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MEASURING DIGITAL OPPORTUNITY

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This report has been drafted by Michael Minges, Senior Market Analyst at TMG, Inc. under the direction of Lilia Perez Chavolla and Tim Kelly of the Strategy and Policy Unit of ITU, with inputs from Esperanza Magpantay and Vanessa Gray of BDT/ITU. It has been prepared for presentation and discussion at the WSIS Thematic Meeting on "Multi-stakeholder partnerships for bridging the digital divide", in Seoul, Republic of Korea, 23-24 June 2005. It marks a first step in responding to the request, in the Geneva Plan of Action of the World Summit on the Information Society, to develop a composite Digital Opportunity Index. The material presented has benefited from discussions at two earlier meetings: "Workshop on Building Digital Bridges", held on 10-11 September 2004 in Busan, Republic of Korea and "WSIS Thematic Meeting on Measuring ICT for Development", held 7-9 February 2005, Geneva, Switzerland.

This paper, together with the others that have been prepared for the WSIS Thematic Meeting, can be found on the website at www.itu.int/wsisbridges. The views expressed in this paper are those of the authors, and do not necessarily reflect those of the ITU or its membership.

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1 OVERVIEW

The first phase of the World Summit on the Information Society (WSIS), held in Geneva, Switzerland, 10-12 December 2003, identified the need for international evaluation and benchmarking through comparable statistical indicators in order to follow up the implementation of the objectives, goals and targets of its Plan of Action.[1] To carry this out, WSIS called for:

- the creation of a composite *Digital Opportunity Index* (DOI);
- all countries to provide statistical information on the Information Society; and
- the establishment of internationally comparable indicator systems.

In regard to the last point, a "Partnership for the measurement of ICTs for Development", comprising international organizations and national statistical agencies, has commenced work on elaborating a set of comparable indicators for measuring the information society. As a first step, they have identified a list of *core* Information and Communication Technology (ICT) indicators in the areas of infrastructure, household and individual access, business use and the ICT sector (see Annex).[2]

This paper outlines how the core set of indicators can be mapped to create a DOI. In that respect, the DOI proposed here uses a novel approach. Most ICT indices (*e-indices*) are based on a set of indicators identified by the index creator while the DOI is created from a set of internationally-agreed indicators. The DOI initially uses the core infrastructure indicators, which are the most widely available among countries. This keeps the research manageable and enables the inclusion of a diverse set of countries since the other core indicator sets generally have more limited country coverage at this point in time. At this stage, the DOI can be defined as an index for *measuring the ICT infrastructure capability of countries*.

2 DOI METHODOLOGY

Indices use a set of indicators to create a single value that can be compared to other countries. This section examines the choice of indicators and the methodology used to convert them to an index value for the DOI.

2.1 Comparison of indicators

It is useful to compare the core infrastructure indicators mentioned above to those used by other e-indices. Although close to two dozen e-indices have been identified,[3] this report looks at popular e-indices such as the IDC *Information Society Index (ISI)*[4], the World Economic Forum *Networked Readiness Index (NRI)*,[5] the Orbicom *Monitoring the Digital Divide*[6] and the ITU *Digital Access Index (DAI)*[7] for comparative purposes (Table 1). Although none of the indicators appears exactly in the same way in all of the indices, some such as main telephone lines per 100 inhabitants or mobile cellular subscribers per 100 inhabitants

[1] See E) Follow-up and evaluation (para 28) in the WSIS Geneva Plan of Action available at: http://www.itu.int/wsis/docs/geneva/official/poa.html

[2] http://measuring-ict.unctad.org/QuickPlace/measuring-ict/Main.nsf/h_Index/215B47A1349CB45AC1256FA400303002/?OpenDocument. The core list was discussed at the WSIS Thematic Meeting on measuring ICT for development, held in Geneva, 7-9 February 2005, and will be discussed further during a statistical side event to be held during the Tunis phase of WSIS, in November 2005.

[3] See, for instance, http://www.bridges.org/ereadiness/ereadiness_tools_bridges_10Mar05.pdf or George Sciadas (2004) "International Benchmarking for the Information Society", at: http://www.itu.int/digitalbridges/docs/background/BDB-intl-indices.pdf.

[4] http://www.idc.com/groups/isi/main.html

[5] http://www.weforum.org/site/homepublic.nsf/Content/Global+Competitiveness+Programme%5CGlobal+Information+Technology+Report

[6] http://www.orbicom.uqam.ca/projects/ddi2002/ddi2002.pdf

[7] http://www.itu.int/ITU-D/ict/dai/index.html

appear in four of the indices. Other core indicators such as mobile population coverage or mobile tariffs do not appear in any of the other indices. Given that only some of the core infrastructure indicators appear in other e-indices, the DOI should produce unique results.

Table 1: Inclusion of the infrastructure and access core indicators in different e-indices

Infrastructure and access core indicators	DAI	NRI	ISI	Orbicom
Basic core				
A-1 Fixed telephone lines per 100 inhabitants	●	●		●
A-2 Mobile cellular subscribers per 100 inhabitants	●		●	●
A-3 Computers per 100 inhabitants		●	PCs per household	●
A-4 Internet subscribers per 100 inhabitants	Internet users	Households online	Internet users	Internet users
A-5 Broadband Internet subscribers per 100 inhabitants	●		Broadband households	
A-6 International Internet bandwidth per inhabitant	●			
A-7 Percentage of population covered by mobile cellular telephony				
A-8 Internet access tariffs (20 hours per month), in US$, and as a percentage of per capita income	●	●		
A-9 Mobile cellular tariffs (100 minutes of use per month), in US$, and as a percentage of per capita income				
A-10 Percentage of localities with public Internet access centres (PIACs) by number of inhabitants (rural/urban)				
Extended core				
A-11 Radio sets per 100 inhabitants		●		●
A-12 Television sets per 100 inhabitants		●		Households with TV

Note: DAI = Digital Access Index (ITU), NRI = Network Readiness Index (World Economic Forum), ISI = Information Society Index (IDC).

Source: Adapted from information on the indices shown above.

2.2 Constructing the DOI

An index needs a framework for converting indicators to a unitary value. Most indices also group related indicators into categories that can be useful for analyzing countries relative strengths and weaknesses. This section reviews methodologies used for various e-indices and describes the structure of the DOI. The indicators are then described with goalposts and weighting within the DOI explained.

2.3 Index methodology

Methodologies and classifications used by e-indices include:

- In the free information available on its website, IDC does not go into detail about how the Information Society Index is constructed.[8] The index features 15 indicators and covers 53 countries. There appears to be a maximum score of 1’000 and the indicators are grouped into four categories (social, Internet, computers and telecom). Beyond that, the free information does not describe how indicators are normalized or the aggregation technique.

[8] The methodology is available in the report that is sold for US$ 3,500.
http://www.idc.com/getdoc.jsp?containerId=32161

- WEF's NRI consists of three component indexes (Environment, Readiness and Usage) each of which has a further three sub indexes. The index uses 48 indicators covering 104 countries. Data are transformed on a scale of 1 to 7; there are no weightings within sub indexes with values averaged to create the value. The NRI is then computed as the average of the component indexes.
- Orbicom follows an innovative approach. The 12 indicators are indexed to a reference country and year. There are two categories: Info density and Info Use. The individual indicators within each category are summed to get an index value. The index covers 139 countries.
- The ITU's Digital Access Index groups 8 indicators into five categories (Infrastructure, Affordability, Knowledge, Quality and Usage). The indicators are normalized relative to desirable values or goalposts. For example, a goalpost of 100 was established for mobile cellular subscribers per 100 inhabitants. Assuming a country had 60 mobile cellular subscribers per 100 inhabitants, then the index value would be 0.6 (60/100). Indicators are weighted within their groups and then the groups are averaged to arrive at the DAI value. This is the same methodology used by the United Nations Development Program's Human Development Index (HDI), which is arguably the benchmark for composite indices, as it is one of the longest-standing and most referenced of all.[9] The DAI covered 178 countries.

The DOI follows the same methodology as the DAI and HDI. Grouping the indicators and using goalposts to normalize the values offers a number of benefits. First, it is a straightforward and transparent methodology since the goalposts are identifiable and the calculations clear. Second, the use of goalposts establishes targets that countries can aspire to and establishes a parameter for achievement. Establishing the goalposts sharpens thinking about the indicators themselves and their relevance to the information society. Third, grouping the indicators allows countries to see where they are relatively strong and weak, which can be useful for policy-making. Fourth, the index can be tracked over time without the index values changing meaning. This is particularly useful for policy evaluation.

There are certain drawbacks with the DOI methodology. The determination of the goalposts is difficult for an ever evolving sector like ICT where technologies decline and grow in importance. Although the goalposts are often determined by best practice or logical limits, they can be exceeded (for instance, several economies now appear to have more mobile phones than inhabitants). National definitions of the indicators can result in exaggerated values; if these are used as best practice, they can establish goalposts that will be impossible for other countries to reach. Best practice, as reflected in an indicator value, is not always possible with ICTs since the indicators can vary for social reasons. The categorization of indicators into sub indexes and the weights assigned involves a degree of subjectivity and can impact the index values. The impact can be minimized through statistical techniques that determine appropriate weights and classifications while retaining the analytical power of categories.

Not all of the core infrastructure and access indicators are utilized for the DOI. The reasons for omission are described below. The remaining indicators lend themselves to a logical classification:

- The first is **Affordability and Coverage**. In order to participate in the information society, consumers must have accessibility to ICT service and must be able to afford it. The *percentage of the population covered by mobile cellular telephony* represents basic accessibility while the two tariff indicators, *Internet access tariffs as a percentage of per capita income* and *Mobile cellular tariffs as a percentage of per capita income* reflect affordability.
- The next category is **Access Path and Device**, which includes the means for electronic communications, *main telephone lines per 100 inhabitants* and *mobile cellular subscribers per 100 inhabitants*. It also includes the equipment that provides the interface between the user and the network; here it is represented by *computers per 100 inhabitants*.
- **Infrastructure** for the DOI includes proxies that reflect advanced higher level information networks such as the Internet. The indicators include *Internet subscribers per 100 inhabitants* and *international Internet bandwidth per country.*

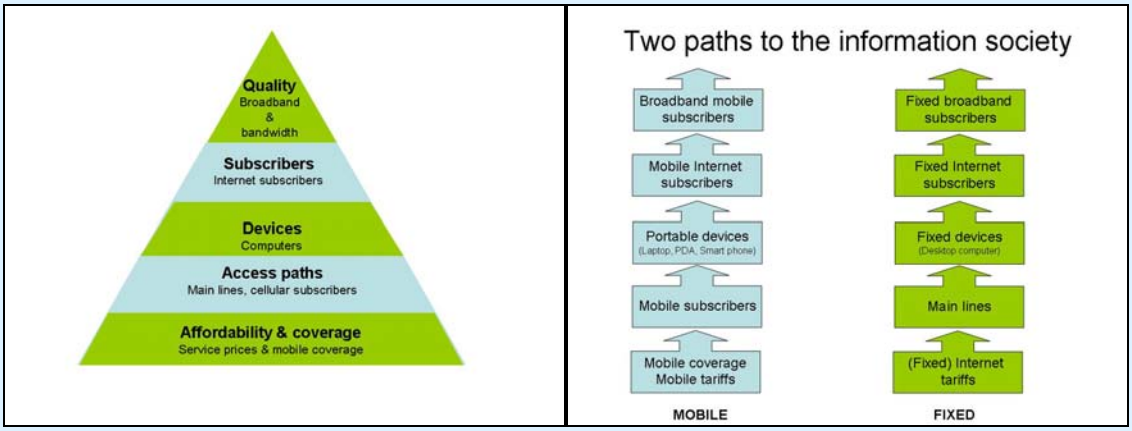
[9] The UNDP uses a similar methodology for its Technological Achievement Index. See http://hdr.undp.org/statistics/indices/#5

- **Quality** reflects a level of access that enables higher degrees of functionality. This provides support for services such as video streaming that can enhance desirable information society applications such as telemedicine, e-government and e-learning. The indicator selected for this category is *broadband subscribers per 100 inhabitants*.

