions. E-Business application allows entrepreneurs to register their businesses in few minutes, while m-Parking allows drivers to park for any City parking using their mobile phones. Since 2000, e-taxation has drastically

reduced the time involved with filing tax-returns and administrative costs of taxation. Estonia paved foundation for this success story through the 'Tiger Leap' project in 1996 which prioritized IT infrastructure investment especially in educational institutions. A strong political leadership supported passage of legislations required to facilitate e-governance instruments such as id cards. Over the years, Estonia has emerged as a training ground for other countries interested in e-governance applications.
Source: http://e-estonia.com

Disruptive Transformations

Digitally- enabled social movements also give voice to alternative politics. Sometimes, these new social movements have been able to enact regime changes[69]. Although the precise role of ICTs in many of the revolutionary movements is debated, there is general acceptance that some regime change would not have happened or at least would not have happened in the same way or timescale, had it not been for ICTs. Similarly, we can see new digital models that empower citizens to a much higher degree. Examples include:

- e-Accountability. The e-government applications discussed above cut humans out of the process in order to eliminate petty, front-line corruption. But that does not solve all problems of corruption or under-performance in government. E-accountability systems seek to do that. Online applications are being used for citizen "sousveillance": to track performance against politicians' promises, to report corruption of public officials, to track budget payments to their intended destinations, and to show which officials were handling a licence application[70]. They are not the sole solution but they can help.
- e-Participation: Very often citizens feel disempowered and distanced from government decision-making. Where e-accountability helps them monitor those decisions, e-participation helps them become part of those decisions. For example, in e-participatory budgeting, citizens are able to determine among themselves – facilitated by online visualisation, scenario modelling, discussion and voting – how public money should be spent[71]. Given expenditure of public money in their district is involved, citizens are often highly motivated to engage with such initiatives, and it can change their view of both themselves and their governments.
- e-Collaboration: Going further still, citizens can be not just participants but collaborators in government, co-producing government goods and services via use of ICTs. For example, interactive community mapping has been undertaken in Africa, using community members and others to capture details of roads, buildings and facilities on a digital map[72]. This is a co-production model between community, government, and technical experts which in some ways therefore puts citizens on an equal footing with government.

At the opposite end of the spectrum, some digital applications significantly shift power towards governments. For example, some states make use of e-surveillance to gather evidence that is used to repress their opponents. They also actively use ICTs for repressive purposes: disseminating propaganda inside and outside the country; hacking into the websites of internal social movements and the email/mobile accounts of organisers; planting disinformation into social movements' communications; using viruses and other tools of cyberwarfare to attack political challengers. As the activities and lives of citizens are

increasingly played out online, digital technologies could also allow greater government monitoring and control over citizens.

C. Policy Implications of a Changing Digital Development Landscape

C1. Broadening the ICT4D discourse

The ICT4D discourse emerged since the mid-1990s, and saw digital ICTs as a useful tool for development. The paradigm arose because of the rough coincidence between general availability of the Internet – a tool in search of purposes – and the Millennium Development Goals – purposes in search of tools. Following the launch of MDGs, ICTs began to be integrated more into development plans and projects as a tool for delivery of development. Integration is progressing, mainstreaming ICTs as a tool to achieve the various development goals gained momentum during the course of MDG implementation. From the development side, we see this expressed in national policy portfolios, in Poverty Reduction Strategy Papers, in UN Development Assistance Frameworks. From the ICT side, we see this expressed in national ICT policies and World Summit on the Information Society action lines.

Over the years, ICT4D discourse focused on incremental impacts of technology such as the improvements in the efficiency of micro-enterprises, better delivery of health or market information. However, this would not encompass the broader, disruptive transformations that ICTs is increasingly enabling in our society, as discussed in the previous section. As we continue to witness, ICTs are becoming part of a "digital nervous system" that fast underpins almost all development activities. As a result, some of the limitations of ICT4D approach are becoming evident, which certainly has implications for policy making. For example, a key policy focus of the ICT4D approach has been the digital divide, with considerable emphasis on those who are not digitally-connected. However, it has become increasingly evident that simply focusing on access misses the point. As the majority of areas and people become digitally "always on", new divides are emerging in terms of capabilities and resources. Further, the ICT4D paradigm has taken a limited view of ICTs within development policy, seeing them as an assistive add-on to some aspects of that policy. But this view will be out-of-synch with a world in which ICTs are becoming a pervasive foundation for all aspects of development policy. And, structurally, the ICT4D worldview has fragmented policy responsibilities into the "silos" of many individual development sectors (health, education, rural development, etc), when what will be needed is a coherence of policy that links across those silos.

Hence there is an increasing need for broadening the ICT4D discourse to incorporate these changing realities in the digital development landscape. ICT4D discourse needs to recognise ICTs as a platform that increasingly mediates development. In other words, digital technologies need to move from a peripheral role in development, to being a central means by which we do and experience development. This broadening of the ICT4D discourse calls for policy interventions in four key areas:

- **Digital ecosystem**: Whatever their form, digital transformations do not just happen or reach their full potential on their own. They require various interconnected components of infrastructure – what we can call a "digital ecosystem" – that lay the foundation for these transformations. In turn that digital ecosystem will require policy interventions in order to create it. A holistic approach to digital policy making would recognize the importance of each individual component within the ecosystem to ensure a balanced digital development. We discuss in detail the main components of the digital ecosystem and their complementarities.

