The Connectivity Scorecard

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Foreword

The idea of a scorecard assessing country connectivity came from Nokia Siemens Networks. I have been studying the impacts of communications networks for about nine years[1] and the idea of defining and comparing "Connectivity" was intriguing.

There are a number of existing Indexes comparing aspects of connectivity; in this study we highlight two: the ITU's Digital Opportunity Index and The Economist's E-readiness Index. While these are excellent, they have a more limited remit. The academic economics/business literature on the impact of ICT generally on economic growth and productivity stresses two factors. First, the importance of computing and communications on economic growth and productivity enhancement is due primarily to the spread of ICT in firms as well as household and government access to the Internet. Second, within firms, investment in ICT increases productivity, especially when the firm changes its practices and invests in skills and complementary assets and services[2].

This academic literature therefore suggest that benchmarking Connectivity should stress not only expansion of infrastructure and usage but also the skills and complementarities required to drive communications networks as an engine of growth. That is, it is "smart" usage which helps make Connectivity a driver of productivity gains and hence economic growth.

The Connectivity Scorecard therefore:

- Includes a number of components relating to the ability of the use of networks to enhance productivity and growth (e.g., the use of enterprise software in business; literacy and access by woman to the Internet; Adjusted Government software and hardware spending per capita)

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[1] Roeller, Lars-Hendrik and Leonard Waverman, "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach," American Economic Review, Volume 91, Number 4, pp. 909-923, 2001.

[2] Brynjolfsson, Erik and Loren Hitt, "Beyond Computation: Information Technology, organizational transformation and business performance," Journal of Economic Perspectives, vol. 14, pp. 43-48, 2000.

• Uses country-specific national accounts data to derive the weights to assign to the three principal "actors" – business, consumers, government

• Weights infrastructure and usage according to the contributions that economic research shows they make to economic growth.

We have selected 16 'Innovation driven' and Emerging economies moving to Innovation driven (We use the World Economic Forum definitions and typology of countries). In addition we select nine Efficiency driven and Resource driven economies. Countries were selected both to provide regional balance and because of data availability. We plan to extend The Connectivity Scorecard to other countries. This is the initial study and we look for feedback.

We hope that The Connectivity Scorecard proves useful – to governments assessing how ICT policy can be advanced; to telecoms operators considering how they can assist the customers and countries they operate in; to businesses considering how to invest in network capabilities; and to consumers addressing choice among connectivity options.

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1 Executive summary

It is widely accepted that most modern economies are ***Information*** economies, and that much of economic growth and productivity growth in the developed nations of Europe, North America and the Far East is driven by information and communications technology (ICT). What is less widely accepted and understood is that actually all economies are information economies. The free flow and availability of information lowers the barriers to economic activity and stimulates growth and productivity in even those economies that we do not normally regard as fully "developed."

Connectivity is usually understood to be the copper wires, fibre-optic cables and networked computers and more recently mobile phones and base stations that enable the fast flow of information regardless of distance, at costs that are much lower than the costs of physical travel and much lower than they were just 15 or 20 years ago. Connectivity is the key enabler of the flow of information that defines modern economies, and it is also the key enabler of an ongoing (and sometimes overlooked) transformation in the economic fortunes of many Asian and African countries.

We, however, define "Connectivity" in a somewhat broader way to embrace more than just infrastructure and hardware. The notion of Connectivity should be expanded to include also the complementary assets and skills — embodied in people, governments and businesses — that determine just how productively the hardware and infrastructure are used.

The research in this report was conducted by a team at LECG under the direction of Professor Leonard Waverman. The Connectivity Scorecard that we have designed is an attempt to capture how "usefully connected" countries around the world really are. Like any Scorecard, ours is essentially a collection of different metrics, but our metrics encompass usage and skills as well as infrastructure. Further we recognise that the primary driver of productivity and economic growth is the ability of businesses to use ICT effectively. Thus we give business — and those measures related to business infrastructure and usage — the weight that economic statistics suggest that it should be given. And we do this based on individual data for each country to the extent possible. Likewise we link the weight given to infrastructure metrics relative to usage and skills to economic statistics for individual countries. In this way, we make a link between Connectivity and economic performance in a way that we believe is innovative and relevant.

Why is it important?

Existing research on Connectivity has many merits, but it does not articulate the benefits of Connectivity explicitly in terms of economic contributions.

Previous indices have focused largely on infrastructure measures (e.g., number of main telephone lines) in assessing connectivity. There has been little attempt to assess the extent to which people are able to employ ICT infrastructure effectively in pursuit of economic development and growth. World class infrastructure (as we will later discuss in the case of Korea) is not sufficient to promote growth unless its adoption is widespread and it is effectively utilised by a skilled population that includes deep use within firms.

The Connectivity Scorecard is also unique in categorizing indicators of Connectivity by consumer, business and government, with weightings between these three and also between groups of indicators tailored to each country. Previous indices have assumed weightings rather arbitrarily or utilised statistical methods that despite several desirable qualities have little relation to economic realities. These indices have either never made, or have simply lost, the tight linkages between Connectivity and economic performance (a linkage that can be extended to wider measures of well-being such as environmental performance in subsequent editions of the Scorecard) that we have strived to make.

What we did and what we found

We have computed two separate Connectivity Scorecards—the first for a group of 16 countries, covering mostly the innovation-driven (Tier 3) economies but also some economies that are making the transition towards being innovation-driven: Hungary, Poland, the Czech Republic and Korea are examples. The second Connectivity Scorecard covers 9 countries, and uses different assessment metrics. The countries covered by the second Scorecard are Resource driven or Efficiency driven economies. The terms "Resource driven", "Efficiency driven" and "Innovation driven" are borrowed from the World Economic Forum (WEF)'s classification.

