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Enabling Transformation: *Information and Communications Technologies and the Networked Society*

“We all belong in this fragile network of interdependence.”

Archbishop Desmond Tutu, World Economic Forum Annual Meeting 2009

Introduction:

Our interconnected world is increasingly marked by fluid boundaries, tighter interlinkages and globally coordinated actions. Among these complexities, **one of the most influential factors shaping our global society are networks**. Culturally, economically and environmentally, the quality and quantity of our networks is shaping our collective future.

Networks serve as a central metaphor for describing the complexities of modern life. But they are also an **undeniable technological foundation for unlocking tremendous social and economic benefits**. Understanding the dynamics of networks — and their potential for positive change — can help us collectively meet our greatest social, economic and environmental challenges.

Looking across today's global networked society, one of the most notable differences is the manner in which value is created. While industrial economies are based on *controlling* the supply of scarce resources, networked economies create value by abundantly *connecting* individuals, functions and endpoints. As each new person and device is connected to a network its collective value grows exponentially.

This paper will examine ways in which this exponentially growing value can be distributed. In particular, it will focus on how Information and Communications Technologies (ICT) can catalyze economic transformation and growth. The second in a series of three reports, it will showcase how ICT can serve as a strategic enabler in the transformation of the health, energy and automotive sectors. Overall, the aim is to demonstrate the vital importance of flexible policy frameworks and balanced incentives for delivering inclusive, intelligent and scalable ICT solutions to help improve the state of the world.

Transforming the Energy Sector

The energy sector provides a clear example of how ICT can serve as the foundation in the transition to a low-carbon, sustainable economy.

Smart services and machine-to-machine (M2M) communications enable businesses to save energy, water and natural resources, create efficiencies and boost revenues, as well as deliver solutions that can improve quality of life while reducing carbon emissions. As society progresses to a sustainable and low-carbon future, investments must be first made to the existing power grid infrastructure. The current legacy electrical transmission and distribution networks are designed for one-way electricity flows and composed of many analog and electromechanical systems. They are highly centralized, prone to unpredictable disruptions, slow and manual in service restoration and limited in transparency concerning pricing options.

Smart grids enable the electricity infrastructure to be more effectively measured, controlled, automated and integrated with both existing systems and new energy sources. Highly flexible and adaptive, the ICT-enabled smart grid generates new business models, new energy management services, new tariff structures and new ways to engage and collaborate with consumers[1]. In particular, the impact of smart grids can be viewed in the following ways:

- Reducing global carbon emissions
- Delivering energy more efficiently and reliably
- Providing the capacity to integrate more renewable energy into existing networks
- Enabling customers to have greater control of their energy consumption[2]

As a result, the smart grid is more efficient, reliable and secure with fewer service interruptions as wireless and wireline access technologies aid utilities to process information in real time as it is collected from generating stations. This provides utilities with enhanced abilities to make critical decisions involving grid efficiency and security.