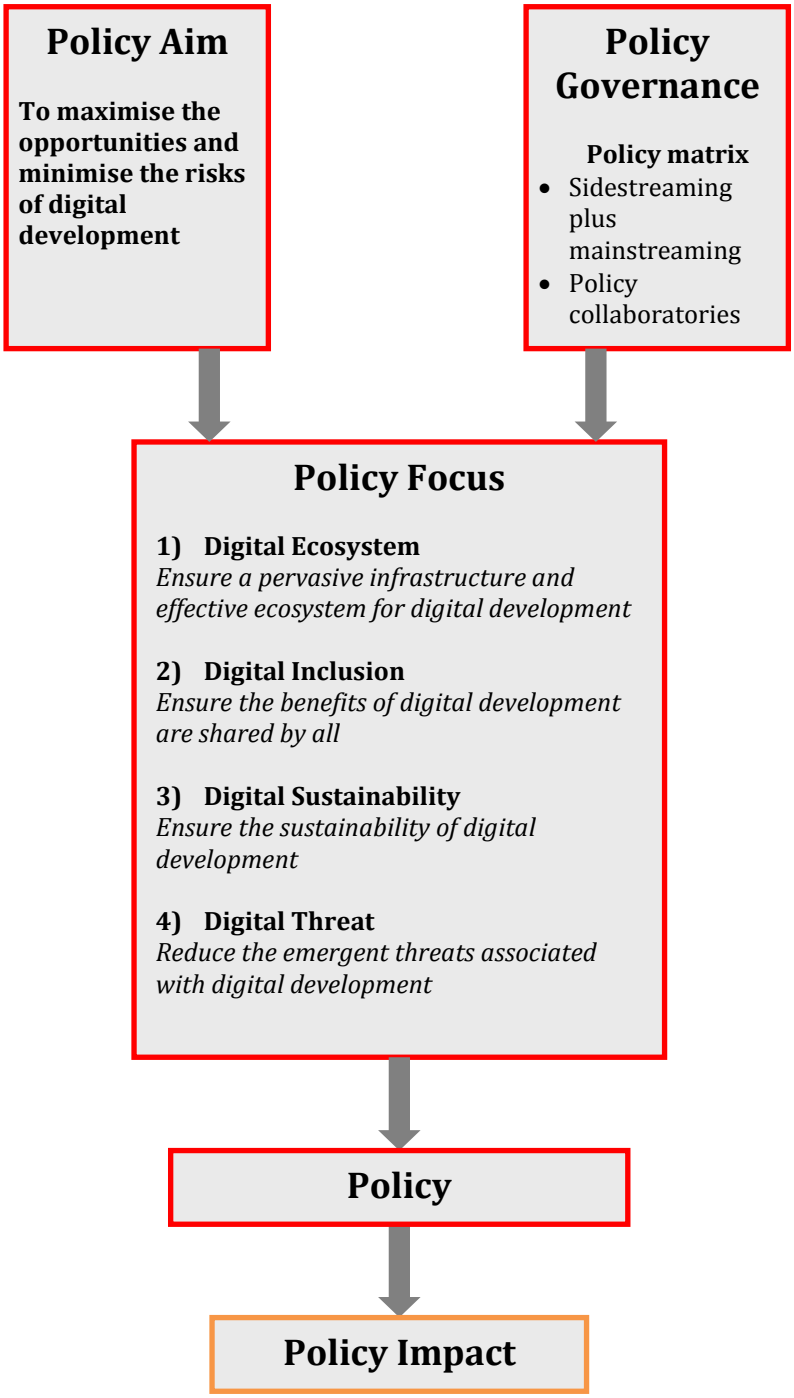
- **Digital inclusion**: where ICTs bring benefits to users, they increase the divide between users and non-users, and they increase the imperative for the policies to allow as many people as possible to share in the benefits of digital development.

- **Digital sustainability**: unchecked, ICTs could contribute to growth of production and consumption that is unsustainable given the planet's limited resources. While ICTs directly and indirectly will drive growth in carbon emissions, they offer at the same time opportunities for climate change mitigation and adaptation.

- **Digital threats**: ICTs could be associated with growth in gambling, pornography, theft and fraud.

Each of these four policy focus areas will be explored below, along with the rationale for their selection, before moving on to specific policy interventions in each of these focus areas. This section will then conclude with discussing some specific aspects of digital governance. Figure 2 provides an overview summary of digital development policy framework, corresponding to the structure of this section.

Figure 2: Overview of Digital Development Policy



C2. Policy Focus Areas of Digital Development

C2a. Digital Ecosystem

The digital ecosystem provides the inputs necessary to create the technical foundations and socio-technical applications required for effective digital development[73]. If private sources around the world invested adequately in digital ecosystems, all would be well. Unfortunately, they do not because ecosystem investments are of a type of public goods where the investor cannot capture all the returns on the investment. This inevitably discourages private investment. Policy intervention is therefore required to set up an efficient digital ecosystem. Such an ecosystem involves:

Technological Infrastructure: the infrastructure of digital technologies should be interoperable (allowing all elements to work together) and cover the greatest possible geographical area with the maximum possible processing and communications capacity. It should allow for both mobile and fixed device connection, and enable multiple, parallel and redundant capacity to ensure the technology is resilient[74]. Given the dependence of digital devices on electrical power, there will be a complementary requirement for electricity infrastructure. New emerging technologies such as 'whitespace' applications particularly attempt to improve the internet access in rural areas. With enabling policies, such technologies could play a key role in strengthening the technological infrastructure at the grass root level.

Data Infrastructure: the principle of interoperability also applies to the data infrastructure; enabling data held on any device and application to be used by any other device and application. A second principle will be data quality: ensuring the value of the data that is in circulation.

Financial Infrastructure: the financing of digital development will need to come from multiple channels. Overall, private sector investments in ICTs in the global South now dwarf those from government and donor agencies, though the pattern is uneven[75]. New sources of financing digital development are arising; for example through new aid donors of the global South or from social enterprises[76]. A number of these are collaborative models including public-private partnerships and crowdfunding[77].

Human Infrastructure: it is widely understood that ICT usage skills are a requirement for development[78]. However, this basic element of human infrastructure needs to be expanded in three dimensions:

- Capabilities: digital development requires capabilities – not just new skills but also new knowledge and attitudes[79]. Thus, for example, ICT users need not just the skills to access data online but also the knowledge to evaluate that data and turn it into information, adding value to the information obtained.
- Roles: as discussed earlier it is not simply about using ICTs, it is about roles of increasing capability – such as producer, worker, entrepreneur, innovator. These are the roles that are of greatest value within a digital development paradigm, and the capabilities must exist for these roles to be fulfilled.

- Complementary Capabilities: Both ICT producers and consumers require more than just ICT capabilities in order to reap development benefits[80]. ICT producers require interpersonal and employment capabilities. ICT consumers require decision and action capabilities.

Institutional Infrastructure:

- Leadership: there is growing recognition that specific digital development initiatives require one or more individuals to champion them and drive them forwards[81].
- Culture: partly covered already by encompassing attitudes within the notion of capabilities, this looks at contextual norms and values, which would need to support or at least be in synch with the norms and values of digital development.
- Other Incentives: of these, one of the most important will be the expressed demand for digital development and its goods and services from citizens in a particular context.
- Policy: appropriate policies and governance structure are required to support the digital ecosystem. These topics are dealt with in more detail in sections C3 and C4.

Systemic Infrastructure: the elements of infrastructure need to be organised together into sub-systems performing different functions. These could be within a single organisation but will more likely be a more open network model. One key example will be the structural arrangements for policy governance, discussed in Section C4. Another key example will be the structural arrangements for digital innovation. With growth in digital capabilities at all levels in society, there will be an expansion in collaborative models such as the co-innovation approaches adopted by living labs[82], and an expansion in grassroots models like digital incubators, hubs, fablabs, hackerspaces and maker faires[83].