We looked at the scores for each country on each metric on a benchmarked basis (relative to "best in class" in its category). In this Scorecard, the highest theoretical score for any country is 10, although this would require the country to be the best on every single metric.

Table 1 shows that the United States tops The Connectivity Scorecard for the Innovation driven segment and Russia for the Resource and Efficiency driven segment ("the emerging world"). The United States is powered by its good performances on usage measures, especially by businesses. Sweden and Japan are close behind, with Japan being rewarded for high use of mobility solutions by businesses in particular. Korea, a star performer on other indexes, finishes 10th largely because very high performance in infrastructure is not matched by correspondingly high scores on usage measures, especially by businesses.

Malaysia and Russia do well in the emerging segment as they have high literacy rates and usage scores, comparable in some cases to Innovation driven economies. India and Nigeria are the lowest scorers on the emerging segment Scorecard, falling behind on both usage and infrastructure metrics.

Table 1: Summary of The Connectivity Scorecard

Innovation driven economies	Connectivity score
United States	6.97
Sweden	6.83
Japan	6.8
Canada	6.5
Finland	6.1
UK	6.1
Australia	5.93
Germany	5.52
France	5.07
Korea	4.78
Hong Kong SAR	4.46
Italy	3.85
Spain	3.56
Hungary	3.18
Czech Republic	3.11
Poland	2.18

Efficiency and resource driven economies	Connectivity score
Russia	6.11
Malaysia	5.82
Mexico	4.37
Brazil	4.28
South Africa	4.11
China	3.42
Philippines	2.38
India	1.68
Nigeria	1.01

Major implications

Little room for complacency

The most striking result of The Connectivity Scorecard is just how low many countries score. *Even the world's best connected countries have little room for complacency and much work to do.* While a perfect 10 is a possibility if and only if a country topped all of the components, the wide dispersion of scores and the failure of any country to score even 7 out of 10 shows that there is not one country that is uniformly strong on all dimensions of Connectivity. For example, even the U.S. registers mediocre performance in broadband relative to the existing best performers today. This shows the potential for catch-up that exists even in the "most usefully connected" nation.

Untapped potential equals significant economic gain

Given that ours is a composite measure of useful Connectivity which links usefulness to economic performance, there are major economic gains to be had from improving Connectivity (as we define it). For example, a well-known study in the United States (by Crandall and Jackson)[3] put the long-term benefits to the U.S. of increased broadband penetration at $500 billion. Holistic improvements in performance could yield long-term economic gains that are multiples of the figure obtained by Crandall and Jackson.

The Connectivity Scorecard shows that there is much untapped potential in even the most advanced markets. Countries that one normally thinks of as highly connected still score poorly on this scorecard. For example, Korea has relatively low spend on certain business telephony measures, suggesting that there is considerable room for growth, given the size and wealth of the country and the quality of some of the supporting infrastructure. Likewise, there is still potential for extensive new infrastructure deployments and far more intensive usage of technology in the United States, the country that ranks first on the Scorecard. The United States did not rank first in any of the three components – business, consumer and government – but did well enough on all three to be first overall.

Lessons for policy-makers, businesses and telecom operators

Policy-makers need to evaluate where their country falls short in Connectivity performance and strive to either develop the infrastructure and complementary assets that would facilitate better performance or eliminate the barriers and rigidities that prevent it. A lot of the necessary change will not be easy in the short term, and it may require governments to remove (for example) the barriers that make it harder for businesses to re-organise themselves around ICT, or the import tariffs that protect domestic producers but cost societies much more by raising the price of access and usage of the relevant infrastructure.

Businesses too clearly have a role to play. The economic gains described above are gains to both consumers and to businesses, which are able to perform much more efficiently if they use more technology more effectively. Businesses also have to accept change, while perhaps investing more in "complementary capital" such as worker training that will enable them to reap larger benefits from technology.

Further, businesses have to show imagination in the way they use technology. As a complement to this Scorecard (and perhaps an input to future iterations of the Scorecard) we surveyed IT managers who operated internationally to gauge their

[3] Crandall, Robert and Charles L. Jackson, "The $500 billion opportunity", Prepared for Verizon Communications, 2001.

satisfaction with the fixed-line and mobile infrastructures and services offered in a range of countries. Somewhat to our surprise, most were quite satisfied with the state of affairs they found. This could suggest that the low scores on our Scorecard are misleading, but it more likely suggests that businesses do not grasp that even existing technologies can be used much more intensively. For example, some mobile banking services and electronic transaction services are better developed in African countries than in the U.S. or Canada.

For Telecommunications operators, The Connectivity Scorecard shows that few markets are truly “saturated.” Operators will have to look at the specific strengths and weaknesses of each country and spot the potential for expansion. In India, there are opportunities everywhere — to expand the existing coverage of mobile and broadband networks, and to increase the usage of these technologies from the existing revenue base. However, other less prominent emerging markets also have significant infrastructure and Connectivity needs, and operators may benefit from moving early to convert those needs into opportunities. In addition, we emphasis ”smart” Connectivity – i.e,, the ways in which networks are used – hence there is much room for operators to assist firms by providing best-in-class training in usage. Thus operators need to re-focus their attention on “smart” sales.

2 Introduction and context

The goal of The Connectivity Scorecard was to measure the extent to which the technologies that make up Connectivity and the ways in which people use these technologies are enhancing social and economic prosperity across the globe.

The starting point of our research was the belief that Connectivity—if properly used—has some important benefits:

- To **businesses and governments**, by virtue of improvements in productivity;
- To **consumers and society**, by offering a wider range of choices for entertainment and convenience;
- To the **environment**, by reducing the need to rely on physical transport.

Existing research

Existing research on connectivity has many merits, but it does not articulate the benefits of connectivity explicitly in terms of economic contribution and ignores many elements of connectivity, particularly with regard to the extent to which people are able to employ ICT infrastructure effectively.