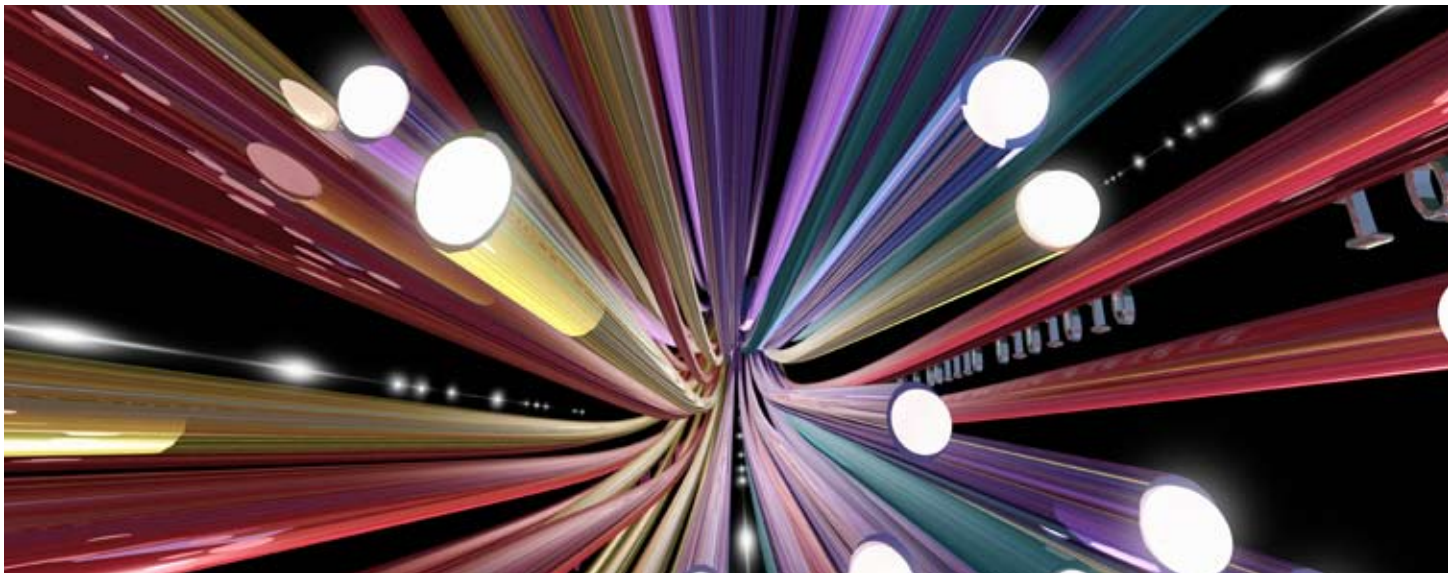
Smart grids will also need to have plug and play capabilities for scalability and ease of service integration. With the ability to add an array of interoperable services and devices (such as smart meters and electric vehicles) it will be easier to incorporate innovative solutions

and manage local loads placed on grids. One critical area of focus will be supporting the development of standards for micro-power generation technologies[3]. Quickly arriving at agreed upon common interfaces and operating procedures of these services will accelerate their adoption and make it easier for new and innovative low-carbon energy sources to develop.

In addition, the smart grid will empower customers with greater control. As it is extended within the home, an array of consumer appliances and devices can be controlled for managing demand during peak times. The smart grid can also engage end users in market-relevant dialog as active participants for designing energy-saving residential solutions. Powered by collaborative social networking technologies and real time information, consumers can monitor consumption to take greater control over their energy usage and to promote broader collective actions. This sharing of information will also create greater market transparency, remove inefficiencies and expand the market for buyers and sellers to connect[4].

Transforming the Automotive and Transportation Sectors

The automotive industry provides an excellent example of a sector whose low-carbon evolution is tightly linked with that of the energy sector. As gasoline-powered internal combustion engines enter their final decades, it is easy to imagine a future where cars become akin to moving electric appliances. But to realize this vision, it will require close cross-industry cooperation between the energy and ICT sectors. The ability of the current electric grid to support millions of cars is highly unlikely.



Along with being an essential element to electrify the transport sector, an additional area where ICT can assist is by managing the complex, real time calculations needed to efficiently and safely navigate cars. An array of capabilities can be unlocked by linking embedded communications from inside a vehicle with sensors and transmitters placed alongside the road. Given the range limitations of plug-in hybrid electrics, it is essential that electric cars know where the next recharging station is located.

But beyond navigation support, intelligent vehicle systems can save lives. Solutions which warn drivers about impending collisions (and automatically apply the brakes), enhance night vision and communicate about accidents and objects on the road are just some of the possible benefits. Cars today can be equipped with mobile technology that provides critical crash data to emergency services. With aggregated information and appropriate analytics, accidents and maintenance repairs could be more accurately predicted as well. Plus, vehicle congestion patterns can be predicted days in advance and traffic jams detected hours before they become serious[5].