C2b. Digital Inclusion

Digital development is based on networks. We can therefore analyse three groups that digital development will create, based on their position vis-a-vis the digital network[84].

"Haves": these are individuals that are particularly well connected on the network with ready access to all of the various resources (money, skills, power, etc) required for network activity. They will benefit from whatever changes digital development throws up. The majority of 'millennials' and 'digital natives' of the global north fall into this category.

"Have-Nots": those who are excluded from digital networks will be in the weakest of all positions. The dimensions of the digital divide that forms this exclusion are well known, with have-nots over-represented in groups including those on lowest incomes, those living in rural areas, women, seniors, those with disabilities, and ethnic/linguistic minorities[85]. The size of excluded groups varies but examples include: 24% of those earning less than US$1 per day in a sample of African countries had no access to a mobile phone, and 7.5% of those earning less than roughly US$2 per day in a sample of Asian countries; 79% of Africa's population, 69% of Asia's population, 55% of the Middle East's population and 45% of South America's population are labelled Internet non-users[86]. Emerging technologies, such as

whitespace and rural-wifi applications, would help to spread the benefits of ICTs to these excluded groups who are most in need of the promised benefits of digital development. Such technologies need to be identified and if found feasible need to be promoted on larger scale.

"Have-Lesses": between the haves and the have-nots are a rather less clear-cut group who simultaneously experience pros and cons of being part of digital networks. For example, those in low-end digital jobs benefit from higher income and higher status but at the same time their employment is unstable and insecure[87]. The have-lesses are often constrained from getting maximum benefits from digital development because they lack complementary resources necessary to create an effective chain linking the digital data they receive to beneficial development results. The 'millennials' of the global south most often find themselves in this category. For example, the 'millennials' in several African countries, though exposed to the opportunities offered through various online hosting platforms, finds it increasingly difficult to make use of the same because their domestic banking system is not yet integrated into global payment gateways (such as Paypal)[88].

Overall, the digital development paradigm is associated with growing inequality between the 'haves' who strongly gain from digital development, the 'have-lesses' who experience fewer gains and sometimes losses, and the 'have-nots' who remains excluded. This inequality is often conceived in terms of polarisation, with the elite progressing away from the rest through their harnessing of ICTs. There is direct evidence of this polarisation from the labour market[89] and from politics[90]. Also, it has been found that digital inequality tends to reflect other inequalities (in terms of employment, education and income) that already exist in the society, based along sub-groups such as gender[91] and ethnicity.

In these situations, inclusion will mean not just connection to the digital network, but also access to the resources and obtaining capabilities that enable digital foundations to be turned into development results. This could be better understood better in terms of the digital "role ladder" that was discussed earlier in the paper. In this context, in order to empower people to take digital 'producer roles' it is not sufficient to merely provide skills but also the employment opportunities to turn those skills into livelihood opportunities[92]. For example, the 'millennials' come with the skill set of greater experience and exposure with ICT applications, but greater efforts are needed to find gainful employment opportunities to channel their skills. Similarly, for empowering the people in digital 'consumer roles' it is not sufficient to merely provide – for example – open government data but it is equally important to strengthen civil society bodies that can turn this data into tools for creating accountability[93].

C2c. Digital Sustainability

The linkages between ICTs and sustainability can be understood in terms of the level or order of the impact[94] :

- First order effects: Those impacts created by the physical existence of ICT sectors. Examples include carbon emissions attributed to manufacturing of ICT related products and e-waste.

- Second order effects: These are indirect impacts from the ongoing use and application of ICTs. The reduction in carbon emissions due to smart-grids and automation of the power sector falls into this category.
- Rebound effects: These are impacts from the behavioural changes that themselves originate from the first and second order impacts. For instance, though ICT might reduce the need for everyday transportation to work by facilitating telecommuting, ICT might motivate people to engage in more use of transportation for leisure activities.
- Third order effects: Originate due to aggregate impact of large number of people using ICT applications in their daily lives. For example, the changes in consumption patterns of the society triggered by ICT usage has environmental and sustainability implications.