The ITU has developed the **Digital Opportunity Index** (DOI) which is calculated for all 181 countries which belong to the ITU. The ITU states:

> *"The Digital Opportunity Index (DOI) has been designed to as a tool for tracking progress in bridging the digital divide and the implementation of the outcomes of the World Summit on the Information Society (WSIS). As such, it provides a powerful policy tool for exploring the global and regional trends in infrastructure, opportunity and usage that are shaping the Information Society."*

The ITU DOI has three clusters: Opportunity, Infrastructure and Utilization, and eleven sub-indicators. It is heavily dependent on measuring the spread and usage of telephony.

As laudable as the ITU's DOI is, it does not purport to measure connectivity as we have defined it – an *index of Connectivity should incorporate measures of ICT which are associated with ICT's transformative qualities.*

The Economist Intelligence Unit (EIU) publishes the **E-Readiness Rankings,** which captures a wider-ranging series of measures, including measures of the institutional and business environment, and consumer and business adoption. This Index captures the multi-dimensional nature of Connectivity. It is a step in the direction of capturing "useful Connectivity" that we wish to make, but it still does not make sufficiently tight linkages between Connectivity and economic performance.

Our vision of a Connectivity Scorecard

A Connectivity Scorecard should thus take into account the differences in the sources of economic growth across different types of economies as well as measuring the ways in which ICT can transform activities and therefore raise productivity and growth.

We have incorporated three crucial insights into the index design.

Insight 1: Three pillars

Connectivity is crucial for the three major actors in an economy – firms (producers of goods and services), consumers (purchasers of goods and services for final consumption) and governments. These three should be accorded weights in proportion to their relative contributions to economic growth and prosperity.

Thus our Connectivity Scorecard has three subcomponents or "pillars" -- for consumers, producers and governments. One of the unique features of our Scorecard is that we have tied the weight given to each of these sectors to the national income accounts for each country.

Insight 2: Infrastructure, usage and skills

The second insight on which we have based our Scorecard design is the idea that simply measuring infrastructure (e.g., number of telephone lines per 100 people) is not sufficiently nuanced to capture accurately the extent to which a country and its inhabitants are "connected". Crucially, the extent to which ICT infrastructure can promote economic growth and societal well-being hangs on the ability of people, governments and firms to effectively utilise ICT technology.

Consequently, we have included a range of usage and skills based measures intended to capture the ways by which people can exploit technology and the extent to which new technologies have been adopted. We have weighted the infrastructure and usage sub-categories within each pillar by reference to their respective contributions to economic well-being or economic progress. For consumers, the relevant economic concept that captures well-being or progress is ‘utility’ – the value brought. The relevant concept for businesses and government is productivity.

The weighting system that we have deployed allows for a significant degree of heterogeneity between countries, tied specifically to their economic structure. For example, in most countries in the OECD, Gross Domestic Product (GDP) has grown on account of (a) increased use of capital, especially capital related to investments in ICT; (b) (in some cases) increased supply of labour; (c) improvements in the quality of labour supplied; and (d) the efficiency with which capital and labour are put to use (what economists refer to as “Total Factor Productivity”, or TFP).

The extent to which GDP growth depends on factors (a), (b), (c) and (d) delineated above will vary significantly even among developed countries. The U.S., for example, has seen large increases in ICT capital use, and an increased supply of higher quality labour; these effects have generally been less pronounced in Europe, barring the Nordic nations.

Consequently, a weighting system based (as much as possible) upon country-specific estimates of the various growth-promoting factors highlighted above has the great merit of providing a good conceptual correspondence with the actual economic structure of each of the countries we have included in the Scorecard. We believe that such a weighting system is an important advance in Scorecard design.

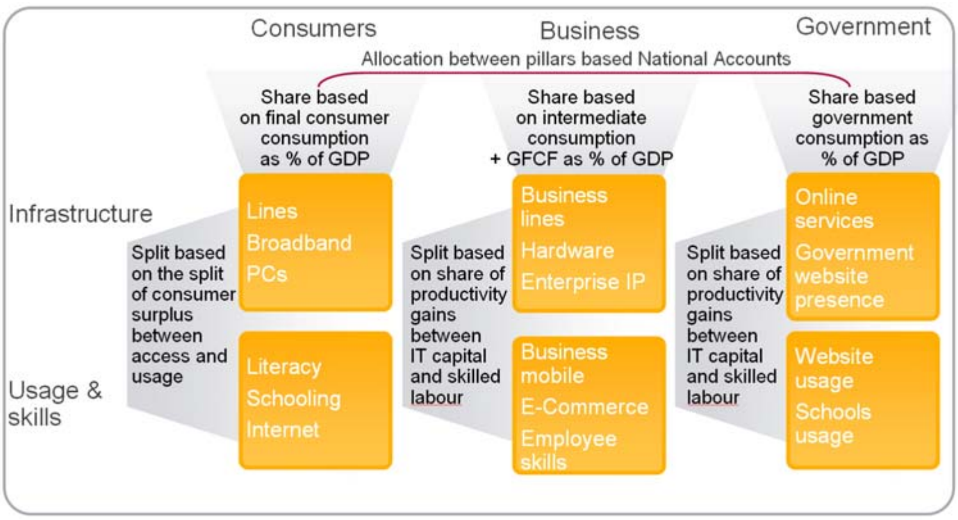
Insight 3: Different Scorecards for different stages of economic development

Just as the WEF has recognised that economies at different levels of development are driven by different factors (innovation, efficiency or resources) we have incorporated the notion that the role played by Connectivity (in terms of both infrastructure and usage and skills) in fostering economic growth and societal prosperity depends on a country's level of development. As a simple example, high speed broadband connections or a steady supply of highly skilled graduates may be important for continued economic growth in the wealthiest economies, but less so in the least developed economies where mobile phone coverage or secondary education may be more important.