ICT also has significant impact in the logistics arena. By combining telematics and centralized fleet management systems, routes can be dynamically optimized to reduce delays. For instance, an example of improving reliability in public transportation routing can be seen in the wireless solution that tracks the movement of city buses. If a bus falls behind schedule, the system automatically alerts the traffic control center, which then accords the bus priority at the remote controlled traffic lights to help it get back on schedule. The system also provides information to digital displays at bus stops and convey information to the mobile devices of end users[6]. These benefits can be applied to an entire urban environment as well. They can

Ubiquitous Intelligence

Along with a high performing networking core, another dimension where communications technology is rapidly advancing is in the area of ubiquitous intelligence. The drive towards ubiquitous intelligence progresses along two dimensions: connecting every thing and connecting everywhere. From an "everywhere" perspective, scale economics and standards have made it increasingly cost effective to provide wireless access around the world. Industry estimates on coverage state that more than 90% of the world's population has access to wireless communications[7]. And the speed of these connections is getting faster. As third and fourth generation wireless access technologies come on line, throughput speeds from wireless broadband will rival that of landline access technologies. The promise of anywhere, anytime and anything communications is fast approaching.

The connecting of every thing (and everyone) is arguably the heart of the transformative power of ICT. With the ever decreasing costs of microprocessors, bits of data are being embedded into virtually every known object. As these inanimate objects connect and share slivers of information with one another (and with larger systems), they morph from inert objects to animated nodes[8]. They become collectively smart.

"Smart" is essentially about coordinating these radically decentralized bits of intelligence throughout the edge, the core, the cloud and with devices. Used by the health, energy and transport industries as overlays of real-time information, "smart services" can act as the cornerstone for providing new orders of adaptability to legacy infrastructures. It creates stronger feedback loops and elevates complex systems to higher planes of efficiency and responsiveness.

Connecting billions and billions of things will require "plug and play" compatibility for unleashing mass adoption. Not surprisingly, the pace and nature of how we arrive at these standards will play a major role for decreasing implementation costs and reducing risks. It should be noted, however, that there is a cost for standardization—primarily in the form of longer time-to-market intervals and typically less robust functionality then proprietary solutions. Given that many smart technologies are in their early and formative stage, arriving at standards prematurely could have unintended consequences such as creating innovation barriers and/or constraining the overall functionality of the system. Platforms where proprietary and standardized solutions can co-exist should be explored. One-size-fits-all standards, with limited incentive for innovation, rarely succeed over time. Given the complexity of multiple interfaces and the required level of capital investment, stakeholders will need to commit to interoperable solutions which are flexible enough for future innovation and extension, compatible with legacy systems and adopted in a streamlined and efficient manner.

help synchronize traffic systems to monitor and manage traffic lights for reduced congestion points and to optimize traffic flows.
Areas where this could have the greatest potential impact would be in the rapidly growing and increasingly congested cities of emerging economies[9]. Urban areas within emerging markets have recently become quite attractive to many mobile communications providers. Although these markets are dominated by low income individuals, there are many successful business models and niche applications. One of the most promising areas is in bottom up solutions for logistics and transportation. By linking the drivers of delivery trucks via SMS to back-office supply chain applications, mobile phones can result in significant efficiencies. By improving the flow of goods, these innovative data services and business models have a positive multiplier effect and address some of the challenges of urban life.

Transforming the Health Sector

As it relates to the healthcare industry, next generation ICT solutions can have a transformational impact across a variety of dimensions. It should come as no surprise that many of the challenges with today's healthcare systems are rooted in a deeply fragmented technology environment. While there are isolated "islands of excellence," in general the patients, doctors and insurance providers of today's health system are simply not interconnected. There are tremendous inefficiencies leading to diminished patient care, limited choice and high costs.

The overarching value which ICT can add to the healthcare system is one of connectivity and integration. Utilizing standards-based networking solutions which interoperate across heterogeneous applications, databases and

High Performance

Often overlooked as it relates to the deployment of broadband access, delivering globally consistent and high performing applications is an area where remarkable progress has been made during the last ten years. Driven largely by the demands of enterprises for "five nines" (99.999%) of reliability for their networks and applications, the days of "best effort" availability is largely a thing of the past. With increasing network complexity and traffic volumes, consistently meeting expectations on the performance, reliability, security and confidentiality of network-centric applications is a top priority.