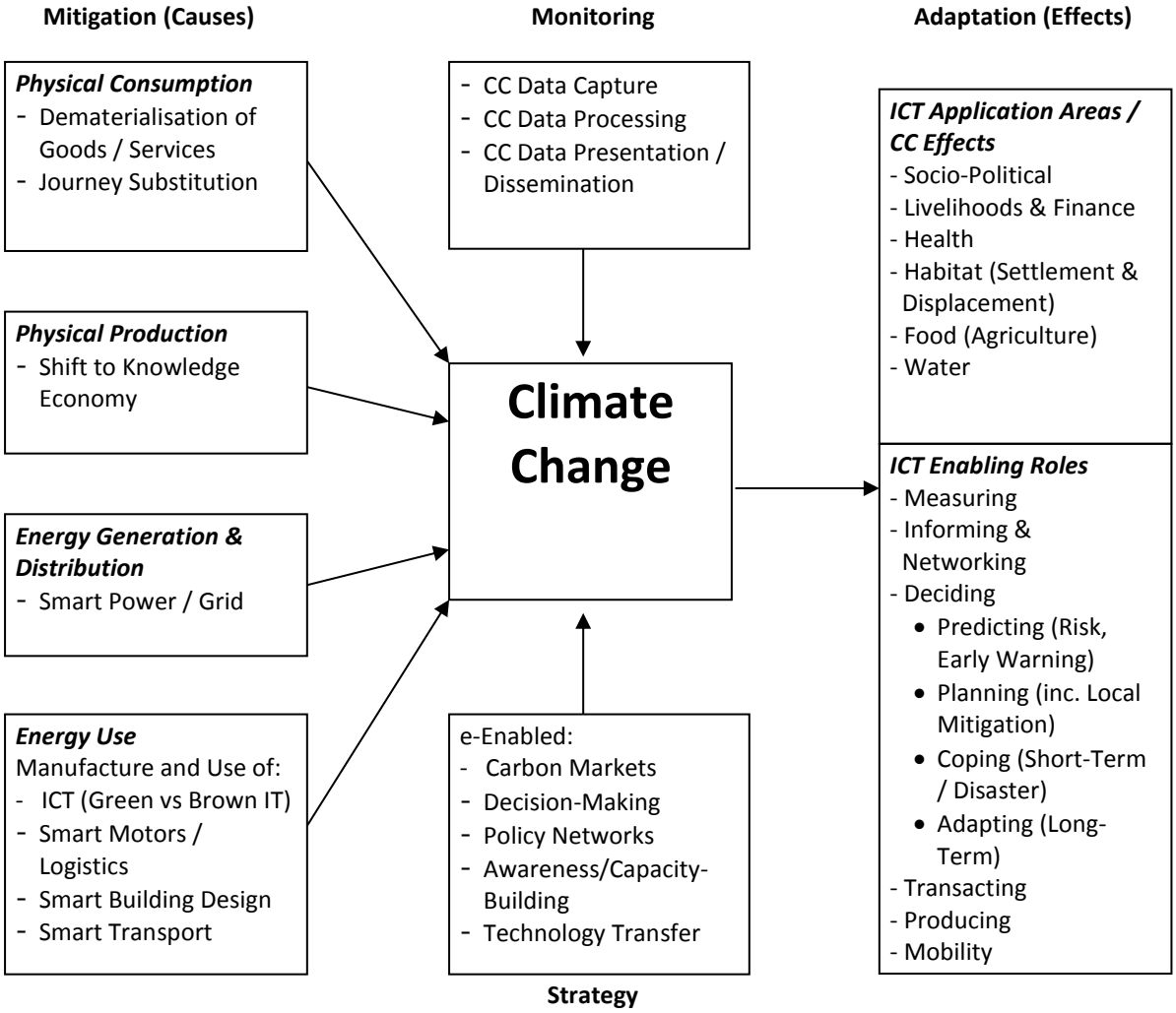


Figure 3: Model of Connections Between ICTs and Climate Change

Through these multi-order impacts ICTs have a central role to play in enabling sustainable development. For instance, the multiple linkages between ICTs and climate change can be principally summarised as shown in Figure 3[95]. A main focus for investment and innovation in the connection between ICTs and climate change, for example, has been mitigation. This

includes understanding the growing carbon footprint of the IT sector itself, and attempts to reduce this via interventions such as 'green IT actions'[3] [96]. As well, it is important to seek opportunities to reduce carbon emissions in other sectors through smart applications[97]. Interventions along this line could be planned in terms of adaptation within individual sectors such as use of ICTs in climate-smart agriculture or in climate-adaptive water projects[98]. Alternatively, it can also be planned on a more holistic basis, by identifying the contribution of ICTs to community-wide resilience[99].

Although the relation between climate change and ICTs has taken the lion's share of attention in relation to sustainability, other environmental issues also require attention. These include e-waste (first-order effects) given that ICTs are a growing source of pollution in developing countries, where e-waste handling and recycling facilities are limited[100].

Emerging technologies, such as that of next generation microsatellites would help to harness the power of space technology in the quest for sustainability. For instance, next generation satellites, such as low-cost nanosatellites, could be put to use in terms of regular monitoring of forest resources, detection of forest fires, early warning systems for catastrophes, emergency responses in the aftermath of disasters, real time gauging of carbon emissions and other pollutants. Such emerging technologies are poised to further increase the linkages between ICTs and sustainability in the near future.

C2d. Digital Threats

There are a range of digital development outcomes which vary from jurisdiction to jurisdiction in terms of their legality but which are regarded in many contexts as problematic. They include:

Cybercrime: which can be divided into:

- "Offences against confidentiality, integrity and availability of information and communication infrastructures" such as hacking, cyberterrorist attacks, wiretapping, computer espionage and extortion.
- "Computer-related traditional crimes" such as fraud, money-laundering, online grooming of children, and attacks on public safety.
- "Content-related offences" such as child pornography, racism, libel, cyberbullying, cyberstalking and incitement to other crimes including terrorism.
- "Offences related to infringements of copyright and related rights"[101].

There are direct beneficiaries of cybercrime (the perpetrators) and indirect beneficiaries (those who make a living in the cybersecurity industry). 'Millennials' are particularly vulnerable to such crimes due to their high usage of internet, recent estimates show that 70% of the 'millennials' are victims of cybercrime[102]. But the costs of cybercrime are:

- Economic: reliable figures are very hard to come by but detailed analysis suggests global costs of direct cybercrime are at least US$3.5bn; of "transitional" cybercrime (payment card fraud relating to transition from traditional to virtual payment) are at least US$46bn; and of the infrastructure to fight cybercrime are at least US$25bn[103].

[3] 'Green IT action' refers to the practice of designing, manufacturing, using, and disposing of all IT related equipment efficiently and effectively with minimal or no impact on the environment.

- Political: in undermining national security of nation-states and trust in national governments[104].
- Social: for example seen in the damage caused to individuals who are the victims of content-related offences[105].

Pornography: one estimate is that 14% of searches and 4% of websites relate to pornography, and that it forms a US$20bn global industry[106]. Assumptions about the damaging impact of pornography run well ahead of the evidence but "consistent findings have emerged linking adolescent use of pornography that depicts violence with increased degrees of sexually aggressive 22behaviour" and that use of pornography leads to negative self-image among adolescent girls and boys[107]. The Internet-enabled expansion of child pornography harms all those involved[108].

Gambling: the great majority of online gamblers are moderate in their betting[109]. However, a small proportion is "problem gamblers": those who invest significant money and time in gambling, with detriments to their own wellbeing and that of others around them[110]. There is evidence that the extent of problems is exacerbated online, with problem gamblers representing a significantly higher proportion of online than physical gamblers, and with evidence that Internet gambling leads to problem gambling[111].

Curtailment of Rights: three types of rights are the subject of particular concerns: the protection of privacy, the freedom expression and opinion, and the intellectual property rights. These are much debated issues in digital development.

Monopoly: although in a different category to the other items mentioned here, the ICT sector leads to emergence of info-monopolies. Great care needs to be taken to avoid some negative assumptions about Internet monopolies[112].

- There are consumer benefits to the network effects of monopoly: the utility of joining large social networking sites is generally greater than that of joining much smaller rivals.
- There are producer benefits for the monopoly suppliers themselves.
- Most Internet monopolies operate in two- or multi-sided markets with clients who benefit from their monopoly (e.g. the advertisers who use Google, or the sellers who use eBay).
- Assumptions about the costs or longevity of dominant players in particular Internet sectors may be exaggerated.

However, there are disbenefits associated with the info-monopolies including damaging competitors by raising costs and other barriers to entry, enforcing exclusivity deals, and predatory pricing; damaging consumers by invasions of privacy and lock-in; and damaging governments by tax avoidance[113]. One way in which these might be partly addressed would be through greater support for "open development" activities[114]. These could potentially challenge monopolistic and proprietary models through ICT-based open and cooperative models.