As such, the third notable element of our overall approach is that we have created two distinct, albeit related Connectivity indices. This partly reflects practical concerns – some data is simply not available for resource and efficiency tiers – but is for the most part driven by a desire to measure Connectivity within an economy in terms of those measures with the strongest links to economic growth and prosperity, and to measure economies against their closest peers and competitors.

Figure 1 provides a schematic diagram showing the mechanics of the Scorecard at a high-level:

Figure 1: Schematic representation of The Connectivity Scorecard



Why is this Scorecard an advance?

In summary, our Connectivity Scorecard represents a major advance over existing indices for the following reasons:

- The Scorecard incorporates a wide range of sub-indicators measuring not just infrastructure and usage but also complementary and enabling assets and skills such as literacy, the use of enterprise software, and the accessibility of women to ICT;
- The Scorecard uses country-specific weights which come from National Accounts in order to aggregate the consumer, business and government sectors;
- The Scorecard provides business its proper role as a driver of ICT enabled economic growth; and
- The Scorecard uses economic research to weight the specific subcomponents in each of the three overall sectors – business, government, consumers; the approach used is (to our minds at least) both intuitive and economically rigorous.

3 Methodology and weighting

Basic methodology and weighting scheme

Conceptual basis

As a starting point, we divided the economy into three distinct groups of economic actors— businesses, consumers and governments.

We then considered how best to assign weights to these three distinctive sets of economic actors. Several options were available to us: (a) using an analytical basis to derive weights, such as Principal Components Analysis (PCA) or Data Envelopment Analysis (DEA); (b) expert-based weighting systems, such as budget allocations or focus groups or opinion surveys; or (c) deriving the relative weights from fundamental economic precepts.[4]

The last option was the most appealing to us, since it had a thoroughly intuitive basis and could be derived on a basis that was consistent with existing research on the role of ICT in expanding economic growth and productivity. For example, much of the economic literature attributes significant gains in productivity from the wider diffusion of ICT into the economy.

However, this same literature finds that (a) gains from ICT have been uneven, with the U.S. and Australia gaining the most, and European countries gaining rather less, and (b) the gains from ICT arise both from technological gains and enhanced efficiencies in ICT production, but also from increasing and more sophisticated ICT usage. Thus we needed to consider infrastructure, spending and usage aspects of ICT, and decide how to weight these aspects on the basis suggested by existing economic estimates. [5]

Our ultimate strategy can be summarised as follows:

[4] Weighting methods, aggregation methods and imputation of missing data in the construction of complex composite Indexes are described in detail in the OECD's *Handbook on Constructing Composite Indicators: Methodology and User Guide*, OECD Statistics Working Paper, August 2005.
[5] There are many studies on the impact of ICT on economic growth and productivity. Among the ones that we have referenced are Ho, Jorgenson and Stiroh (2004), and O'Mahony, Timmer and Van Ark (2007), along with a host of publications from National Statistical Offices such as Statistics Canada and the Australian Productivity Commission.

In order to allocate weights between the three over-arching categories of consumers, governments and businesses we use data from national statistical offices. In particular, we made extensive use of national Input-Output tables.

We measured the weight of business in the economy as the ratio of intermediate consumption and investment relative to the sum of intermediate consumption, investment and consumption by governments and consumers. Government's share is thus estimated as the share of government consumption in the sum of intermediate consumption, investment and consumption by governments and consumers. Consumers' share is computed in a similar way.

We then had to allocate weights to the "infrastructure" and "usage and skills" sub-categories for consumers, businesses and governments alike. We derived these splits by considering the relative contribution of infrastructure and a proxy for "usage and skills" (labour force skills) to productivity growth (for businesses and government) and hoped to do so for utility (for consumers);

Estimates of the sources of productivity/economic growth can be obtained for many OECD economies, although by no means all. For example, for the United States, we based the split between infrastructure and usage contributions to business and government productivity on estimates of the contribution of ICT capital and labour skills to GDP growth in the United States. These estimates are provided in Jorgenson and Stiroh (2004). The most harmonised measures that we could find were contained in the EU Klems database available from the Groningen Growth and Development Centre (GGDC).

For consumers, we attempted to find literature that showed the relative welfare contribution of access to infrastructure (e.g., having access to basic telephone service) versus usage of that infrastructure (e.g., from making telephone calls). For example, a study that calculated the consumer surplus from having the option to make calls (i.e., having access to a telephone) versus consumer surplus from minutes spent on the telephone would have matched our goals.

While there is considerable literature on consumer surplus from telephony, we were unable to find studies that clearly divided that surplus between the access and usage facets of telephony.[6] Thus, we gave equal weight to both usage and infrastructure for consumers.

Non-OECD country exceptions

For Efficiency and Resource driven economies, it is harder to find good data or academic studies that estimate the contribution of ICT capital to growth. Thus, we have used the contribution of overall physical capital relative to labour composition changes to growth in several developing countries. Some estimates can be found in (for example) Bosworth and Collins (2001). In many cases, however, we have had to impute data using standard techniques of imputation referred to in the OECD's handbook on Index construction[7].

Indicators and sources used

Once we had established the conceptual basis for the weightings that we had used, we then had to choose specific indicators and assign them to various categories.

We relied upon a wide variety of sources — the World Bank, the ITU, the OECD, and the i2010 programme of ICT statistics being implemented by Europe's national statistical agencies were major sources of information for much of the basic data on infrastructure, such as broadband penetration rates, telephone lines in use, literacy rates, and even gender breakdowns of Internet usage. Other useful sources of information were individual countries' statistical offices, Brown University's E-government rankings and private vendors such as Frost and Sullivan and Gartner. We also used proprietary data from Nokia Siemens Networks to construct measures of mobile e-mail and Internet usage.