The classification is sequential, in that each category is dependent on the previous (Figure 1, left). The classification also reflects higher levels of access, from basic voice communications to broadband connectivity. In order to have an access path, users must be covered by the service and able to afford it. Internet subscription depends on having an access channel and a device. Finally, given all the prerequisites for connectivity, users will then want to aspire to higher levels of quality through broadband access.

The popularity of mobile communications and introduction of high-speed 2.5 and 3G (third generation) services make wireless technology a key component of the information society. Almost all of the indicators selected for the DOI have a mobile component. Some are explicit, such as mobile coverage or mobile subscribers, while others are embedded in indicators such as computers (e.g., smart phones, PDAs) or Internet subscription (which can include mobile Internet subscriptions). This lends the DOI to an alternate classification of fixed versus mobile (Figure 1, right). This allows analysis of the relative importance of each in a country's progression to the information society. The trend toward ubiquity[10] suggests that countries should not sacrifice one path at the expense of the other but that both should be pursued simultaneously.

Figure 1: Classifying the DOI



Source*: TMG Inc.*

3 ANALYZING THE CORE INDICATORS

The core ICT indicators represent international agreement about the main statistics to be used for analyzing the information society. This section analyzes the choice of indicators, pointing out their utility as well as their limitations with possible repercussions for index results. [11] It also review trends in the indicators, and suggests goalposts that can be used to normalize them for the DOI.

[10] See, for instance, the research conducted for the ITU New Initiatives workshop, on Ubiquitous network Societies, held 6-8 April 2005, Geneva, at http://www.itu.int/osg/spu/ni/ubiquitous/ and the presentations made at the WSIS Thematic Meeting on Ubiquitous Network Societies, held 16-17 May 2005, in Tokyo, at www.wsis-japan.jp.

[11] Definitions for most of the indicators are available from the ITU: http://www.itu.int/ITU-D/ict/material/Top50_e-Oct2004.doc

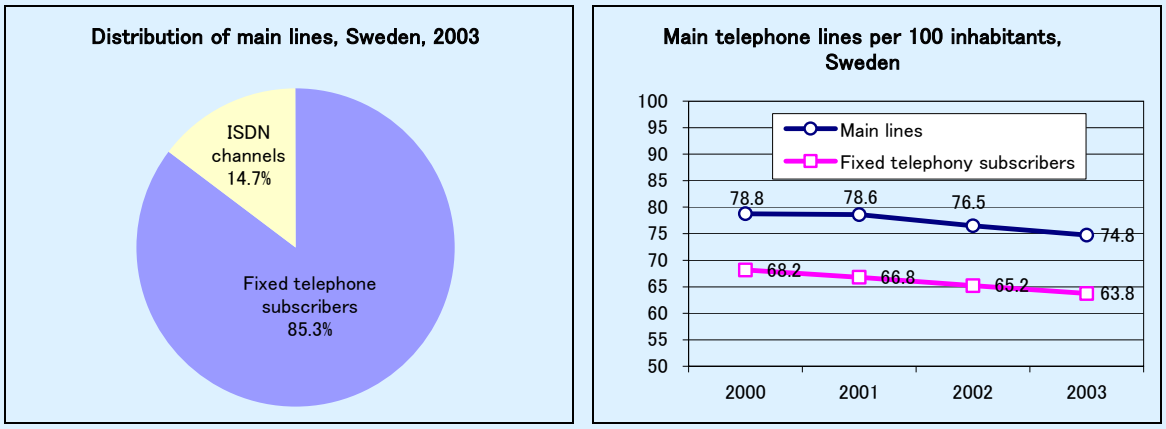
3.1 Access paths and devices

3.1.1 Fixed telephone lines per 100 inhabitants

Often referred to as *teledensity*, this is one of the oldest indicators used to analyze the telecommunication sector. As such, definitions are robust and data availability generally good. Although they have been eclipsed by mobile, fixed telephone lines nonetheless are a major form of voice communications. Service charges for fixed tend to be cheaper than mobile communications making fixed more attractive. Fixed telephone lines also provide a basis for Internet access in most economies, whether through dial-up, ISDN (Integrated Services Digital Network) or higher speed DSL (Digital Subscriber Line) services.

Some countries include the number of ISDN channels (two for basic ISDN subscriptions and 23 or 30 for primary rate subscriptions) when counting fixed lines. These virtual channels artificially inflate the number of main lines since there is no actual physical increase. This will tend to produce higher rankings for countries that have a large number of ISDN subscribers. Take Sweden for instance which leads the world in fixed telephone lines per 100 inhabitants with a figure of 74.8 in 2003. Some 15% of main lines in Sweden are ISDN channels (Figure 2, left). Sweden reflects a trend common in other countries where both the number of fixed lines and ISDN channels are in decline due to mobile and broadband substitution (Figure 2, right). This makes it difficult to establish a goalpost for this indicator. For this iteration of the DOI, Sweden's result for 2003, 75, is used as the goalpost for main telephone lines per 100 inhabitants. The indicator is assigned a 33 percent weight within the Access Paths category.

Figure 2: Fixed line trends



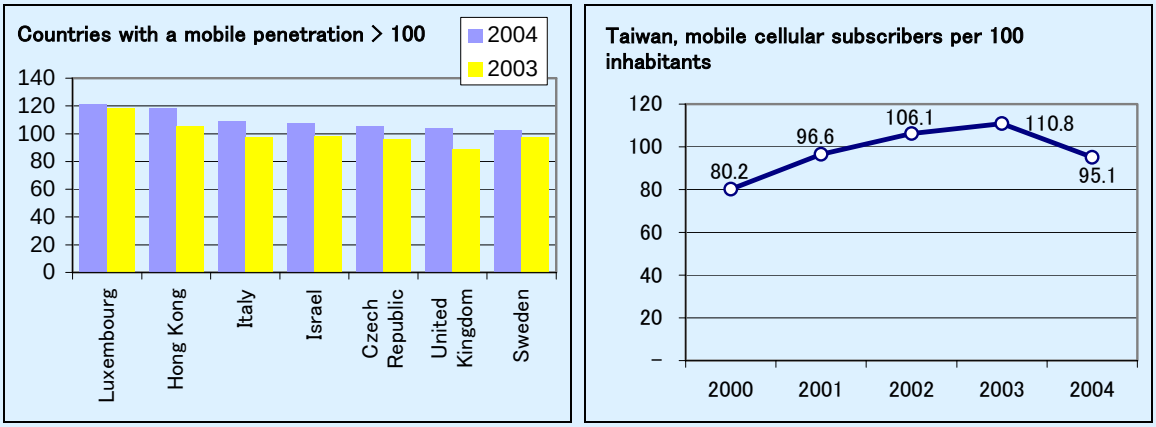
Source: Adapted from the National Post and Telecom Agency, The Swedish Telecommunications Market 2003.

3.1.2 Mobile cellular subscribers per 100 inhabitants

This is the universal indicator for measuring mobile penetration. Mobile is becoming the predominant method of communications in most economies and is thus a fundamental indicator of information society development. Like fixed, mobile also suffers from comparability problems. These arise primarily from issues to do with prepaid. On the one hand, the number of mobile subscribers can include inactive prepaid users; operators vary in the length of time they consider a prepaid subscriber inactive. On the other hand, some subscribers maintain two or more typically prepaid subscriptions because of cheaper on-net calls as well as other reasons (e.g., work number versus personal number, enhanced roaming capability, car phones etc.). As a result, mobile cellular subscribers per 100 inhabitants can exceed 100 (reached by three countries in 2003 and seven in 2004, Figure 3, left). This implies that there are already more mobile phones than inhabitants, which is likely to be the case as we approach ubiquitous network societies in which computer and communication capabilities are embedded into the environment and objects around is. But is creates a problem when trying to establish a goalpost for this indicator. Indeed, the difficulty of establishing goalposts is illustrated by the case of Taiwan, China, which had exceeded a mobile cellular penetration of more than 100 in 2003, only to see it decline to below 100 in 2004 when subscriber rolls were cleaned up (e.g., inactive subscribers deleted from reported operator figures). A theoretical maximum of 100 is established as the goalpost for this indicator. Note that countries such as Finland, Japan and the US, which have a relatively

low percentage of prepaid subscribers, tend to be penalized with this indicator. The indicator is assigned a 33 percent weight within the Access Paths category.

Figure 3: Mobile cellular subscription trends



Source: ITU/KADO Digital Bridges Project and Directorate General of Budget, Accounting and Statistics.

3.2 Infrastructure

3.2.1 Computers per 100 inhabitants

Computers are critical components of the information society. They can be used by themselves to enrich personal productivity through word processing, spreadsheets, presentation and dozens of other applications. They are also important for providing the interface between users and the Internet. This indicator uses the generic *computer* rather than Personal Computer (PC). In addition to mini and mainframe computers, this indicator should also include other devices that have a processor and computer-like components such as screens and keyboards. This would thus incorporate devices such as laptops computers, Personal Digital Assistants (PDAs) and smart phones.[12]

This is possibly the most difficult of all the indicators to obtain precise information for. It is hard to know how many computers there are in a country and few countries report this statistic. Most estimates are based on shipment data which is not collected any inter-governmental agencies and is generally only available at steep prices from market research organizations. In addition, data is not generally attainable for many developing nations. Where shipment data are available, using them to estimate the stock of computers is not an exact science. Most estimates are derived from assumptions about how long a computer is in use, which can vary tremendously between countries.

Virtually all of the statistics on the stock of computers for countries is based on PCs (generally, but not always including laptops). Although it may not include larger computers, this is usually not an issue since they comprise only a small proportion. However, the stock of computers would not include devices such as Internet-enabled phones, which essentially perform the a similar service as that of a PC but for mobile networks. Therefore if one reason for measuring computers per 100 inhabitants is to examine its relationship to Internet access, then the mobile market would be left out (except for those who use mobile networks for high-speed data access from laptops with suitably equipped data cards).

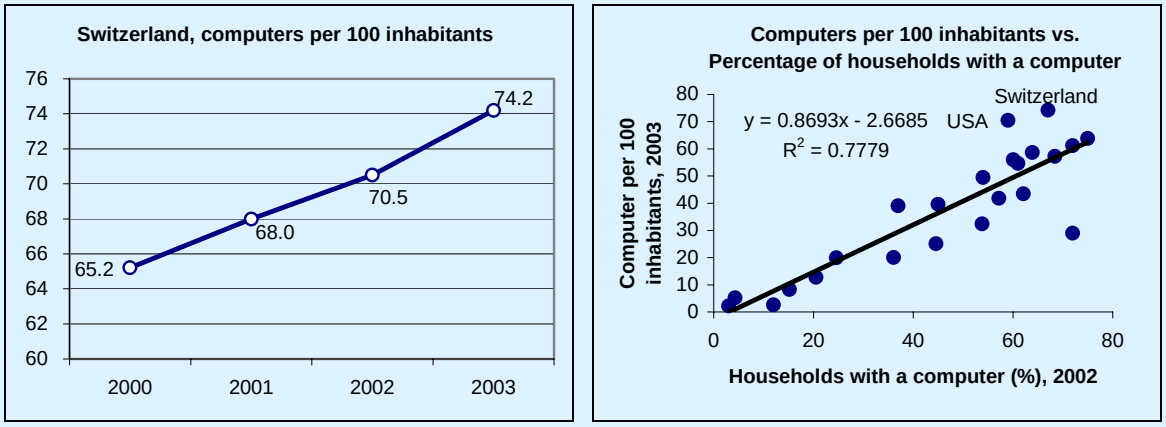
Switzerland ranks first in the world with a penetration of 74.2 computers per 100 inhabitants in 2003 (Figure 4, left). One reason may be that Switzerland is one of the few countries that publish statistics on the stock of computers. It is possible that for other countries, the data is being underestimated. Yet ironically, even the Swiss data appear to be estimated from shipment data on the basis of a computer being replaced every five years. However, the Swiss data on sales of computers is higher than that reported by organizations that track this statistic. One way of testing the per capita computer penetration data is to compare it to

[12] Some estimate that sales of devices using Windows for PDAs and Smart Phones will surpass those for conventional computers by 2008. http://www.c-i-a.com/pr0403.htm

household computer penetration. The latter tends to be more reliable since it is derived from household surveys. The relationship suggests that the data might be overestimated for countries with high levels of per capita computer penetration compared to household penetration such as Switzerland and the US (Figure 4, right). On the other hand, there may be a proportionally higher level of computers in Swiss and US businesses than other nations. All this makes it difficult to determine what the optimum level of computer penetration should be in a country in order to establish a goalpost. It is probably preferable to use indicators such as the percentage of households with a computer or businesses with a computer since the limit is known (i.e., 100 percent).