C3. Key Policy Instruments to Support Effective Digital Development

There are two primary reasons for policy interventions associated with digital development: Firstly, to address any shortcomings within the digital ecosystem which will act as constraints to effective digital development; secondly, to address any disbenefits of digital development that emerge within the spheres of inclusion, sustainability and threats. This section recommends certain key policy instruments in the four key policy focus areas described in the previous section: namely, digital ecosystem, digital inclusion, digital sustainability and digital threat.

C3a. Digital Ecosystem Policy

The objective of state policy should be to ensure a pervasive infrastructure and effective ecosystem for digital development. In pursuit of that objective, it may develop a number of goals to be achieved via a variety of policy instruments. Preparatory work would include an audit of the current digital ecosystem in order to identify those particular areas in which it was weak.

Digital Ecosystem Policy Objective: to ensure a pervasive infrastructure and effective ecosystem for digital development	
Policy Goals	**Policy Instruments**
A pervasive, high-capacity, interoperable technological infrastructure	• Invest directly in telecommunications infrastructure including broadband • Encourage private sector investment in telecommunications infrastructure • Ensure independent regulation of telecommunications infrastructure • Regulate cost-based interconnection between networks • Develop country-level Internet Exchange Points • Set minimum, universal access speed requirements
A pervasive, high-quality, interoperable data infrastructure	• Promote or mandate use of interoperable data standards • Invest in capacity for data capture, analytics and visualisation • Introduce regulations on data integrity, retention, consent, usage and administration
A high-volume flow of financial investment with long-term perspective	• Steer development financing, including crowd-funding, into ICT investments • Provide direct funding for ICT investments • Encourage private sector funding of ICT including use of public-private partnerships
A pervasive, full-spectrum set of ICT consumption and production capabilities	• Introduce ICT skills as a component of primary, secondary and tertiary education curricula including higher-level entrepreneur and innovator capabilities • Provide specific support for building higher-level capacities among digital natives and millennials that enables them to emerge as innovators and entrepreneurs. • Provide subsidy or tax breaks for in-service ICT-related

	training
A pervasive, full-spectrum set of ICT-complementary consumption and production capabilities	• Provide specific support for building complementary capabilities especially, among digital natives and millennials. • Facilitate collaborative partnerships between millennials across countries through appropriate university and research virtual networks. • Provide a supportive legal environment for economic digital transformation • Interventions to promote ICT application in all development sectors (health, education, agriculture, small enterprise, public administration, etc)
The necessary legal framework to enable digital processes	• Promoting legal recognition for digital signatures, contracts and transactions
A supportive institutional infrastructure for digital development	• Identify and develop digital development champions • Raise understanding and awareness of digital development impacts
The necessary structures and processes to support digital development	• Support development of online IT employment databases that will cater to the needs especially of millennials • Provide business development services specifically for digital economy enterprises • Support digital economy enterprises through other investments and incentives e.g. around R&D • Support digital innovation through direct funding, subsidy and tax breaks including co-creation

C3b. Digital Inclusion Policy

The objective of state policy should be to ensure the benefits of digital development are shared by all. A core goal would be to ensure that the digital ecosystem, in all its elements, extends to encompass excluded groups. Preparatory work would include an audit of the dimensions of digital exclusion: income, geography, gender, ethnicity, disability, age, etc.

Digital Inclusion Policy Objective: to ensure the benefits of digital development are shared by all	
Policy Goals	**Policy Instruments**
The digital ecosystem encompasses marginalised groups	• Universal service funds or obligations for mobile, Internet and other ICT infrastructure • Facilitate the experimentation and adaptation of emerging technologies such as whitespace that enables ubiquitous access to broadband internet in rural areas. • Targeted financing for digital inclusion initiatives • Targeted ICT capability-building for marginalised groups including higher-level entrepreneur and innovator capabilities
Adequate incentives for inclusive digital innovation	• Support new partnerships for IDI e.g. international consortia, and public-private

(IDI)	• Funding to procure IDIs and/or for R&D to pilot IDIs including cost-sharing • Promote universal design and usability principles • Support information flows about digital innovation needs of excluded groups e.g. via market research • Competition policy to push firms to expand into marginalised (e.g. low-income) markets • Support grassroots innovator links to formal sector (e.g. network events, fairs, competitions/award, innovation databases, reports to amplify awareness of grassroots IDI, marketing assistance, quality assurance, government procurement) • Support IDI intermediaries (capacity-building, financial interventions)
Promote effective uptake of ICTs by marginalised groups	• Embed ICTs into government information and service delivery • Support ICT embedding by others (NGO, private sector) delivering information and services to marginalised groups • Accelerate affordability via financial support (subsidy, tax exemption, etc) for inclusive ICT goods and services • Targeted ICT-complementary capability-building for marginalised groups including digital business development support • Capacity-building and financial support for infomediaries in marginalised (e.g. low-income) communities • Support for ICT incubators / hubs / clusters in marginalised communities

C3c. Digital Sustainability Policy

The objective of state policy should be to ensure the sustainability of digital development.

Digital Sustainability Policy Objective: to ensure the sustainability of digital development	
Policy Goals	**Policy Instruments**
Reduce the environmental impact of the ICT sector	• Introduce sustainability initiatives such as green IT[4] actions for design and sourcing of IT • Ensure effective recycling of e-waste via recycling capacity-building and/or extended producer responsibility
Reduce the environmental impact of non-ICT sectors	• Provide funding and capacity-building for smart applications (power, motors, buildings, transport/logistics)
Improve the management of climate change	• Develop ICT-based capacity to model and monitor climate change • Encourage the design and experimentation of next generation satellites (such as nanosatellites) and their

[4] 'Green IT action' is defined as the practice of designing, manufacturing, using, and disposing of all IT related equipment efficiently and effectively with minimal or no impact on the environment.

	applications in adaptation and mitigation of climate change, disaster response and pollution control • Support ICT-enabled strategic tools for climate change e.g. carbon markets and technology transfer • Support ICT application in climate change policy-making • Integrate ICTs into making and content of National Adaptation Programmes of Action • Support ICT application in climate-smart agriculture • Support ICT application for adaptation in other vulnerable sectors (poverty, water, health, habitat, ecosystems, disaster management)
Increase the resilience of development systems	• Improve robustness e.g. by providing ICT tools to support system institutions • Improve self-organisation e.g. by enabling e-deliberation • Improve learning e.g. by developing ICT-enabled communities of practice • Improve other resilience attributes e.g. scale by providing ICT-based links to wider institutions

C3d. Digital Threats Policy

The objective of state policy should be to reduce the other emergent disbenefits associated with digital development.