For each component of the Scorecard, countries are benchmarked against the best in class in their tier; thus if a country was best in all dimensions, it would score a maximum of 10.0. If a country scores a 5.0 for example, that means it is 50% of the best–in-class over all countries in its category.

The large number of business infrastructure and usage indicators in our Scorecard clearly distinguishes our efforts from those of previous researchers. We have collected data on business lines, the proportion of such lines that are

[6] Several authors such as Lester Taylor (1994) make reference to valuing access as an "option value", but there are few clear-cut studies that quantify this option value in the way that we would have been able to use.

VoIP-based, the prevalence and extent of business-dominated services such as value-added data services and web hosting; in addition, we have been fortunate enough to access very recent survey data from Nokia Siemens Networks on mobile usage by business users.

The actual calculation of The Connectivity Scorecard results can be represented mathematically as follows:

$$Index\ Score = w_{ci}\left[\frac{1}{CI}\sum_{j=1}^{CI} S_j^{Country\_i}\right] + w_{cu}\left[\frac{1}{CU}\sum_{k=1}^{CU} S_k^{Country\_i}\right] + w_{bi}\left[\frac{1}{BI}\sum_{l=1}^{BI} S_l^{Country\_i}\right] + w_{bu}\left[\frac{1}{BU}\sum_{m=1}^{BU} S_m^{Country\_i}\right] + w_{gi}\left[\frac{1}{GI}\sum_{n=1}^{GI} S_n^{Country\_i}\right] + w_{gu}\left[\frac{1}{GU}\sum_{p=1}^{GU} S_p^{Country\_i}\right]$$

Where:

w_{ci} = weighting for consumer infrastructure
w_{cu} = weighting for consumer usage & skills
w_{bi} = weighting for business infrastructure
w_{bu} = weighting for business usage & skills
$w_{g}i$ = weighting for government infrastructure
w_{gu} = weighting for government usage & skills
CI = number of consumer infrastructure indicators
CU = number of consumer usage & skills indicators
BI = number of business infrastructure indicators
BU = number of business usage & skills indicators
GI = number of government infrastructure indicators
GU = number of government usage & skills indicators
$S_j^{Country\ i}$ = score on indicator j for country_i

Table 2 provides a listing of the countries for which we have prepared a Scorecard, grouped according to their WEF classification.

Table 3 provides a listing of some of the indicators used covering the Innovation driven and more advanced of the Efficiency driven economies. We also list the sources from which we obtained the relevant information. A complete list of

[7] Handbook on constructing composite indicators: methodology and user guide (Nardo et al., 2005)

indicator definitions can be found in Appendix 1, along with the list of indicators used to construct the Scorecard for the Resource driven economies.

Table 2: Countries according to WEF Classification

Tier	Country	Country
Resource driven economies	China	India
	Nigeria	Philippines
Efficiency driven economies	Czech Republic	Hungary
	Poland	Korea
	Brazil	Mexico
	Russia	South Africa
	Malaysia	
Innovation driven economies	Sweden	France
	Germany	Italy
	Spain	Finland
	UK	Japan
	Hong Kong	United States
	Canada	Australia

List of indicators used for the Innovation driven and more advanced of the Efficiency driven economies

Indicator	Source
Public telephones per 1,000 people	ICT Opportunity Index (ITU)
Total telephone lines (per 100 people)	ICT Opportunity Index
Mobile subscribers (per 1000 people)	ICT Opportunity Index
Internet users (per 100 people)	ICT Opportunity Index
Broadband subscribers (per 1000 people)	ICT Opportunity Index
Literacy rate	World Bank
Adjusted Software spending by Consumers	LECG calculations
Female home internet users	
Mobile e-mail composite (Private users) [8]	Nokia Siemens Networks, LECG calculations
Mobile internet composite (Private users)	Nokia Siemens Networks, LECG calculations
International bandwidth per capita	World Bank, HDI 2005
Business PSTN Lines per 1,000	Gartner, LECG calculations
Business data access lines per 1,000	Gartner, LECG calculations
Personal computers (per 1,000 people)	World Bank
Adjusted Business software and hardware spending per capita	WITSA, LECG calculations
Application secure internet servers per million	World Bank
International outgoing telephone traffic (per capita)	ITU
Percentage of population with at least primary school complete" in the 15 and over workforce	Barro-Lee Dataset
Mobile e-mail composite (Business users)	Nokia Siemens Networks Pulse
Mobile internet composite (Business users)	Nokia Siemens Networks Pulse
e-Government ranking	Brown University
Schools connected to internet	World Bank
Adjusted Government software and hardware spending per capita	WITSA, LECG calculations
Government services online	Brown University
Adjusted computer services spending by Government	WITSA, LECG calculations

[8] These composite measures are based upon multiplying the proportions of users who are aware of the feature, the proportions that use the feature, and the frequency of use.

4 Discussion of results

Major findings

Low scores

The average scores on our Scorecard are significantly lower than scores on other Indexes. The leading country in The Connectivity Scorecard has a Connectivity score of 6.97 out of 10. By contrast, this same country (the U.S.) scores nearly 9 out of 10 on the e-Readiness Index. This is a reflection of the multi-dimensional nature of our Scorecard, the weighting system that we utilised, and the attention to country-specific economic structures that are embedded in the weightings.

Low scores are a reflection of unutilised potential from Connectivity. They can be interpreted as a call to arms for governments and businesses. They crucially also suggest significant potential for further economic gains from Connectivity.