Another complication is how devices such as smart phones and PDAs impact this indicator; ideally for symmetry these should also form part of the indicator. However data is not widely available. For now, a goalpost of 75 is established (just above the Swiss figure) although in a number of countries, this level would probably result in a household penetration greater than 100%. This indicator is part of the Access Path and Device category where it is assigned a weight of 33%. This helps to reduce the impact of the high level of estimation required for this indicator. In the future, it would be preferable to use the percentage of households with a computer for greater reliability and to include Internet-enabled mobile devices to widen the scope.

Figure 4: Computer trends



Note: Computers refer to personal computers.
Source: Adapted from OFCOM, *Statistiques des Telecommunications*; ITU and ITU/KADO *Digital Bridges Project data*.

3.2.2 Internet subscribers per 100 inhabitants

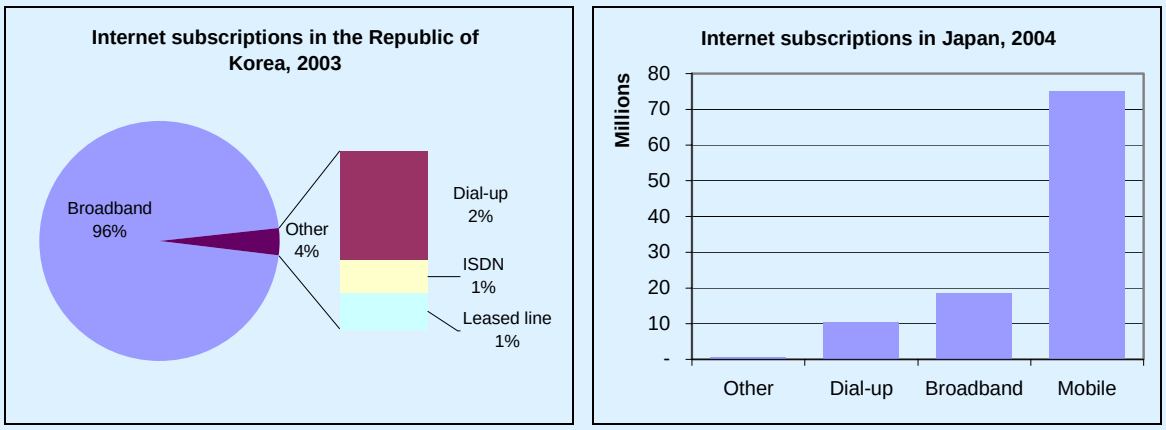
Internet subscriptions should theoretically give an indication of the extent of individuals and businesses accessing the Internet through paid services. As such, it could be a useful indicator of the information society in terms of demand as well as a proxy for the overall Internet infrastructure in place. However, this particular indicator has several drawbacks, which will impact the DOI results.

First, there are data issues. Some countries disseminate data on the number of Internet subscribers but many do not. Therefore, the data must be estimated for many countries and its accuracy is therefore questionable. Second, the figure can be both over and under stated. In some countries, the number of Internet subscribers includes those who do not have a monthly subscription but could hypothetically use the Internet over dial up on a pay as you go basis. For instance, in Singapore, all subscribers with the capability to access the Internet over their fixed telephone line are included as an Internet subscriber regardless of whether they have actually used the Internet recently. In other countries, such as Thailand, there is a significant usage of prepaid Internet cards for access, which are not normally included in subscriber counts. Third, a subscriber is not a proxy for user since there are many people that share subscriptions or access from public locations. Fourth, with the trend toward broadband, the day may come when all fixed Internet subscriptions will be broadband. That day has almost arrived in the Republic of Korea where 96% of all Internet subscriptions were broadband by the end of 2003 (Figure 5, left). Thus Internet subscribers per 100 inhabitants will be increasingly redundant since there is already an indicator for broadband subscribers.

More comparable indications of Internet subscription could be obtained from the other core indicator sets (i.e., percentage of households and businesses with an Internet connection). This is one reason why most other e-indices do not include individual Internet subscriptions.

Another issue is the growing trend towards Internet access over mobile networks. This form of access is not normally included in the data for those countries that publish Internet subscription statistics. Yet for some countries such as Japan, this is the leading means of Internet access (Figure 5, right).

Figure 5: Distribution of Internet subscribers



Source: Adapted from National Internet Development Agency of Republic of Korea and Ministry of Internal Affairs and Communications, Japan.

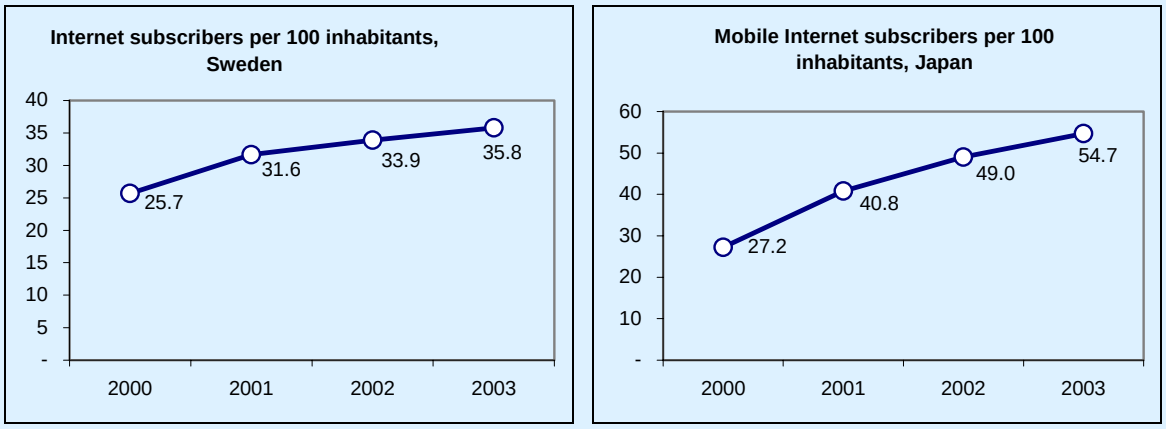
Like conventional Internet subscriptions, there are data and methodological issues with mobile Internet subscribers. Because mobile Internet access is relatively recent, most countries do not report data on the number of subscribers.[13] Some operators report the number of high-speed subscriptions (e.g., GPRS, 3G) as an equivalent for mobile Internet subscribers regardless of whether the user actually accesses the Internet. Other operators report the number of subscriptions to their mobile portal services (e.g., i-mode, Vodafone Live, etc.), again, regardless of whether users actually use the service. Some users utilize mobile cellular networks to access the Internet using laptop computers. Indeed, access to some 3G networks is often initially only possible through data cards connected to computers while other 3G networks only offer high-speed data and not voice. There is little consensus as to whether these types of users should be considered fixed Internet subscribers or mobile Internet subscribers. Finally, the concept of Internet access is seriously challenged when including mobile, since the users' experience is entirely different and many so-called mobile Internet users are not actually surfing websites *per se* but downloading logos and ring tones or sending picture messages.

These issues make it difficult to determine goalposts for this indicator. For fixed Internet subscription, Singapore ranks first in the world with 52 Internet subscribers per 100 inhabitants. However, as noted, these include all the country's fixed telephone subscribers since they can theoretically access the Internet via pay-as-you go dial-up with no prior registration. It is estimated that the number of active dial-up subscribers in Singapore is only around 40% of the total reported, effectively cutting the Internet subscription rate in half to 27 per 100 inhabitants (when including broadband subscriptions). That leaves Sweden as the highest ranking country in terms of *active* Internet subscribers per 100 inhabitants with a figure of 35 for 2003. This equates to around 70% of households having an Internet connection; an Internet subscription penetration rate of 50 would imply all Swedish households having an Internet connection; this is used as the goalpost for fixed Internet subscription per 100 inhabitants. The indicator forms part of the Infrastructure category where it is given a weight of 25%.

[13] Note that a high-speed mobile network is not essential for mobile Internet access. There are numerous instances of mobile subscribers using GSM networks at speeds of 9.6 kbps to access the Internet. In addition, Japan's popular i-mode service operates at this speed.

Japan leads the world in mobile Internet with a subscription rate of over half the population in 2003 (Figure 6, right). Several surveys on Internet use suggest these subscriptions are not all active. However, in order to establish a goalpost, there could be symmetry with mobile subscriptions per 100 inhabitants where the goalpost was set at 100. Given that mobile is a prevalent and personal form of communications where per capita indicators are likely to be more relevant, then it would be desirable for at least three quarters of mobile subscribers to have access to the Internet. Therefore a goalpost of 75 is established for this indicator; it is given a weight of 25% within the Infrastructure category.

Figure 6: Internet subscription trends



Source: *Adapted from National Post and Telecom Agency, Sweden and Ministry of Internal Affairs and Communications, Japan.*

3.2.3 International Internet bandwidth per capita

International Internet bandwidth is a critical building block of information infrastructure (Figure 7). In most developing countries, a significant portion of Internet traffic is to foreign sites due to their greater availability of content. The amount of international bandwidth impacts the speed users will experience when accessing websites in a foreign country.

There are several factors to consider with this indicator. First, the amount of international Internet bandwidth is not directly controlled by users. While a user can decide whether to purchase a computer or subscribe to Internet service, the amount of international bandwidth is determined by Internet Service Providers (ISP). In theory, the amount of bandwidth should be dictated by demand to ensure acceptable performance, but ISPs in many developing nations are constrained by pricing and therefore may not offer an optimum level of international Internet capacity.[14] Second, data on international bandwidth is often not available from official sources. Few government agencies compile and disseminate this statistic.[15] Third, the data is not exactly comparable. Bandwidth is generally asymmetric (e.g., more coming in than going out) and there is no consensus on how this should be recorded for statistical purposes (e.g., only incoming or outgoing, both incoming and outgoing combined). The data can also refer to total capacity rather than contracted capacity or utilization at a particular date.[16] Fourth, the amount of international bandwidth a country needs depends on how much users access overseas websites. In countries such as Japan or the Republic of Korea, where few other countries use the same language, or the United States, where there is considerable local content, there is less need to access websites abroad. As a result, they will have relatively lower values for this indicator.