Digital Threats Policy Objective: to reduce the other emergent disbenefits associated with digital development	
Policy Goals	**Policy Instruments**
Reduce levels of cybercrime	• Appropriate legislation to outlaw hacking • Actions to raise awareness of cybercrime and cybersecurity • Create cybersecurity agencies and capabilities • Create appropriate anti-cyberterrorist and anti-cyberwarfare agencies and capacity at national and international level • Extend conventional crime legislation to cover online activity (e.g. espionage, fraud, grooming, child pornography, hate crime, bullying, stalking)
Reduce the threats caused by socially-equivocal applications	• Policies limiting access to online pornography • Policies limiting access to online gambling
Protect digital rights	• Appropriate legislations for protection of online privacy, freedom of opinion and expression, and intellectual property rights.
Reduce the disbenefits of info-monopolies	• Anti-trust, anti-monopoly regulation and other competition law covering online activity • Clear application of taxation rules to online activity • Improved monitoring of digital financial flows
Support open development	• Capacity building and incentives for open data initiatives in

	public and other sectors • Use of open standards for IT in public sector • Use of open source software in public sector • Development of open e-learning resources and open access publication of scientific research • Incentives and capacity-building to support use of ICTs in cooperatively-owned organisations and in cooperative production processes • Co-produced e-government services and deliberative e-participation initiatives

C4. Digital Development Policy Governance

For effective digital development to be encouraged, more than new policy content is needed[115]. Policy makers must also consider the governance of digital development policy; especially the structures through which digital development policy is made.

During the pre-digital era, the structural approach to ICT policy has been sidestreaming, i.e., locating ICT policy in a single specialist body; typically a Ministry with one or more of "Information", "Communications" and "Technology" in its title. But this becomes untenable as ICTs diffuse into ever-more areas of activity, requiring a broader range of policy responses.

The ICT4D has attempted to encourage countries for mainstreaming ICT policies, i.e., moving or developing responsibilities for ICT-related policy within other Ministries. The need for mainstreaming becomes even greater as countries continue to give ICTs a more central role in their development policies. Hence, every Ministry would be involved in policy for digital development and so there must be pervasive mainstreaming of ICT policy in future.

However, there are several dangers in mainstreaming[116]. These include a lack of adequate understanding of ICTs within mainstream Ministries, and fragmentation and incoherence of digital policy across sectors. Hence, following up on the 'digital ecosystem' approach we discussed earlier, what is required then, is a holistic understanding and allocation of responsibilities, filling the type of skeleton shown in Table 2.

Table 2: Digital Development Policy Responsibilities	
Policy Actors	**Policy Responsibilities**
Core ICT Policy (e.g. Ministry of ICT)	Technical and data elements of Digital Ecosystem, Inclusion, Sustainability, Threats policies
Contextual Policy (e.g. Ministries of Finance, Enterprise, Trade & Industry, Education, Science & Technology)	Broader aspects of Digital Ecosystem and Digital Inclusion policies: finance, capabilities, digital processes, business development, innovation
Specific Policy	Particular aspects of particular policies e.g. Digital

	Inclusion (Ministry of Community Development); Digital Sustainability (Ministry of Environment); Digital Threats (Ministry of Information and Media; Ministry of Trade & Industry)
Sectoral Policy (e.g. Ministries of Agriculture, Health, Education, Finance, Enterprise, Public Administration, National Security, etc)	Sectoral aspects of Digital Ecosystem policy promoting transformative ICT application
International Policy (e.g. UN and other supranational bodies)	Cross-national aspects to Digital Ecosystem, Inclusion, Sustainability, Threat policies
Business Strategy (e.g. leading, transnational digital corporations)	Recognition that business strategies of key digital corporations form part of the policy system
Civil Society	Informing the government about the needs of the society such as weakness in components of digital ecosystem, specific issues related to digital inclusivity, sustainability and to control digital threats.

But to make this allocation of division of responsibilities to work properly, a proposal is that a cross-cutting structure will need to be created: something like a “Digital Development Policy Collaboratory", summarised graphically in Figure 4. This will perform a dual bridging role, drawing in horizontally policy actors from both ICT and development (and context); and drawing in vertically those connected with both government and other sectors. Indeed, experiences with various types of ICT policy suggest the value and merits of autonomous and capable state agencies, combined with strong representative bodies for both the private sector and civil society and a mechanism for robust interaction between these three groups. Digital Development Policy Collaboratories should also adopt an experimental and iterative approach to policy, allowing incremental learning and policy revision.

Governments could seek to develop a single collaboratory for all areas of digital development policy. However, this could become unwieldy given digital activity extends to every area of government responsibility. Governments could therefore consider separate collaboratories for each of the four main areas: Ecosystem, Inclusion, Sustainability and Threats. There will also need to be more specific policy collaborations to ensure coherence around particular convergence issues. For example, Ministries of Finance and ICT will need to work together on the implications of m-money and e-money becoming the basis for financial and banking transactions; Ministries of Employment and ICT will need to work together on the implications of how best to generate jobs for the millennials and digital natives, also, identify in advance sectors that will lose jobs due to ICT applications in future; Ministries of Education and ICT will need to work together on the increasing digital mediation of learning.