Dispersion and a "Connectivity Elite"

Even among countries that are considered relatively advanced and affluent economies there is considerable dispersion in Connectivity performance. We find a relatively small number of countries scoring 6 or above on the Scorecard. Most of these are either Anglo-Saxon or Nordic countries with the one exception of Japan. Our findings suggest a scope for considerable "catch-up" potential in Continental and Eastern Europe. It appears that in some countries there is adequate infrastructure which is not matched by creative use of the infrastructure by businesses and government.

Substantial work to do

The Connectivity Scorecard shows clearly that almost every nation has substantial work to do before achieving an ideal level of Connectivity. The mean level of Connectivity in the 16 Tier 4 and Tier 5 economies is just over 5. Thus, there is no room for complacency in even the most advanced or 'connected' of economies and much work to be done in all sectors of all economies.

The best of Connectivity is yet to come

Even the best performing countries score below 5 out of 10 on at least one indicator. Since performance is benchmarked against the *existing* best-in-class performers, this strongly suggests that in *all* nations there at least some technologies that are being under-deployed or underused. Our research shows strong potential for significant economic gains merely from better use of existing technology. When we consider that even more transformative technology is on the horizon, we find it difficult to believe that any country is “saturated” with ICT. *The best of Connectivity is yet to come.*

Discussion of individual country results

Korea’s relatively low score

One of the most surprising results of our Scorecard is the relatively low ranking of Korea. Korea typically scores very highly on other indices; it is the top performer on the ITU’s DOI, and on the E-Readiness Index, Korea is again a strong performer, finishing 8th out of 69 countries. Using our weights and set of indicators, however, Korea finishes only 10th in the rankings of 16 Innovation driven and emerging economies benchmarked. Korea scores well in the government and consumer components of the Scorecard, which tend to dominate other indices, but quite poorly in business usage and complementary assets and services. Simply put, Korea has spent a good deal of public money to encourage the spread of a very sophisticated broadband infrastructure, and this tends to push up its score on measures where—implicitly or explicitly—such measures are given a high weighting.

However, Korea does not appear to be a top performer in the business arena—indeed, Korean productivity on a per worker basis is much lower than European or North American productivity, and the difference is even more pronounced on a per-hour worked basis given that Korean workers work several hundred hours per year more than their counterparts in Europe. Other sources (not used in computing index scores) confirm that in business telephony usage and spending, Korea lags well behind other Asia-Pacific Innovation driven nations like Japan and Australia in the use of business enterprise telephony solutions. Frost and Sullivan data show that:

- In 3Q 2005, the Korean market for IP telephony generated revenues of $11.8 million, compared to $110.5 million for Japan, and $49.3 million for Australia;
- In 3Q 2005, the Japanese enterprise telephony market generated revenues of $285 million, compared to $41 million for Korea, and $93 million for Australia; and

- The differences between Korea, Japan and Australia cannot be explained in terms of population—Australia's population is half the size of Korea's, and Japan's markets are between 6 and 10 times the size of Korea's, although the population is only 2.5 times that of the Korean population.

United States in 1st position

A perhaps unanticipated result of our research is the U.S. finishes first. Other indices have ranked the U.S. fairly low relative to Western Europe and East Asia, although the EIU e-readiness index also ranked the U.S. first. When one considers consumer infrastructure measures – as is typical of most indices – the U.S. performance is mediocre on some metrics. However, our results are actually consistent with much published research showing that the U.S. economy has benefited more strongly from ICT than most others, with the primary difference lying in more intensive ICT use by business.

India, China and Russia

Another striking disparity in our Connectivity Scorecard is in the Resource and Efficiency driven economies. The key difference is between China and India. India scores just 1.95 on our modified Scorecard for resource-driven economies, compared to 3.38 for China. Both countries, of course, have a significantly long way to go before they can claim that they are meaningfully connected societies, but the Indian performance is especially poor. Much has been made of late of the burgeoning competition between the two superpower economies of the future, but it is clear from this research that both India and China still lag a considerable way behind the Innovation driven economies and indeed behind many Efficiency driven economies.

India scores lower than China on virtually every major dimension of Connectivity—consumer infrastructure and usage, business infrastructure and usage, and government infrastructure and usage. Literacy in India is substantially lower, and there is a glaring gender disparity in Internet access (only 23% of Internet users are female in India). For India, the immediate Connectivity priority would appear to be better infrastructure provision, followed by better provision of complementary capital (e.g., better overall education).

It may surprise some that Russia performs well in our Scorecard. However, when benchmarked against China, India and Latin American economies, it is not surprising that Russia does well. Russia scores well in literacy, gender equality in

Internet access, and also in usage of technologies such as mobile by business users. The Scorecard captures the fact that Russia has a relatively strong human capital endowment that may serve it well in making the transition to being an Innovation driven economy.

Table 4 below provides some comparisons between India, China and Russia.

Table 3: India, China and Russia compared on basic metrics

Indicator	India	China	Russia
Adult literacy rate	61%	91%	99%
Female home internet users	23%	40%	38%
Mobile e-mail usage (Business users)[9]	0.12	0.10	0.92
Mobile internet usage (Business users)	0.11	0.47	1.63

Comparison with other Indices

The Connectivity Scorecard shows country rankings that are in some cases quite different from those of other Indices. The ITU's DOI top 20 is as follows:

Table 4: ITU Digital Opportunity Rankings 2007

Rank	Country	Rank	Country
1	Korea (Rep)	11	Finland
2	Japan	12	Norway
3	Denmark	13	Luxembourg
4	Iceland	14	Israel
5	Singapore	15	Macao, China
6	Netherlands	16	Switzerland
7	Taiwan, China	17	Canada
8	Hong Kong, China	18	Austria

[9] Mobile e-mail and internet usage by business users are composite measures created by LECG using Nokia Siemens Networks Pulse and mobile penetration data. The composite measures capture mobile phone penetration, access to technology and frequency of use. A higher score reflects a higher rate of mobile e-mail or internet usage among business users.