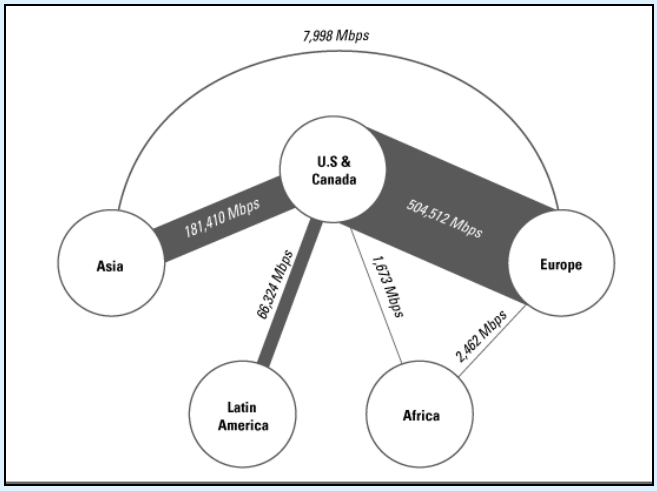
[14] For example, many developing countries must pay for the full cost of an Internet link even though the hub country benefits. See http://www.itu.int/itunews/manager/display.asp?lang=en&year=2005&issue=03&ipage=interconnectiv-poor&ext=html

[15] A private firm, TeleGeography Inc, compiles this statistic for some 65 economies. http://www.telegeography.com/products/gig/index.php?PHPSESSID=3de6c5f0ad000528f66a115c01b39bb7

[16] Some ISPs refer to the total theoretical capacity of a link while others define bandwidth as the amount of capacity they have actually contracted for. Neither is equal to actual volume of traffic that passes over the connection. See: http://www.itu.int/dms_pub/itu-d/md/02/isap2b.1.1/c/D02-ISAP2B.1.1-C-0025!!PDF-E.pdf

The top ranked country for international bandwidth in 2003 was Denmark with over 20 kbit/s per inhabitant. This is a significantly high value considering that it is per inhabitant and the amount available to actual users would be much higher. A value of 10'000 bits per inhabitant is established as the goalpost. Assuming that half the country was using the Internet at the same time, this amount of bandwidth would be sufficient to provide an acceptable experience.[17] The indicator is normalized using a logarithmic function since international bandwidth is more important at early stages of Internet development. It forms part of the Infrastructure category where it is assigned a weight of 50%.

Figure 7: International Internet bandwidth



Source: TeleGeography Inc.

3.2.4 Broadband Internet subscribers per 100 inhabitants

Many socially desirable applications envisioned for the information society are only possible with broadband access. The definition of broadband hinges on speed and mode. There is a growing consensus that a service should be considered broadband only if it offers speeds of at least 256 kbit/s in at least one direction. In some instances, the service (e.g., DSL, cable modem) is considered broadband even when they offer speeds less than 256 kbit/s and they are included in the country statistics because the service provider sells them as "broadband". But this practice is not to be encouraged.

"Mode" refers to the network over which broadband is utilized. Most data only cover "fixed" broadband access (e.g., DSL, cable modem, fixed wireless, fibre optic, Ethernet LAN, etc.) and therefore do not include broadband mobile cellular network subscribers. Given that high speed Internet access over mobile networks is growing, this should be included in the indicator where the service is availble.

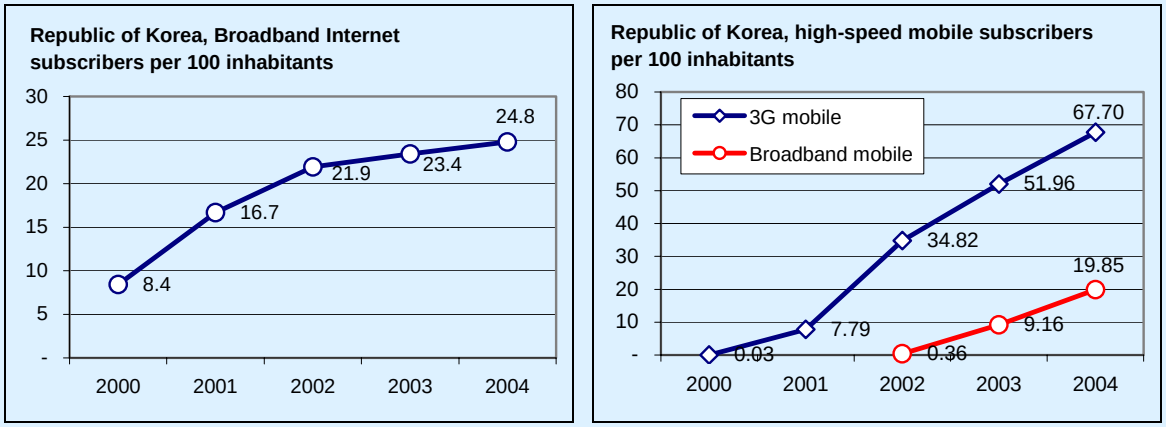
For the purposes of the DOI, this indicator is divided into two, each with equal weight. The first is conventional fixed broadband and the second mobile broadband. The Republic of Korea leads the world in broadband with a penetration of 24.8 per 100 inhabitants in 2004. A goalpost of 30 is selected since that would imply all of Korea's households having broadband access. It is given a weight of 50% within the Quality category.

For definitional consistency, mobile broadband should also refer to the number of subscribers to mobile cellular networks offering speeds of at least 256 kbit/s in one direction. So far, only two 3G technologies (CDMA EV-DO and W-CDMA) fulfil this requirement. Like fixed broadband, Korea also ranks first in the world in this category with a mobile broadband penetration of 19.9 in 2004. One caveat is that mobile broadband is unlike fixed broadband where users subscribe because they want the higher speed. With mobile, users often subscribe to a network because of reasons other than broadband access *per se*. Broadband

[17] According to a study commissioned by the Swedish telecom regulator, 20 kbit/s provides an acceptable response time for ordinary Internet use. http://www.pts.se/Dokument/dokument.asp?ItemId=2930

mobile does offer considerable advantages in terms of quality making the indicator consistent with its categorization. A goalpost of 100 is thus established for mobile broadband. This makes it consistent with the goalpost for mobile cellular subscribers per 100 inhabitants implying that ideally all mobile subscriptions should eventually have access to broadband speeds to meet the highest level of quality. It is given a weight of 50% within the Quality category.

Figure 8: Broadband subscription trends



Note: In the right chart, 3G refers to CDMA2000 1X (153 kbit/s) and EV-DO (2 Mbit/s) whereas broadband mobile refers to EV-DO only. CDMA EV-DV and W-CDMA services are soon to be launched in Korea, as well as WiBro, which is considered by some to be a 4G mobile service. Note that, in the right chart, "subscribers" refers to the service as a whole (voice and data) and does not imply that all users with suitably-equipped mobile phones make use of the high-speed data services.

Source: Adapted from National Internet Development Agency of Korea (NIDA) and Korean mobile operators (SKT, KTF and LGT).

3.3 Coverage and affordability

3.3.1 Percentage of population covered by mobile cellular telephony

This is an ideal indicator for measuring *potential* access to communications. In order to enable access, users have to have access to infrastructure. This indicator measures that since if users had a mobile phone and a subscription, they would be able to use the service. It is also a widely available indicator, disseminated by many mobile operators. The goalpost is set at 100, a point at which mobile cellular is available to all inhabitants of an economy. A number of economies have achieved this. This indicator is included in the Coverage and Affordability category and assigned a weight of 33%.

3.3.2 Internet access tariffs (20 hours per month), in US$, and as a percentage of per capita income

Affordability is a vital component of demand and use of ICT services but often difficult to determine. There are different types of Internet access (e.g., dial-up, broadband, wireless) and comparing prices between countries does not always reflect this quality aspect. In addition, flat rate pricing is a typical option for broadband and some dial-up packages; the cost advantage is typically dependent on intensity of use. There is also the issue of whether the telephone line rental charge should be included (or, in the case of cable modem access, the monthly subscription charge).

The selection of 20 hours of use per month for this indicator is a popular yardstick. For example, the European Union includes 20 hours in its Indicator access cost *e*Europe indicator[18], the OECD used 20 hours of use in its analysis[19] and the ITU featured the same amount of use for the Digital Access Index. According to market research, the average time spent at home accessing the Internet was 24 hours in December 2003 (Figure 9, left).

[18] http://europa.eu.int/information_society/eeurope/2002/news_library/documents/benchmarking05_en.pdf
[19] http://www.oecd.org/dataoecd/43/5/2767166.xls

Because affordability is of concern, the cheapest package available that provides *at least* twenty hours of use (spread over peak and off-peak times) is used to derive this indicator. The calculation does not include the telephone line rental but does include telephone usage charges if applicable. The Internet tariff is divided by monthly Gross National Income to obtain the percentage of per capita income.

Hong Kong, China has both the lowest Internet access tariff (US$3.85) and the most affordable (0.19 percent of per capita income). Therefore the goalpost, Internet access tariff as a percentage of per capita income, was established at 0.20. This indicator is part of the Affordability and Coverage category where it is assigned a weight of 33%.

3.3.3 Mobile cellular tariffs (100 minutes of use per month), in US$, and as a percentage of per capita income

Given that mobile is now the predominant form of voice communications, mobile tariffs are a key measure of affordability for individual consumers (fixed lines remain more important for businesses). One complication is the wide variety of tariffs available, which makes comparisons difficult. Although the "core indicator" is shown as including 100 minutes of use per month, in reality, levels of use tend to be lower (84 minutes per month for a sample of 40 countries, Figure 9, left).[20] Furthermore, mobile tariffs tend to differ for on-net (calls within the mobile network of the same operator) and off-net (calls outside an operator's mobile network). The indicator itself does not provide a guideline of how the 100 minutes of use per month should be computed. The indicator included for the DOI is based on pre-paid tariffs, the predominant form of access in most developing nations, and uses the OECD low user basket methodology which is applicable to prepaid tariffs.[21] The OECD basket for low usage results in 37 minutes of use per month—significantly less than what the core indicator specifies—but does include 30 text messages per month. Because of the difficulty of determining registration (i.e., initial connection or installation) charges, which are, in any case, often waived or bundled with other services for pre-paid customers, these are excluded from the basket.[22] The resulting basket values were then divided by monthly Gross National Income per capita to create an affordability indicator. As with Internet tariffs, pre-paid mobile is most affordable in Hong Kong, China at 0.16 percent of per capita income. This is used as the goalpost. The indicator is part of the Affordability and Coverage category where it is assigned a weight of 33%.

3.4 Percentage of localities with public Internet access centres (PIACs) by number of inhabitants (rural/urban)

In many developing countries, communications access through public localities such as call centres and Internet cafes is a primary form of access. This indicator was recently recommended by a workshop on community access and has been adopted as a core indicator.[23] Because of its novelty, data is not yet available for a significant number of countries. Therefore, this indicator has not been included in the DOI for now, but should be revisited if and when the data become available.

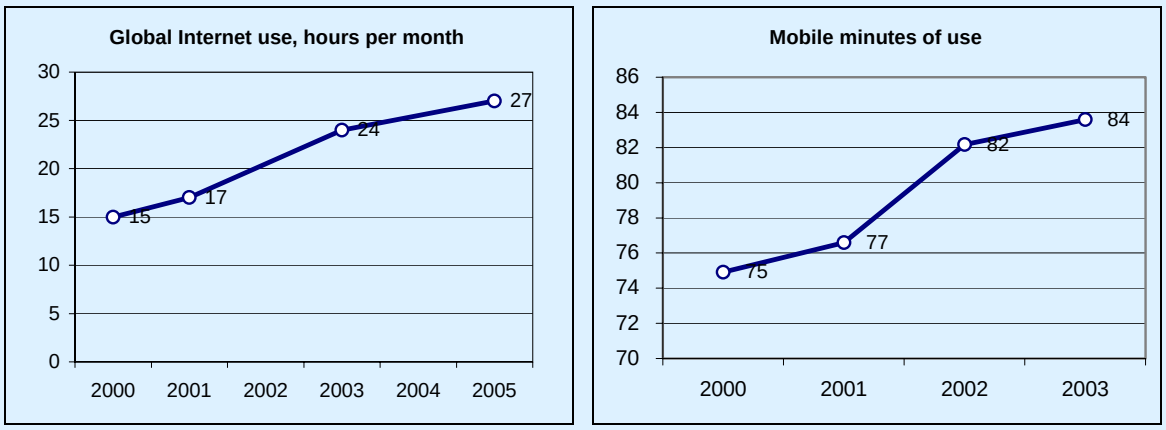
[20] A simpler and possibly more realistic measure of mobile affordability might be the cost of a monthly prepaid card. In many countries, mobile usage is related to the amount available on the recharge voucher with users often economically limited to one voucher per month.