The challenge in delivering heightened levels of performance and reliability is that simply "throwing" bandwidth at the issue is rarely sufficient by itself. To fully leverage and orchestrate the potential of globally inter-connected information infrastructures, sophisticated traffic management and monitoring platforms are required, as well as a variety of business models for carrying traffic with different performance requirements. For example, a real-time remote tele-medicine surgery has different application performance and bandwidth requirements than smart-grid meter monitoring which needs an occasional burst of data during off-peak network hours.

Advanced content management, network management and monitoring platforms have a continuous need for granular operational data. As the source of this data originates from IP-based endpoints increasingly linked to individuals and their personal behaviors, the worlds of technology and public policy are colliding. Handheld electronics, locative media, telecommunications networks, and a wide assortment of tags and sensors are constantly collecting real-time information on various components of our lives and the environment we inhabit, including our movements, purchases, social interactions, Internet activities and much more. The information collected and stored on these individual behaviours, transactions and geo-location holds tremendous potential for societal good, individual customer efficiency, wealth creation and new business models.

For example, aggregate data sets can be used beneficially to predict traffic patterns, track pandemic spreads, personalize efficient and predictive access to information. But there are very valid privacy concerns if this data is misused. Frameworks to ensure accountability and transparency on issues such as data ownership and privacy are just now emerging and require the continued attention of industry, civil society and governments. Multi-stakeholder solutions which provide end-users with confidence and assurance on how their usage data is being handled will be vital for informing and gaining public trust for the use of advanced communications technologies.

networks, ICT can help the healthcare system adapt more responsively, improve the quality of care and lower its overall cost structures.

One example of how ICT can address some of the fragmentation challenges within the healthcare sector can be seen in the U.K. with the National Heath Service's N3 network. Serving 1.3 million employees through 63 points of presence across England and Scotland, the N3 network supports innovative online healthcare applications including the NHS care records service, the electronic transmission of prescriptions, and the picture archiving and communications system[10]. As one of the largest secure virtual private networks in the world, N3 provides a consolidated platform for the delivery of advanced healthcare solutions[11]. From a wireless perspective, a number of solutions can support healthcare workers to achieve higher levels of productivity and perform a wider variety of tasks. At the point of care, bar codes can be scanned at the patient's bedside to verify that the right patient is receiving the correct medication. Critical pages can be answered and urgent phone calls placed or returned while walking through the halls. Patient data and other crucial applications can be accessed more efficiently by healthcare workers: at the patient's bedside, at the nurse's station, in the operating room and beyond. In general, better access to information enables more informed clinical decision-making and improved patient safety. The ability to update clinical records in real time at the point of care improves data quality and reduces human error[12].

Reaching beyond the traditional walls of hospitals and doctor's offices is where some of the most innovative applications are developing. One emerging trend is "ubiquitous life care" which provides preventive monitoring and remote dispensing of medicine thereby lessening the need for individuals to be in hospital facilities.

An example of preventative monitoring are the new wireless devices which are small enough to be worn by patients and capable of providing real-time diagnostic information. These devices are creating a new class of telemedicine where a continuous feed of information provides trends, not data points, to better monitor chronic conditions[13]. Doctors and hospitals can now have a constant stream of diagnostic information from patients with heart problems, diabetes, blood disorders and much more.

Virtualized Assets

A third technology development which has matured during the last decade is the utilization and deployment of distributed and virtualized IT assets. Generally referred to as "cloud computing," this dynamically scalable computing architecture is "a development, deployment and delivery model, enabling real-time delivery of products, services and solutions over the Internet[16]". A concept which has been proposed for nearly 50 years, cloud computing is generally recognized for delivering new cost structures (shifting capital-expenditures to operational-expenditures), shorter cycle times and greater efficiencies in utilizing unused computational and infrastructure resources.

From an impact perspective, one of the most powerful attributes of cloud computing is the device and location independence it provides end users. Wherever end-users are located or whatever device they may be using, cloud computing aims to enable access to applications and data from nearly any place in the world. This location independence holds great promise for delivering advanced computational services to emerging markets and remote locations where there may be financial and technical constraints.