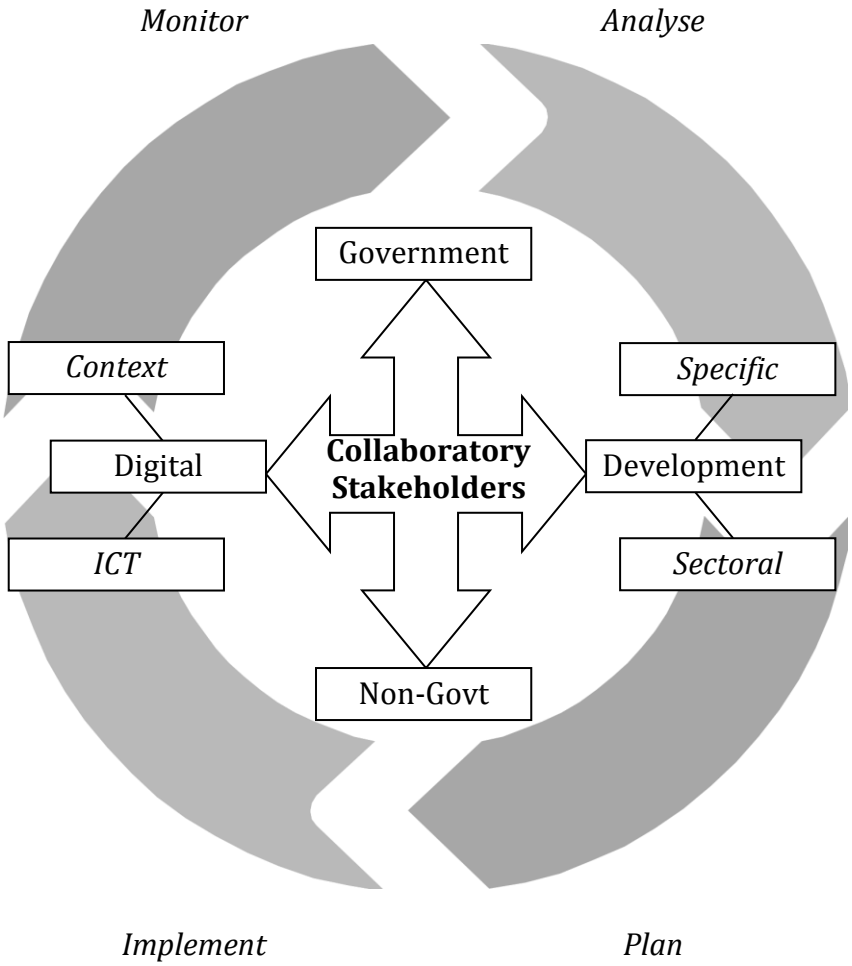


Figure 4: Digital Development Policy Collaboratory

Conclusion

ICTs are becoming more central to our lives and the way we conceptualise and experience development. This paper began with analysing the changing landscape of ICT4D. It identified significant changes observed in terms of digital technologies (including the five big emerging trends in ICT, rural wifi though whitespace, next generation satellites), digital demographics (geographic shift in the composition of users as well as demographic changes in terms of millennials and digital natives) and new development priorities in terms of the emerging post-2015 development agenda. The paper then listed some transformative impacts of these changes on society particularly in two important sectors, namely, economy and politics.

In light of these changes and their implications, the paper explained the need to broaden the current ICT4D discourse such that ICTs receive a more central role in development process. In order to facilitate this broadening of ICT4D discourse, four focus areas were identified for policy interventions, namely, creating a digital ecosystem, ensuring digital

inclusion, and digital sustainability, and mitigating the digital threats. Key policy interventions were then identified for each of these four policy focus areas. The paper concluded with analysing the current digital policy structure and providing a proposal for a new cross-cutting policy structure to ensure effective digital development.

Questions for Discussion

1. What is the role of 'millennials' in driving the transition towards a new digital development era?
2. What are the best ways to use ICT to harness the power of the 'millennials' in the path towards sustainable development?
3. What are the prospects of emerging technologies (such as application of whitespace to enable rural wifi access) in making digital development more inclusive?
4. In which aspect are digital ecosystems (technical, data, financial, human, institutional and systemic infrastructure), especially in developing countries, currently weakest?
5. How can we strengthen digital ecosystems of developing countries?
6. What policies can be undertaken to promote the development and applications of technologies such as next generation micro satellites towards ensuring digital sustainability?
7. How can we give ICT a more central role in the emerging post-2015 development agenda?
8. Are there already examples of Digital Development Policy Collaboratory-type bodies that we can learn from? How effective will such cross-cutting structures be in digital development policy making?

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Appendix 1: Ubiquitous Access in the Digital Age through WhiteSpace Technology and Nanosatellites[5]

Introduction

Broadband Internet and innovative technologies contribute to inclusion of developing countries in world economy, science and technology for development. According to recent Internet World Stats, however, 2 out of 3 persons around the world have no access to Internet i.e.: fixed broadband access is unaffordable for 4.3 billion people [1]. A majority of this population lives in rural or remote areas. Access to Internet in these areas is technically difficult. In even the most developed countries, there are huge gaps in internet access. [2]. To circumvent this problem, diverse solutions are proposed relying on radiocommunication and efficient use of radio spectrum. One of the most promising of these is the use of whitespace for rural internet access.

Use of white space for broadband Internet

National and international bodies assign different frequencies for specific uses and in most cases license the rights to provide services over these frequencies. This frequency allocation process creates a band-plan, which for technical reasons assigns white space between used radio bands or channels to avoid interference [3]. In this case, while the frequencies are unused, they have been specifically assigned for a purpose, such as a guard band (unused part of the radio spectrum between radio bands to avoid interference). Most commonly these white spaces exist naturally between used channels to avoid harmful interference. In addition to white space assigned for technical reasons, there is also unused radio spectrum which is becoming free as a result of technical changes. In particular, the switchover to digital television frees up large areas of the spectrum. Experiments are being carried out how to use white space for broadband Internet [4], [5].

Initiatives to offer broadband Internet access in rural areas using white space.

More and more viable initiatives exist to use white space. Some examples:

3.1 Indigo Telecom/Microsoft and the Kenyan government is reportedly delivering bandwidth speeds of up to 16 Mbit/s to three rural communities which lack electricity. TV White Space technology operates in the unused portions of the broadcasting band (470-862 MHz) to provide internet connectivity in rural (underserved) areas [6].

3.2 In Namibia "Citizen Connect" project, a collaboration between the Microsoft 4Afrika Initiative, the MyDigitalBridge Foundation, and the MCA-N (Millennium Challenge Account Namibia), has been started to deliver broadband Internet to "twenty-seven schools and seven circuit offices of the Ministry of Education using "TV White Space technology" [7],[8] and [9].

3.3 In South Africa, Google, in a partnership with the Independent Communications Authority of South Africa, the Council for Scientific and Industrial Research (CSIR),

[5] Based on a contribution by CSTD Vice-Chair Mr. Peter Major.

the Wireless Access Providers Association (WAPA) and Carlson wireless delivers wireless access to 10 schools through 3 base stations at the campus of Stellenbosch University's Faculty of Medicine and Health Sciences in Tygerberg, Cape Town [10].

Rural areas are often inhibited from wireless access because they are inaccessible and off the local power grid. Cell towers are difficult to install and cannot connect, either. Fortunately, White Space power stations can be charged with solar panels, and the excess electricity generated can also power other institutions in the area such as schools [11].

Use of communication satellites to offer broadband Internet access in rural areas

Many pilot projects have been conducted to use communication satellites for Internet access. They have been used in rural areas and developing nations since the early days of the Internet, and the industry has remained viable as a result of technical progress in launch technology (public and private), antennas, solar power, radios and other electronics, as well as tuning of TCP/IP protocols to account for the 1/4 second latency due to the orbital altitude. It Is suggested that these technologies progressed to the point where High altitude platform stations (HAPS) and lower orbit satellites are now viable as well.