[21] The OECD mobile basket methodology was originally developed as part of a series of tariff comparison baskets developed in the late 1980s, in a methodology described in OECD (1990) "Performance Indicators for Public Telecommunication Operators". The methodology has been revised over time and a dull explanation can be found in Commission of the European Communities. December 2004. *Commission Staff Working Paper Volume II. Annex to the European Electronic Communications Regulation and Markets 2004 (10th Report).* http://europa.eu.int/information_society/topics/ecomm/all_about/implementation_enforcement/annualreports/10threport/index_en.htm

[22] Many operators feature a free number of minutes or offer a subsidized phone for new subscribers. There is often insufficient information about the breakdown among these items in order to determine the actual connection cost.

[23] http://www.itu.int/ITU-D/ict/mexico04/annex/

Figure 9: Talking and surfing



Note: Data in the left chart refer to home and work access for 2000-2001 and home access for 2003-2005. Data in the right chart is the average of 40 countries and refers to outgoing traffic.
Source: Adapted from Nielsen//NetRatings and ITU/KADO Digital Bridges Project.

3.5 Extended core

Two additional indicators were adopted outside of the main infrastructure indicators: *radio sets per 100 inhabitants* and *television sets per 100 inhabitants*. Broadcasting is a traditional ICT and has great significance, particularly for developing nations. However, these indicators have been excluded from the DOI for a number of reasons. First, they do not form part of the main infrastructure indicator set. Second, they are not likely to be of major relevance for the initial group of countries considered in this analysis. It would be unlikely that the rankings will be affected since broadcasting indicators are likely to be related to the other indicators used. Third, and perhaps the most important reason, these are not the best indicators to use for measuring broadcast penetration. As the case for computers noted above, few countries publish data on the number of broadcast sets. It is more accurate to use data from household surveys on the availability of broadcast devices in the home. These form part of the core household and individual access indicators and could thus be incorporated in future permutations of the DOI.

3.6 Summary

The exact indicators selected for the DOI and their goalposts and weights are identified in Table 2, while Table 3 provides an example of how the DOI is computed (as well as serving as a good example of data availability). Each of the four categories is assigned is a weight of 25% to derive the final DOI value. A statistical analysis suggests that the weighting has little impact on the overall results.[24] Therefore, while not duly impacting the results, the categories make it easier for analysts to see which areas a country is relatively strong or weak.

[24] The results generated by weighting indicators within categories and then averaging the categories to obtain the DOI are almost the same as if the indicators were not categorized and simply averaged across the board.

Table 2: DOI structure

Category / indicator	Goalpost	Weight within category (%)	Note
Coverage and affordability			
Percentage of population covered by mobile cellular telephony	100	33	2003 data used. A number of countries have already reached the goalpost.
Mobile cellular tariffs as a percentage of per capita income	.16	33	2005 data used (divided by 2004 annual average exchange rates). The most affordable service was in Hong Kong at 0.16 of per capita income. The indicator is adjusted by the goalpost and subtracted from 100 to be consistent (since for other indicators, high values are the most desirable).
Internet access tariffs as a percentage of per capita income	.20	33	2005 data used (divided by 2004 annual average exchange rates). The most affordable service was in Hong Kong at 0.18 of per capita income. The indicator is adjusted by the goalpost and subtracted from 100 to be consistent (since for other indicators, high values are the most desirable).
Access path and device			
Fixed telephone lines per 100 inhabitants	75	33	2003 data used. The highest value for this indicator was in Sweden with 74.8.
Mobile cellular subscribers per 100 inhabitants	100	33	2003 data used. A few economies have already exceeded the goalpost.
Computers per 100 inhabitants	75	33	2003 estimates used. The highest value for this indicator was in Switzerland with 74.2.
Infrastructure			
(Fixed) Internet subscribers per 100 inhabitants	50	25	2003 data used; when possible, data have been adjusted to include only active subscribers. The highest value for this indicator was in Sweden with 35.
(Mobile) Internet subscribers per 100 inhabitants	75	25	2003 estimates used. The highest value for this indicator was in Japan with 54.7.
International Internet bandwidth per inhabitant	10’000	50	Measured in bits per second. 2003 estimates used. The highest value was in Denmark with 21,981. This indicator is transformed using a logarithmic function as the distribution is non-linear..
Quality			
(Fixed) Broadband Internet subscribers per 100 inhabitants	30	50	2003 data used. The highest value for this indicator was in the Republic of Korea with 23.
(Mobile) Broadband Internet subscribers per 100 inhabitants	100	50	2003 estimates used. The highest value for this indicator was in the Republic of Korea with 9.

Table 3: Calculating the DOI for Hong Kong

2003	Base data	Indicator	Sub index	Weighted	Note on data sources used for benchmark
Coverage & affordability				**0.98**	
Percentage of population covered by mobile cellular telephony	100.00	100.00	1.00	0.33	3 mobile coverage
Mobile cellular tariffs as a percentage of per capita income	3.35	0.16	0.99	0.33	Pre-paid call charges for CSL (http://prepaid.hkcsl.com/english/es_charges.html) based on the OECD low user tariff basket.
Internet access tariffs as a percentage of per capita income	3.85	0.18	0.99	0.33	i-Cable dial-up tariff; includes 20 hours per month including telephone usage charges for HK$30. http://www.i-cable.com/ourservices/dialup/e-home.html
Access paths & device				**0.77**	
Fixed telephone lines per 100 inhabitants	3,819,882	55.8	0.74	0.24	Exchange lines (OFTA)
Mobile cellular subscribers per 100 inhabitants	7,194,335	105.1	1.00	0.33	Public Mobile Radiotelephone Subscriber Units (OFTA)
Computers per 100 inhabitants	2,980,000	43.5	0.58	0.19	Derived from PC shipment data (from Gartner) on the basis of a five year replacement rate
Infrastructure				**0.66**	
Internet subscribers	2,338,125	34.4	0.68	0.17	Derived from dial-up, calling cards, leased lines and broadband Internet access customer accounts (OFTA)
Number of mobile telephone Internet subscribers	729,554	10.65	0.14	0.04	2.5G subscribers (OFTA).
International Internet bandwidth per inhabitant	18,780 (Mbps)	2,742.45	0.91	0.45	Capacity of International Private Leased Circuits for the Provision of Internet Service (OFTA, September 2003)
Quality				**0.30**	
Broadband Internet subscribers	1,230,607	18.09	0.61	0.30	Estimated no. of registered broadband Internet access customer accounts (OFTA)
Broadband mobile subscribers	0	-	-	-	3G launched only in Jan-04 (OFTA).
DIGITAL OPPORTUNITY INDEX				**0.678**	
Reference					
Population	6,803,100				Mid-year (Census & Statistics Department)
Gross National Income per capita (US$)	25,760				World Bank.
Annual average exchange rate	7.79				2004, HK$ per one US$ (World Bank)

Note: Base data refers to the statistic used to compute the indicator (by dividing by population or Gross National Income per capita in the case of tariffs). The indicator is divided by the goalpost shown in Table 2 to obtain the sub index value. The weighted value is obtained by multiplying the sub index by the weight shown in Table 2. The Digital Opportunity Index is calculated by averaging the five category scores.

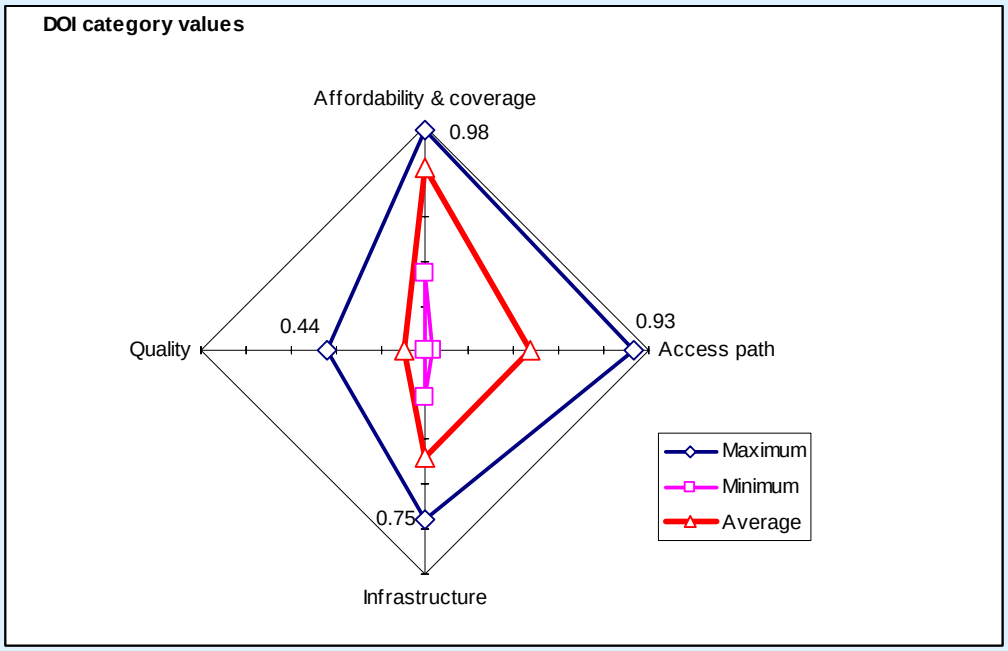
Source: Adapted from Office of the Telecommunications Authority (OFTA, http://www.ofta.gov.hk/en/datastat/main.html), Census & Statistics Department, World Bank.

4 ANALYZING THE RESULTS

The DOI was applied to a group of 40 leading economies that are geographically and economically diverse (Table 4). A number of observations can be made. The top ten economies are all developed (though three are not OECD members) but geographically diverse: four from Europe, five from Asia and one from North America. The bottom ten are all developing but also geographically diverse with four from Asia, four from South America and two from Africa. The DOI shows a huge digital divide with Sweden, the highest ranked, having a score over four times greater than the lowest ranked, India. While Sweden scored 69% of the maximum, India only had a DOI of 14% of the maximum. There is also some geographic clustering: the Asian Tigers all ranked in the top ten as did the Nordics included in the sample, a number of Western European countries ranked in the high teens, Central and Eastern European nations ranked in the low twenties and some Latin American economies in the high twenties.

Looking at the categories, almost all economies did relatively well in the Affordability and Coverage category (Figure 10). Most developed economies ranked high in the Access and Infrastructure categories. Almost all economies did relatively poor in the Quality category with none able to achieve a score of better than 50%. This reflects how far economies still have to go to reach high levels of broadband connectivity.

Figure 10: DOI category values



Source: ITU/KADO Digital Bridges Project.

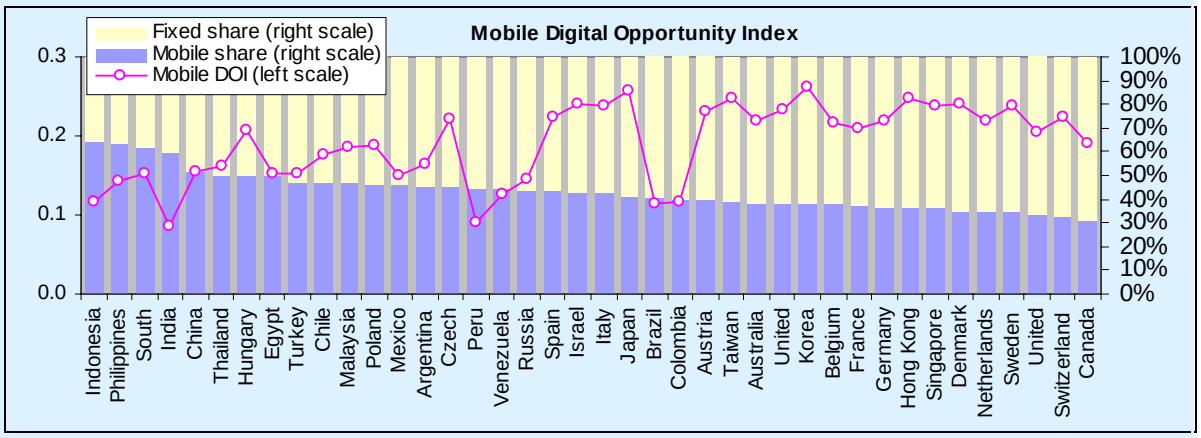
As mentioned earlier, the DOI can also be disaggregated by fixed and mobile networks/services. The Republic of Korea and Japan, ahead in 3G mobile, lead in the mobile DOI (Figure 11). However, the share of mobile in their overall DOI is still less than their fixed share. Mobile has a much bigger impact on the DOI for developing nations; in Indonesia, for instance, mobile accounts for 64% of its overall DOI score.