One of the major uncertainties surrounding cloud computing is that of data control and ownership. Because cloud computing does not typically allow users to physically store their data, it leaves control in the hands of the provider. Governments have complex and incompatible regulations on cloud computing data when operators deliver services across national borders. As such, efficiently serving the global market at scale has become a complex challenge. A great deal of policy harmonization on data governance and the cloud is required.

Of these conditions, real time cardiac monitoring holds great promise as many heart rhythm problems occur infrequently. By continuously monitoring electro-cardio-gram information as the patient goes about normal daily activities, diagnosing cardiac arrhythmias is greatly improved[14].

Another significant trend transforming the healthcare sector is empowering individuals with tools and information for more effectively managing their personal health, making improved lifestyle choices and for improved purchasing of healthcare related services. Through the use of web-based technologies, many people are creating, maintaining and owning personal health records (PHR) to consolidate their health information and medical history. Making this information accessible online to anyone with the required electronic credentials, the democratization of this content reinforces the trend towards transparency observed in other sectors.

The impact of affordable and ubiquitous communications within the healthcare industry is not just limited to developed economies. Leveraging the affordability, openness and ubiquity of ICT delivers tremendous yield in developing economies. It helps to increase the capacity of health professionals, streamline processes in health data collection, lower barriers for accessing health information and efficiently connect remotely located individuals. By utilizing anonymous and aggregated data from mobile devices, disease outbreaks could be identified more quickly. Correlating behavior data with medication data from millions of people could make drug therapies more effectiveand accelerate the ability to detect drug interactions[15].

It also is important to remind ourselves how simple solutions can often be the most effective for developing nations and for serving the needs of the poor. In that light, supporting the use of interactive voice response systems with pre-recorded health information (as well as agriculture and education advice) can have a tremendous yield. Audio-based information applications and call-center applications are a rich and promising way to serve those with limited literacy skills.

Next-generation contact-center applications can also have a significant impact in developed markets as well. Unified virtual contact centers with intelligent call routing and e-health information distribution can more effectively share information across the network, leading to greater patient responsiveness, better care and reduced costs. The flexibility and scalability of these integrated contact center solutions provides the ability to deliver continuous patient service improvements using a blend of voice, email, web chat and other communication channels.

Summary Recommendations

The potential benefits of accelerating the evolution towards a networked society are very major and the opportunity costs of procrastination equally high. As the previous examples have shown, achieving desired long-term outcomes and benefits across multiple industries will require pragmatic policy and regulatory structures with incentives for competition, innovation and sustained investment.

Failure to fully leverage a ubiquitous, reliable and standards-based ICT infrastructure will reduce opportunities for multiple industries to create new products and services, to strengthen relationships with end-users and to support sustainable, low carbon global economic growth.

To create an environment for transformation, reinvigorated levels of public-private collaboration will be required across businesses, governments and civil society organizations. Policy-makers and leaders will have roles to play at multiple levels to ensure robust competition, sustained investment, innovation and positive societal contribution.

Areas of particular importance for consideration include:

- Deepening the appreciation for the complexities and interdependencies of the evolving ICT industry. Policy and regulatory changes should aways seek to ensure robust market competition and innovation throughout the entire ecosystem

- To maintain the sustainability of affordable services, *all* relevant stakeholders need to extract fair value, or they won't be able to sustain investment and innovation over the long term.

- Continued attention of industry, governments and civil society in the use of personal and geo-located data. Large data sets provide tremendous opportunity for individual and social enhancement and learning, if used responsibly. Frameworks to ensure accountability and transparency on issues such as data ownership and personal privacy are just now emerging and require continued attention and support

- Promoting interoperability and development of industry standards that follow international norms, such as the Global Standard Consortium norms, will assist to reduce implementation costs and reduce risks. "Open-ness" does not mean one-size fits all uniformity that stifles further innovation, but rather, means that there should be transparency of practices with the opportunity for choice. Given the urgent nature of many of the issues addressed, accelerating the process for agreeing upon standards which are backwards compatible yet flexible and "future-proof" is vitally important.

- Continuing multistakeholder dialog to identify opportunities for advanced infrastructure and economies of scale across multiple industries. This particularly applies to areas where integrated and globally deployed communications and computing infrastructures can deliver the greatest value.

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