9	Sweden	19	Germany
10	United Kingdom	20	United States

Figure 2 below plots the Scorecard results against the ITU DOI for Innovation driven economies and other relatively developed economies. While the correlation between the two indices is high, substantial significant differences exist.

Figure 2: The Connectivity Scorecard plotted against the ITU's Digital Opportunity Index

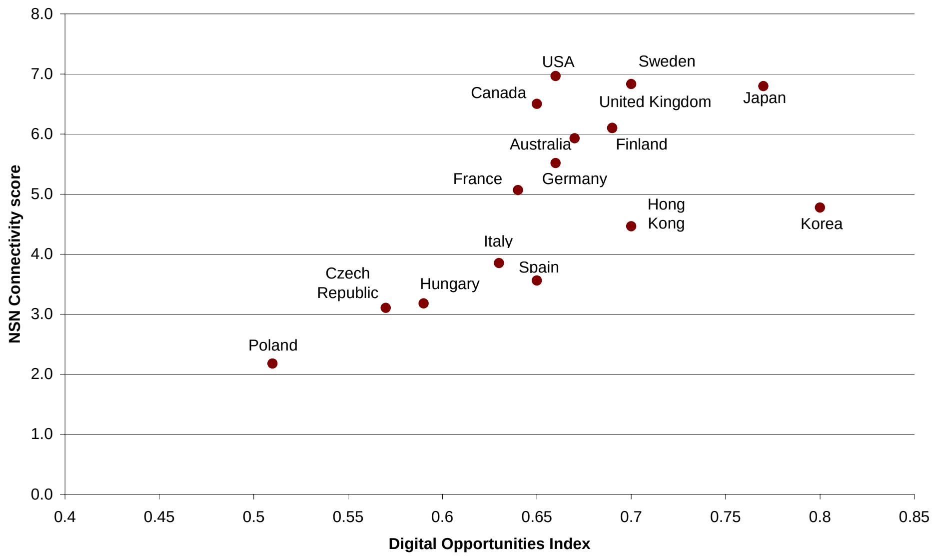
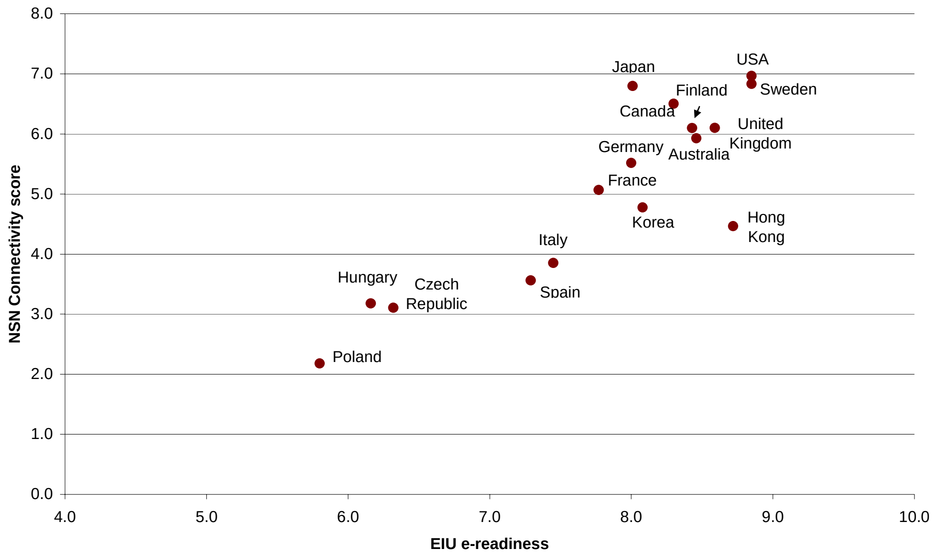


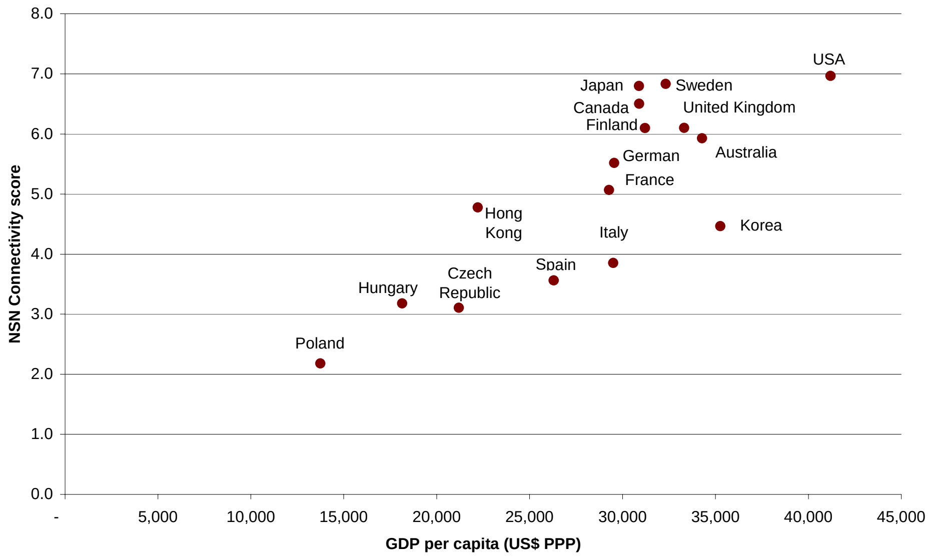
Figure 3 below plots The Connectivity Scorecard against the EIU's e-readiness index. Again there is a high level of correlation between the two indices, but significant differences do occur. Noticeably both our Scorecard and the EIU rank the U.S. 1^{st} whereas most other indices give the U.S. a relatively modest score.