Table 4: DOI ranking

		Affordability & Coverage	Access paths & device	Infrastructure	Quality	DOI
1	Sweden	0.95	0.93	0.70	0.18	0.69
2	Denmark	0.96	0.86	0.71	0.22	0.69
3	Korea (Rep.)	0.95	0.69	0.66	0.44	0.68
4	Switzerland	0.95	0.92	0.66	0.19	0.68
5	Hong Kong, China	0.98	0.77	0.66	0.30	0.68
6	Singapore	0.97	0.73	0.75	0.17	0.66
7	Taiwan, China	0.97	0.72	0.66	0.22	0.64
8	Netherlands	0.95	0.75	0.63	0.20	0.63
9	Japan	0.95	0.65	0.71	0.19	0.63
10	United States	0.96	0.76	0.60	0.14	0.62
11	Canada	0.95	0.67	0.59	0.24	0.61
12	United Kingdom	0.95	0.77	0.64	0.09	0.61
13	Germany	0.94	0.73	0.63	0.09	0.60
14	Austria	0.93	0.68	0.58	0.14	0.58
15	Belgium	0.93	0.58	0.59	0.21	0.58
16	Australia	0.93	0.73	0.55	0.06	0.57
17	France	0.94	0.64	0.58	0.10	0.57
18	Italy	0.93	0.63	0.61	0.07	0.56
19	Israel	0.95	0.66	0.45	0.16	0.55
20	Spain	0.91	0.58	0.49	0.09	0.52
21	Czech Republic	0.83	0.56	0.56	0.01	0.49
22	Hungary	0.71	0.46	0.46	0.03	0.42
23	Poland	0.86	0.34	0.41	0.01	0.41
24	Malaysia	0.89	0.30	0.39	0.01	0.40
25	Chile	0.78	0.30	0.37	0.04	0.37
26	Argentina	0.85	0.20	0.37	0.01	0.36
27	Russia	0.76	0.24	0.33	0.00	0.33
28	Mexico	0.78	0.20	0.33	0.01	0.33
29	Turkey	0.70	0.28	0.32	0.00	0.32
30	Thailand	0.82	0.19	0.29	0.00	0.32
31	Egypt	0.85	0.09	0.28	0.00	0.31
32	China	0.70	0.17	0.30	0.02	0.30
33	Colombia	0.68	0.15	0.33	0.00	0.29
34	Venezuela	0.67	0.17	0.29	0.01	0.29
35	Brazil	0.56	0.23	0.34	0.01	0.28
36	South Africa	0.50	0.20	0.28	0.00	0.24
37	Philippines	0.52	0.12	0.26	0.00	0.23
38	Peru	0.38	0.09	0.32	0.01	0.20
39	Indonesia	0.44	0.05	0.23	0.00	0.18
40	India	0.33	0.03	0.21	0.00	0.14
	MEDIAN	**0.90**	**0.57**	**0.48**	**0.05**	**0.51**

Note: On a scale of 0 to 1 where 1 = highest value. Economies with the same DOI value are ranked by thousands of a decimal point.

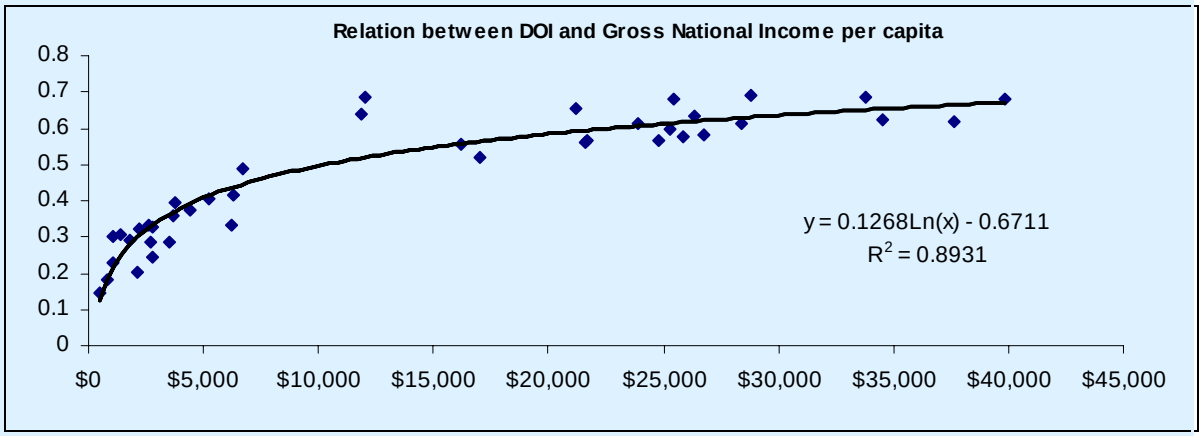
Figure 11: Mobile impact on DOI



Source: ITU/KADO Digital Bridges Project.

As would be expected, there is a close relationship between the DOI and income (Figure 12). Nonetheless, there are some outliers with economies such as the Republic of Korea and Taiwan, China doing much better in ICTs than their incomes would suggest. On the other hand, countries such as Austria and the United States are not doing as well in ICTs as they should be, considering their level of income (Figure 13). This can be interpreted as showing how important are factors other than income (e.g., policy, company performance), and is thus, in some ways, even more meaningful for policy-makers than the DOI itself.

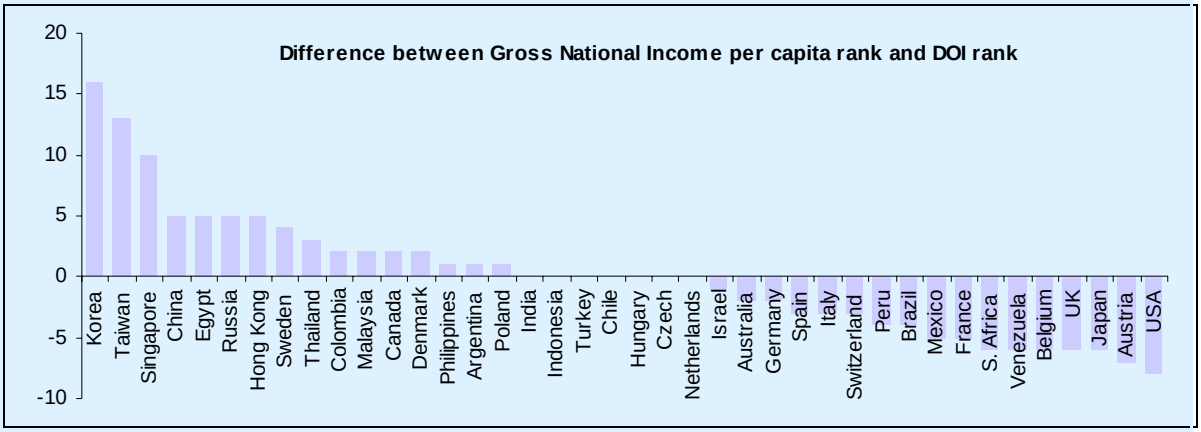
Figure 12: The DOI and Gross National Income per capita



Source: ITU/KADO Digital Bridges Project.

The DOI has a modular design so that it can be linked to other data sets. For instance, the DOI might be enhanced by eventually including indicators from the other core sets that have been adopted, but where data is not yet widely available. As an example, assume that the *proportion of households with a television* from the core indicators on access and use of ICTs by households and individuals is to be included in the DOI. This can be done by re-weighting each of the existing sub-indices from 0.25 to 0.20 and adding a new category, "broadcasting" with the indicator proportion of households with a television. A goalpost is easy to establish: the ideal is that all households have a television. As discussed earlier, broadcasting penetration should not have a significant impact on the DOI since it tends to be correlated to other variables. Indeed, there is no impact on the rankings for more than half the countries (22). For the others, the impact is small with rankings changing at the most three positions (Figure 14, left). This example is for illustrative purposes only since it is unlikely so much significance ($1/5^{th}$ weight) would be attached to one indicator.

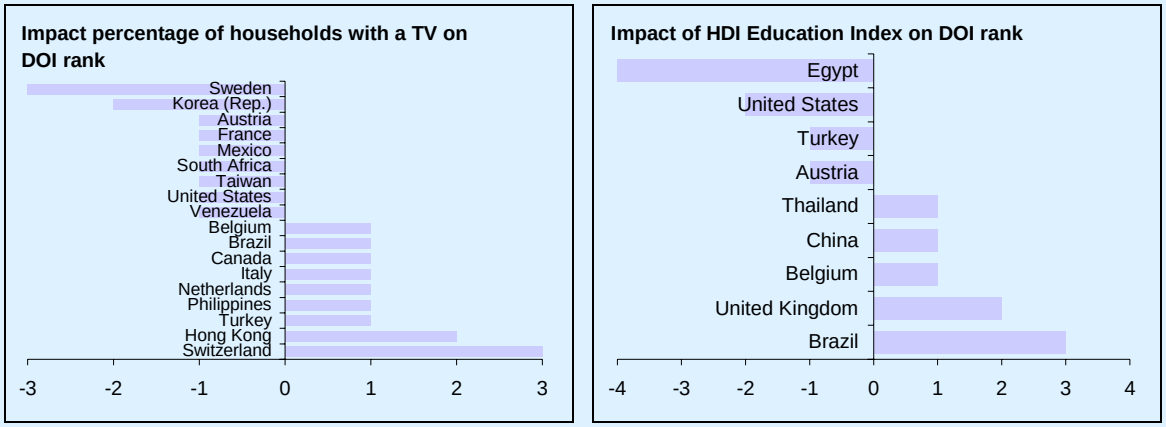
Figure 13: Difference between Gross National Income per capita and DOI ranks



Source: ITU/KADO Digital Bridges Project.

The DOI could also be linked to other indices outside the ICT sector for instance, to investigate the impact of "soft" variables such as income and education on digital opportunities. In this case, the sub-indices of the Human Development Index, such as the Education Index could be used.[25] The technique is the same as described above for adding household broadcast penetration. The four sub-indices of the DOI are rescaled from 0.25 to 0.20 and the Education Index is added (also with a weight of 0.20). Surprisingly, adding in a knowledge factor does not have much impact as overall rankings did not change for 31 of the 40 countries. For the countries whose rankings were affected, the change ranged from +3 in Brazil to -4 in Egypt (Figure 14, right). This suggests both that the Index, as calculated here, is relatively robust and that factors like income and education are auto-correlated with the DOI.

Figure 14: Extending the DOI



Source: Adapted from ITU/KADO Digital Bridges Project and UNDP data.

The DOI rankings can also be compared to those of other e-indices (Table 5). Sweden, which ranks first in the DOI, was also first in three out of four other e-indices. The DOI rankings come closest to those for the DAI. Reasons include overlap of a number of indicators as well as the usage of non-subjective indicators. The methodologies are also similar.

[25] The Education Index is calculated from adult literacy and primary, secondary and tertiary school enrolment.