Technology	Altitude (km)	Latency	Footprint
High altitude platform	15-30	Very low	Very small
Low Earth orbit satellite	160 – 2,000	Low	Small
Medium Earth orbit satellite	> 2,000	Medium	Medium
Geostationary satellite	36,000	High	Largest

Table 1: Satellite orbits and characteristics [12]

High altitude platforms (HAPs) are non-rigid airship, drones or balloons that hover or circulate in the stratosphere. They have cloudless access to solar energy and being above the weather helps with control, but their signals must travel through rain and clouds. They are the lowest flying technology, so packet latency is relatively small, but so is their "footprint" - the area their signal covers on the ground.

Low Earth orbit satellites (LEO) move relative to the ground, which means that either communication windows are intermittent or many satellites are needed to cover the planet. Most satellites, like the International Space Station and sensing satellites are LEO satellites. Today, the best-known LEO communication system is Iridium's satellite phone service, consisting of 66 LEO satellites.

Medium Earth orbit (MEO) satellites are used for communication and navigation.

Geostationary satellites positioned above the equator and remain stationary with respect to the surface of the earth since they orbit exactly once per day. Their orbit altitude enables multi-country footprints, but latency and launch costs are high. Today's commercial satellite Internet connectivity is provided mostly by geostationary satellites.

Initiatives to offer broadband Internet using satellite communication

5.1 Google Project Loon uses high-altitude balloons placed in the stratosphere at an altitude of about 32 km to create an aerial wireless network with up to 3G-like speeds. Google began a pilot experiment in June 2013 in New Zealand. The balloons are manoeuvred by adjusting their altitude to float to a wind layer after identifying the wind layer with the desired speed and direction. Each super-pressure balloon is massive with a whopping 15-meter diameter. It is made of very thin, very light polyethylene plastic. It is strong enough to lift the flight computer and other electronics. All these are powered by a solar power panel [13],[14].

5.2 Google recently announced another project with O3b Networks (other three billion). O3b currently has four satellites in 8,000 kilometer equatorial orbits and they plan to launch four more this year to offer continuous service to all parts of the Earth within 45 degrees of the Equator. In the project Google plans spending billions dollars and putting at least 180 satellites in orbit.

Google, along with Facebook, is a founding partner of Internet.org, which seeks "affordable internet access for the two thirds of the world not yet connected"[15].

Ubiquitous access to satellite services

Satellite communication is used to promote education, earth science, testing innovative technologies, technology transfer and collaboration between countries, universities, scientific organisations. Nano and picosatellites are relatively fast to develop, cheap to build and launch. These satellites are of 1-10kg have an edge length of less than 30 cm. Their mission lifetime is less than 3 years.

Category	Mass [kg]	Typical cost US$	Max dimensions [m]	Development time [years]	Orbit	Mission duration [years]
Large	> 1000	100 -500 M	3-10	3-10	GEO MEO LEO	10-20
Mini	100- 1000	30 – 200 M	1- 5	1- 5		5 – 10
Micro	10 - 100	10 – 150 M	0,5 – 1	1- 3	LEO	2 – 6
Nano	1-10	100k – 10M	0, 1 – 0, 5			1- 3
Pico	0,1 – 1	50k – 2M	0,02 – 0,1			
Femto	< 0,1	< 50k	< 0,03	1		< 1

Table 2: Satellite categories and characteristics [16]

It is suggested that In the future, everyone on Earth will have ubiquitous access to outer space [16]. Just 30 years ago, access to a computer was limited, elitist, and expensive. Today, computers are ubiquitous, inexpensive, and for everyone. In developing countries view

computing and access to the Internet as a necessity, even an economic right. The nascent commercial space industry is reliving a similar pattern seen during the late 20th century computer revolution. Nanosatellites are transforming space access the way personal computers made the mainframe computer obsolete, started the modern technological era, and radically altered society. Nanosatellites are bringing space into everyday life: they offer greater possibilities of individualized satellite access for entertainment, education, convenience, and a myriad of practical applications [17].

The growing number of these satellites puts great pressure on the frequency bands currently in use. Preparatory work is carried out in the ITU to study characteristics, spectrum requirements and services of nano and pico satellites [18], [19]. Nanosatellites are bringing space exploration to the masses. The first Kickstarter.com satellite project went online in early 2012 [20], and there have now been dozens of projects that empower individuals to collect data and pictures from space.

Policy implications

Efficient use of radio spectrum has policy and regulatory implications. In the International Telecommunication Union studies have been undertaken to address growing spectrum shortages. It is expected that these studies will produce results in the coming 3-4 years and will be considered by the World Radiocommunication Conference in 2018 (WRC-18). Some governments (China, Kenya, Namibia, the Russian Federation, South Africa, UAE, UK, USA, etc) have taken initiatives to support the private sector experiments and/or conduct feasibility studies on the use of white spaces. Characteristics, spectrum requirements and services of nano and pico satellites are also on the preliminary agenda of WRC-18.

Initiatives are reported about cooperation of universities on national and international level. University Space Engineering Consortiums (UNISEC) provide framework for this cooperation. UNISECs exist in Canada, Egypt, Germany, Ghana, India, Italy, Japan, Korea, Mexico, Mongolia, Nigeria, Peru, the Philippines, Russia, Saudi Arabia, South Africa, Taiwan Province of China, Tunisia, Turkey, etc. UNSECs are being formed with the ambitious target to create a world where university students can participate in practical space projects in more than 100 countries by the end of 2020[22]. In some countries governments, national and international space agencies are involved in these projects. More governmental commitment and funding would contribute to raising awareness and capacity building in satellite communications and to the deployment of microsatellites to be used in weather forecasting, earth observation, climate change, remote sensing and communication.

Conclusion

Radiocommunication already contributes and will continue to contribute to ubiquitous access to Internet, new technologies, scientific research and cooperation and development. Satellite services in the future may allow having more accurate weather prediction due to availability of data about weather and our planet, accurate models about climate change, drought, and other natural disasters like earthquakes or tsunamis and exact estimates about endangered animals on land and in the ocean [21]. Satellites warn us about Near Earth Objects, and individuals replicate the billion-dollar missions of Kepler and Hubble to make

new discoveries about the origin of the universe. There are still technical, economical and regulatory challenges that have to be resolved to allow developing countries to better integrate in the world economy and science.

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