Table 5: Comparison of DOI ranks with other e-indices

Country	DOI	NRI			ISI			DAI			Orbicom		
		*	**	***	*	**	***	*	**	***	*	**	***
Sweden	1	6	4	(3)	1	1	-	1	1	-	1	1	-
Denmark	2	4	2	-	2	2	-	2	2	-	2	2	-
Korea (Rep.)	3	24	17	(14)	16	13	(10)	4	3	-	19	14	(11)
Switzerland	4	9	7	(3)	7	4	-	13	10	(6)	6	6	(2)
Hong Kong	5	7	5	-	18	15	(10)	7	5	-	8	7	(2)
Singapore	6	1	1	5	12	9	(3)	14	11	(5)	13	9	(3)
Taiwan	7	15	12	(5)	24	19	(12)	9	6	1			
Netherlands	8	16	13	(5)	3	3	5	6	4	4	4	4	4
Japan	9	8	6	3	17	14	(5)	15	12	(3)	20	15	(6)
United States	10	5	3	7	8	5	5	11	8	2	5	5	5
Canada	11	10	8	3	10	7	4	10	7	4	3	3	8
United Kingdom	12	12	10	2	11	8	4	12	9	3	15	11	1
Germany	13	14	11	2	13	10	3	18	14	(1)	14	10	3
Austria	14	19	15	(1)	9	6	8	17	13	1	18	13	1
Belgium	15	26	18	(3)	15	12	3	20	16	(1)	8	7	8
Australia	16	11	9	7	14	11	5	19	15	1	16	12	4
France	17	20	16	1	21	17	-	23	18	(1)	22	16	1
Italy	18	45	28	(10)	23	18	-	22	17	1	26	18	-
Israel	19	18	14	5	20	16	3	25	19	-	23	17	2
Spain	20	29	20	-	26	20	-	29	20	-	27	19	1
Czech Republic	21	40	26	(5)	27	21	-	31	21	-	30	20	1
Hungary	22	38	24	(2)	29	22	-	36	22	-	32	21	1
Poland	23	72	37	(14)	33	25	(2)	40	23	-	42	24	(1)
Malaysia	24	27	19	5	37	27	(3)	46	25	(1)	45	25	(1)
Chile	25	35	22	3	31	23	2	43	24	1	39	22	3
Argentina	26	76	38	(12)	36	26	-	54	26	-	41	23	3
Russia	27	62	34	(7)	42	31	(4)	63	27	-	61	30	(3)
Mexico	28	60	33	(5)	39	29	(1)	64	28	-	56	27	1
Turkey	29	52	31	(2)	49	36	(7)	70	31	(2)	57	28	1
Thailand	30	36	23	7	47	34	(4)	68	30	-	68	33	(3)
Egypt	31	57	32	(1)	45	33	(2)	98	38	(7)	91	37	(6)
China	32	41	27	5	50	37	(5)	84	36	(4)	79	35	(3)
Colombia	33	66	35	(2)	41	30	3	79	34	(1)	66	32	1
Venezuela	34	84	39	(5)	43	32	2	73	32	2	63	31	3
Brazil	35	46	29	6	38	28	7	65	29	6	48	26	9
South Africa	36	34	21	15	32	24	12	78	33	3	59	29	7
Philippines	37	67	36	1	48	35	2	90	37	-	80	36	1
Peru	38	90	40	(2)				83	35	3	70	34	4
Indonesia	39	51	30	9	52	39	-	116	39	-	94	38	1
India	40	39	25	15	51	38	2	119	40	-	106	39	1

Note: DOI = Digital Opportunity Index. NRI = Network Readiness Index. ISI = Information Society Index. DAI = Digital Access Index. * Overall rank including countries not shown here. ** Rank among countries shown here. *** Difference in ranking from DOI.

5 CONCLUSIONS

The Digital Opportunity Index (DOI) is the first e-index based on internationally agreed ICT indicators. This makes it a valuable tool for benchmarking those indicators considered to be the most important for measuring the information society. Because the indicators used for the DOI have been endorsed by the international community, they will increasingly be collected over time by countries, adding to the coverage of the index enhancing its inclusiveness.

The core infrastructure indicators selected for constructing the DOI lend themselves to various analytical possibilities. On one hand, the index can be deconstructed along categories such as affordability and access,

access path and device, infrastructure and quality. This assists analysts to determine where countries are relatively strong and weak in order to focus attention on the appropriate area. On the other hand, the DOI lends itself to a fixed/mobile disaggregation, useful for analyzing the degree to which each is impacting the path countries are taking towards becoming an information society.

The DOI is modular so that core indicators for different sectors can be easily incorporated. For example, indicators from the other core areas such as access and use of ICTs by households and individuals or access and use of ICTs by businesses could be included in future versions of the DOI. The DOI can also incorporate social and economic dimensions that impact ICT take-up for instance by linking to the Human Development Index.

The DOI could also be adapted to different analytical uses. For example, a version tailored to low and middle income countries could be created that incorporates communication access indicators once sufficient data is available and would also include the core broadcasting indicators since radio and television are important development tools. Core indicators that lend themselves to disaggregation by sex can also be utilized to generate a gender-based DOI. Finally, although the research in this report is based on economy level analysis, the DOI could be modified to provide national or regional ICT indices.

6 ANNEX: CORE INDICATORS[26]

6.1 Infrastructure and access core indicators

Basic core
A-1 Fixed telephone lines per 100 inhabitants
A-2 Mobile cellular subscribers per 100 inhabitants
A-3 Computers per 100 inhabitants
A-4 Internet subscribers per 100 inhabitants
A-5 Broadband Internet subscribers per 100 inhabitants
A-6 International Internet bandwidth per inhabitant
A-7 Percentage of population covered by mobile cellular telephony
A-8 Internet access tariffs (20 hours per month), in US$, and as a percentage of per capita income
A-9 Mobile cellular tariffs (100 minutes of use per month), in US$, and as a percentage of per capita income
A-10 Percentage of localities with public Internet access centres (PIACs) by number of inhabitants (rural/urban)
Extended core
A-11 Radio sets per 100 inhabitants
A-12 Television sets per 100 inhabitants

6.2 Core indicators on access and use of ICTs by households and individuals

Basic core
HH-1 Proportion of households with a radio
HH-2 Proportion of households with a TV
HH-3 Proportion of households with a fixed line telephone
HH-4 Proportion of households with a mobile cellular telephone
HH-5 Proportion of households with a computer
HH-6 Proportion of individuals that used a computer (from any location) in the last 12 months
HH-7 Proportion of households with Internet access at home
HH-8 Proportion of individuals that used the Internet (from any location) in the last 12 months
HH-9 Location of individual use of the Internet from all locations in the last 12 months
Response categories:

- At home
- At work
- Place of education
- At another person's home
- Free Public Internet Access Centre (specific denomination depends on national practices)
- Charged Public Internet Access Centre (specific denomination depends on national practices)
- Others

HH-10 Internet activities undertaken by individuals in the last 12 months
Response categories:

- For getting information
  - About goods or services
  - Related to health or health services
  - From government organisations/public authorities via websites or e-mail
  - Other information or general Web browsing
- For communicating
- Purchasing or ordering goods or services
- Internet banking or other financial services
- For education and learning
- For dealing with government organisations/public authorities
- For leisure activities
  - Playing/downloading video or computer games
  - Obtaining movies, music or software
  - Reading/downloading electronic books, newspapers or magazines
  - Other leisure activities

Extended core
HH-11 Proportion of individuals with use of a mobile telephone
HH-12 Proportion of households with access to the Internet by type of access from home

[26] Based on discussions at the WSIS Thematic Meeting on Measuring the Information Society, Geneva, 7-9 February 2005.

- Response categories should allow an aggregation to narrowband and broadband, where broadband will exclude slower speed technologies, such as dial-up modem, ISDN and most 2G mobile phone access, and which will usually result in a speed of at least 256 kbit/s.

HH-13 Frequency of individual access to the Internet in the last 12 months (from any location)
Response categories:

- at least once a day
- at least once a week but not every day
- at least once a month but not every week
- less than once a month

Reference indicator
HH-R1 Proportion of households with electricity[27]

6.3 Core indicators on access and use of ICTs by businesses

Basic core
B-1 Proportion of businesses using computers
B-2 Proportion of employees using computers
B-3 Proportion of businesses using the Internet
B-4 Proportion of employees using the Internet
B-5 Proportion of businesses with a website (or web presence where the business has control over the content)
B-6 Proportion of businesses with an intranet
B-7 Proportion of businesses receiving orders over the Internet
B-8 Proportion of businesses placing orders over the Internet
Extended core
B-9 Proportion of businesses accessing the Internet by modes of access

- Response categories should allow an aggregation to narrowband and broadband, where broadband will exclude slower speed technologies, such as dial-up modem, ISDN and most 2G mobile phone access, and which will usually result in a speed of at least 256 kbit/s.

B-10 Proportion of businesses with a Local Area Network (LAN)
B-11 Proportion of businesses with an extranet
B-12 Proportion of businesses using the Internet by type of activity
Response categories:

- Internet e-mail
- Getting information
    - About goods or services
    - From government organisations/public authorities via websites or e-mail
    - Other information searches or research activities
- Performing Internet banking or accessing other financial services
- Dealing with government organisations/public authorities
- Providing customer services
- Delivering products online

6.4 ICT sector basic core

ICT-1 Proportion of total workforce involved in the ICT sector
ICT-2 Value added in the ICT sector (as a percentage of total value added)
ICT-3 ICT goods imports as percentage of total imports
ICT-4 ICT goods exports as percentage of total exports

[27] Since electricity is not specifically an ICT commodity, but important nevertheless for developing countries prerequisite for using ICT, it is not included in the core list, but included as a reference indicator, just like the number of households, population, GDP etc. will be.

7 ANNEX: CORE INFRASTRUCTURE DATA

Economy	Main telephone lines	Mobile cellular sub-scribers	Internet sub-scribers	Mobile Internet subscribers	Inter-national Internet band-width (Mbps)	Personal computers	Broad-band sub-scribers	Broad-band mobile sub-scribers	Average Internet access cost US$	Mobile coverage	Mobile tariff US$
Argentina	7'745'600	7'842'000	1'742'753	200'000	6'000	3'300'000	257'208	0	$12.01	95.00	$8.26
Australia	10'815'000	15'459'000	5'211'000	1'100'000	12'582	10'900'000	698'700	87'000	$23.34	97.00	$22.19
Austria	3'881'000	7'094'502	1'300'000	840'000	33'903	3'200'000	679'500	11'000	$25.58	98.00	$26.42
Belgium	5'073'760	8'069'682	1'892'000	250'000	84'099	2'600'000	1'273'575	0	$38.50	99.00	$24.91
Brazil	42'317'000	46'373'266	4'700'000	1'200'000	12'000	15'200'000	1'200'000	0	$20.55	68.20	$18.92
Canada	19'950'901	13'221'819	7'013'000	500'000	172'529	18'600'000	4'653'000	0	$15.88	93.00	$6.72
Chile	3'250'855	7'520'280	841'396	200'000	2'000	2'000'000	357'623	0	$22.44	100.00	$17.03
China	263'000'000	269'000'000	64'484'000	2'000'000	27'216	41'500'000	13'543'000	0	$10.14	72.70	$2.87
Colombia	8'768'052	6'186'206	712'868	25'000	3'620	1'840'000	64'436	0	$7.02	74.00	$10.39
Czech Republic	3'626'025	9'708'683	2'112'631	280'000	25'000	2'000'000	34'347	0	$30.56	99.00	$15.15
Denmark	3'610'059	4'767'277	1'677'681	930'907	118'559	3'300'000	717'452	5'000	$24.00	99.00	$19.86
Egypt	8'735'653	5'797'530	900'000	50'000	1'148	1'500'000	4'850	0	$4.13	98.00	$4.07
France	33'905'438	40'388'700	10'524'727	2'210'000	339'591	23'380'000	3'524'727	0	$12.85	99.00	$30.23
Germany	54'350'000	64'800'000	23'000'000	5'049'000	348'848	34'530'000	4'613'015	0	$12.79	99.00	$30.59
Hong Kong	3'819'882	7'194'335	2'338'125	729'554	18'780	2'980'000	1'230'607	10'000	$3.85	99.90	$3.35
Hungary	3'602'912	7'944'586	673'732	336'000	10'000	1'205'000	192'002	0	$66.03	99.00	$13.32
India	48'917'000	26'154'405	4'140'000	200'000	3'000	9'039'468	140'362	0	$10.77	41.40	$2.45
Indonesia	8'476'968	18'800'000	865'706	300'000	1'200	3'489'000	50'000	0	$17.32	85.00	$4.58
Israel	2'913'000	6'674'000	1'050'000	300'000	1'273	2'190'000	650'000	0	$20.26	97.00	$9.47
Italy	26'596'000	55'918'000	17'000'000	3'500'000	119'794	13'400'000	2'429'767	453'000	$38.38	99.80	$14.00
Japan	70'000'000	86'658'645	33'905'035	69'732'000	75'946	52'680'000	13'774'830	2'040'000	$17.78	99.00	$29.11
Korea (Rep.)	22'877'019	33'591'758	11'178'498	19'550'000	37'069	26'741'000	11'178'000	4'378'000	$17.35	99.00	$2.11
Malaysia	4'571'561	11'124'112	3'007'481	500'000	2'170	4'200'000	110'104	0	$8.42	95.00	$5.79
Mexico	16'311'130	30'097'700	2'458'000	50'000	7'000	8'600'000	312'000	0	$19.85	81.00	$18.53
Netherlands	10'004'000	12'500'000	5'000'000	900'000	50'000	8'500'000	1'929'944	0	$12.79	99.00	$24.55
Peru	1'839'165	2'930'343	556'125	100'000	1'500	1'400'000	90'663	0	$29.29	75.00	$19.64
Philippines	3'255'000	22'460'000	830'000	300'000	1'000	2'140'000	25'000	0	$16.20	80.00	$4.03
Poland	12'275'000	17'359'000	2'358'000	100'000	13'000	4'857'000	239'000	0	$22.23	98.00	$6.51
Russia	37'400'000	36'230'000	2'800'000	400'000	10'000	16'138'000	125'000	0	$10.00	77.60	$6.30
Singapore	1'889'500	3'577'500	2'202'800	500'000	15'564	2'400'000	421'700	0	$16.00	99.90	$5.72
South Africa	4'821'000	16'860'000	900'000	65'000	775	3'680'000	20'313	0	$61.00	96.00	$14.57
Spain	17'567'533	37'506'697	5'217'453	801'000	50'000	8'190'000	2'121'930	0	$28.22	99.00	$21.48
Sweden	6'711'000	8'801'000	3'211'000	516'000	100'000	5'730'000	964'000	12'000	$28.91	99.00	$15.75
Switzerland	5'261'000	6'172'000	2'400'000	150'000	51'482	5'430'000	837'000	0	$29.22	98.60	$33.03
Taiwan	13'355'032	25'089'644	7'822'117	2'790'000	44'923	6'557'000	3'004'623	0	$8.69	99.00	$2.37
Thailand	6'600'034	21'887'000	1'000'000	600'000	1'437.69	3'487'000	15'000	0	$6.07	92.00	$6.84
Turkey	18'916'721	27'887'535	3'500'000	500'000	2'200	3'200'000	56'500	0	$16.47	68.00	$6.39
United Kingdom	34'591'000	52'984'000	14'203'000	4'790'000	534'814	29'420'000	3'195'730	361'000	$30.28	99.40	$19.10
United States	181'599'933	158'721'981	78'100'000	18'200'000	708'598	206'000'000	25'110'000	10'000	$14.95	95.00	$10.78
Venezuela	2'955'175	7'015'735	321'330	100'000	680	1'700'000	111'066	0	$13.73	77.40	$25.66

Source: ITU/KADO Digital Bridges Project and ITU World Telecommunication Indicators Database.

8 ANNEX: DOI INDICATORS

Economy	Fixed telephone lines per 100 inhabitants	Mobile cellular subscribers per 100 inhabitants	Computers per 100 inhabitants	Internet subscribers per 100 inhabitants	Mobile Internet subscribers per 100 inhabitants	Broadband Internet subscribers per 100 inhabitants	Broadband mobile subscribers per 100 inhabitants	International Internet bandwidth per capita	Internet access tariffs as a % of per capita income	% of population covered by mobile cellular telephony	Mobile cellular tariffs as a % of per capita income
Argentina	20.45	20.71	8.20	4.60	0.26	0.68	0.00	149.62	3.92	95.00	2.72
Australia	54.23	77.52	50.86	26.13	1.63	3.50	0.94	533.92	1.10	97.00	1.23
Austria	48.07	87.88	37.41	16.10	0.99	8.42	0.37	4'479.76	1.69	98.00	1.19
Belgium	48.92	77.80	24.14	18.24	2.89	12.28	0.00	8'113.69	1.48	99.00	1.16
Brazil	24.05	26.36	7.30	2.67	0.68	0.68	6.57	53.72	11.79	68.20	8.38
Canada	62.90	41.68	48.70	22.11	1.26	14.67	12.61	2'841.82	0.68	93.00	0.34
Chile	20.61	47.68	11.52	5.33	0.41	2.27	0.16	127.08	6.14	100.00	4.66
China	20.35	20.82	2.76	4.99	0.04	1.05	0.10	7.30	12.94	72.70	3.13
Colombia	20.03	14.13	3.70	1.63	0.02	0.15	0.00	12.67	12.20	74.00	6.89
Czech Republic	36.03	96.46	17.74	20.99	2.98	0.34	0.00	2'189.08	4.50	99.00	2.70
Denmark	66.93	88.39	57.68	31.11	2.08	13.30	0.06	20'319.84	0.68	99.00	0.71
Egypt	12.73	8.45	1.66	1.31	0.14	0.01	0.00	10.92	4.47	98.00	3.52
France	56.60	67.43	34.71	17.57	10.52	5.88	0.00	3'353.62	0.77	99.00	1.46
Germany	65.88	78.54	39.82	27.88	6.06	5.59	0.00	3'161.30	0.75	99.00	1.45
Hong Kong	56.15	105.75	42.20	34.37	1.98	18.09	0.00	1'866.77	0.19	99.90	0.16
Hungary	34.86	76.88	10.84	6.52	2.90	1.86	0.00	246.26	4.13	99.00	2.52
India	4.63	2.47	0.72	0.39	0.01	0.01	0.58	1.79	21.85	41.40	5.55
Indonesia	3.94	8.74	1.41	0.40	0.09	0.02	0.00	2.70	37.62	85.00	6.79
Israel	43.06	98.64	24.26	15.52	1.48	9.61	14.78	213.70	2.13	97.00	0.70
Italy	46.27	97.28	21.43	29.57	2.61	4.23	0.79	1'197.72	1.04	99.80	0.78
Japan	54.89	67.96	39.72	26.59	28.48	10.80	10.79	237.66	0.76	99.00	1.01
Korea (Rep.)	47.88	70.30	49.49	23.39	25.06	23.39	51.96	362.32	1.18	99.00	0.21
Malaysia	18.16	44.20	14.68	11.95	0.79	0.44	0.00	53.84	2.85	95.00	1.84
Mexico	15.77	29.11	8.20	2.38	0.05	0.30	0.01	57.18	4.59	81.00	3.57
Netherlands	61.43	76.76	46.66	30.70	3.07	11.85	0.00	10'326.15	1.21	99.00	1.12
Peru	6.77	10.79	4.30	2.05	0.18	0.33	0.74	50.69	19.22	75.00	10.96
Philippines	4.01	27.69	2.77	1.02	0.37	0.03	0.00	11.20	20.06	80.00	4.48
Poland	31.81	44.98	10.56	6.11	0.26	0.62	0.00	163.59	4.12	98.00	1.48
Russia	25.54	24.75	8.87	1.91	0.85	0.09	0.03	61.17	5.61	77.60	2.90
Singapore	45.03	85.25	62.20	52.49	8.24	10.05	0.00	1'416.58	0.64	99.90	0.32
South Africa	10.40	36.36	7.26	1.94	0.28	0.04	0.00	12.42	15.38	96.00	6.29
Spain	42.91	91.61	19.60	12.74	3.40	5.18	0.00	1'144.31	1.72	99.00	1.52
Sweden	74.77	98.05	62.14	35.77	7.21	10.74	0.13	10'613.83	1.08	99.00	0.66
Switzerland	71.89	84.34	70.87	32.80	2.05	11.44	0.00	9'040.63	0.71	98.60	0.99
Taiwan	59.00	110.84	39.46	34.56	1.99	13.27	0.13	656.75	0.74	99.00	0.24
Thailand	10.55	35.00	3.90	1.60	0.48	0.02	0.36	16.33	4.23	92.00	3.75
Turkey	27.70	40.84	4.46	5.13	0.66	0.08	0.00	16.83	9.52	68.00	2.75
United Kingdom	58.12	89.02	40.57	23.86	5.01	5.37	0.61	5'409.95	1.13	99.40	0.81
United States	62.13	54.30	68.97	26.72	3.22	8.59	10.61	1'323.63	0.51	95.00	0.34
Venezuela	11.50	27.30	6.09	1.25	0.19	0.43	0.39	26.98	5.71	77.40	8.82

Source: ITU/KADO Digital Bridges Project.

9 ANNEX: REFERENCE DATA

Economy	Population 2003	Annual average exchange rate to 1US$ 2004	Gross National Income per capita, US$, 2003
Argentina	37'869'730	2.92	$3'650.00
Australia	19'941'300	1.36	$21'650.00
Austria	8'073'000	0.80	$26'720.00
Belgium	10'372'469	0.80	$25'820.00
Brazil	175'955'500	2.93	$2'710.00
Canada	31'720'400	1.30	$23'930.00
Chile	15'773'500	609.53	$4'390.00
China	1'292'270'000	8.28	$1'100.00
Colombia	43'782'500	2'628.61	$1'810.00
Czech Republic	10'064'600	25.70	$6'740.00
Denmark	5'393'500	5.99	$33'750.00
Egypt	68'648'000	6.20	$1'390.00
France	59'900'268	0.80	$24'770.00
Germany	82'504'000	0.80	$25'250.00
Hong Kong	6'803'100	7.79	$25'430.00
Hungary	10'334'200	202.63	$6'330.00
India	1'056'890'900	45.26	$530.00
Indonesia	215'091'300	8'938.85	$810.00
Israel	6'765'700	4.48	$16'240.00
Italy	57'482'000	0.80	$21'560.00
Japan	127'520'000	108.15	$34'510.00
Korea (Rep.)	47'782'466	1'145.24	$12'020.00
Malaysia	25'170'400	3.80	$3'780.00
Mexico	103'408'700	11.29	$6'230.00
Netherlands	16'285'200	0.80	$26'310.00
Peru	27'148'000	3.41	$2'150.00
Philippines	81'100'000	56.04	$1'080.00
Poland	38'589'000	3.65	$5'270.00
Russia	146'412'200	28.81	$2'610.00
Singapore	4'196'500	1.69	$21'230.00
South Africa	46'365'000	6.44	$2'780.00
Spain	40'939'600	0.80	$16'990.00
Sweden	8'975'670	7.35	$28'840.00
Switzerland	7'317'677	1.24	$39'880.00
Taiwan	22'636'600	33.37	$11'836.00
Thailand	62'531'600	40.27	$2'190.00
Turkey	68'284'000	1'448'898.55	$2'790.00
United Kingdom	59'518'000	0.55	$28'350.00
United States	292'300'000	1.00	$37'610.00
Venezuela	25'697'600	1'886.13	$3'490.00

Source: National statistical offices and World Bank.

10 ANNEX: OECD MOBILE BASKET

	Fixed	On-net	Off-net	TOTAL	Call distribution by time of day
Call distribution	42%	40%	18%	100%	100%
Calls	10.50	10.00	4.50	25	
Number of calls per period	10.50	10.00	4.50	25	
Peak	3.99	3.80	1.71	10	38%
Off-peak	3.68	3.50	1.58	9	35%
Weekend	2.84	2.70	1.22	7	27%
Duration (minutes per call)	1.60	1.40	1.40		
Call length (minutes)	16.80	14.00	6.30	37.10	
peak	6.38	5.32	2.39	14.10	
off-peak	5.88	4.90	2.21	12.99	
weekend	4.54	3.78	1.70	10.02	
Calls	25	per month			
SMS	30	per month			

Source: OECD.