Figure 3: The Connectivity Scorecard plotted against the EIU's e-readiness index



Finally, Figure 4 below presents the Scorecard results plotted against GDP per capita on a Purchasing Power Parity (PPP) basis. The figure shows a fairly high level of correlation between the Scorecard and GDP per capita but large dispersion. There are a number of countries with GDP per capita of around $30,000 yet there is considerable heterogeneity in Connectivity performance between these countries.

Figure 4: The Connectivity Scorecard plotted against GDP per capita (PPP)



Policy recommendations

Given that ours is a composite measure of useful Connectivity which links usefulness to economic performance, there are major economic gains to be had from improving Connectivity (as we define it). For example, a well-known study in the United States by Crandall and Jackson put the long-term benefits to the U.S. of increased broadband penetration at $500 billion. Holistic improvements in performance could yield long-term economic gains that are multiples of the figure obtained by Crandall and Jackson.

Policy-makers need to evaluate where their country falls short in Connectivity performance and strive to either develop the infrastructure and complementary assets that would facilitate better performance or eliminate the barriers and rigidities that prevent it. A lot of the necessary change will not be easy in the short term, and it may require governments to remove (for example) the barriers that make it harder for businesses to re-organise themselves around ICT, or the import tariffs that protect domestic producers but cost societies much more by raising the price of access and usage of the relevant infrastructure.

Businesses, too, clearly have a role to play. The economic gains described above are gains to both consumers and to businesses, which are able to perform much more efficiently if they use more technology more effectively. Businesses also have to accept change, while perhaps investing more in “complementary capital” such as worker training that will enable them to reap larger benefits from technology.

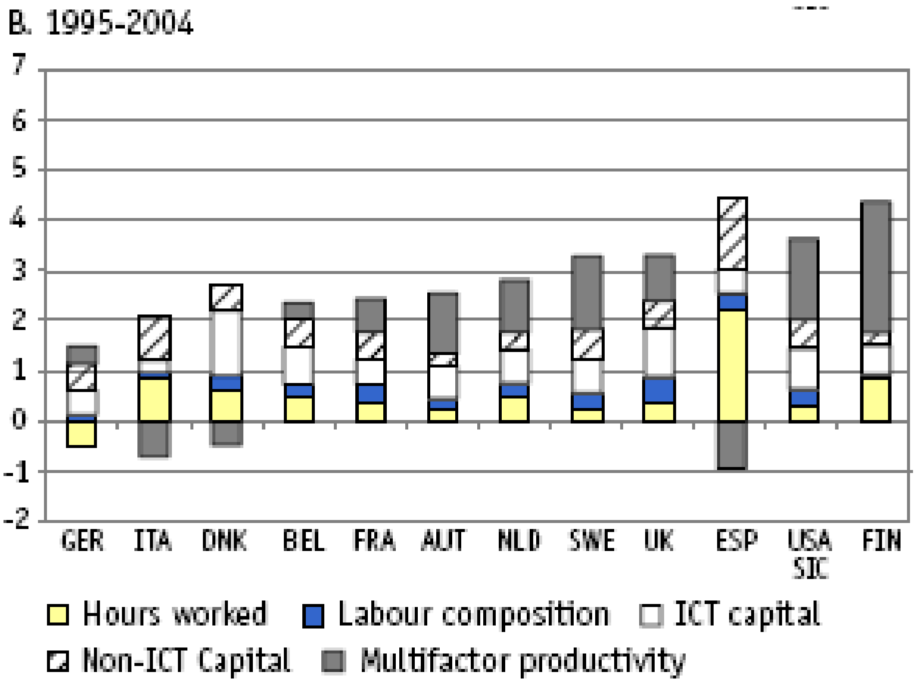
Further, **businesses** have to show imagination in the way they use technology. As a complement to this Scorecard (and perhaps an input to future iterations of the Scorecard) we surveyed IT managers who operated internationally to gauge their satisfaction with the fixed-line and mobile infrastructures and services offered in a range of countries. Somewhat to our surprise, most were quite satisfied with the state of affairs they found. This suggests either that the low scores on our Scorecard are misleading, but more likely suggests that businesses do not grasp that even existing technologies can be used much more intensively. For example, some mobile banking services and electronic transaction services are better developed in African countries than in the U.S. or Canada.

For **Telecommunications operators**, The Connectivity Scorecard shows that there is much untapped potential in even the most developed markets, some of which have been written off as “saturated.” They will have to look at the specific strengths and weaknesses of each country and spot the potential for expansion. For example, Korea has relatively low spend on certain business telephony measures, suggesting that there is considerable room for growth, given the size and wealth of the country, and the quality of some of the supporting infrastructure. In the U.S. and some of Europe, there is clearly still expansion potential for broadband and even mobility solutions. In India, there are opportunities everywhere — to expand the existing coverage of mobile and broadband networks, and to increase the usage of these technologies from the existing revenue base. In addition, since Connectivity requires “smart” usage to be a source of significant productivity gains, telecoms operators are well placed to offer more than hardware. These operators can be sources of information on the best ways in which infrastructure can be used to increase productivity.

The figure below provides evidence similar to our findings showing the heterogeneous contribution of connectivity and ICT to economic growth over the past decade. While the determinants of this uneven performance are too complex to discuss here, Figure 5 demonstrates that our Connectivity Scorecard may be in some ways more consistent with the general thrust of economic research in the area of productivity growth. The Labour Composition component of Figure 5 refers to the contribution made to economic growth by the skill composition of each hour worked as a result of increasingly skilled and experienced workers. Multifactor productivity in turn measures changes in output per unit of combined inputs. In effect this is the efficiency with which inputs are put together to produce outputs.

In Korea, which is not shown in the table, GDP per hour worked is less than half that in many European and North American countries.[10] This fact is consistent with the evidence demonstrating low relative use of advanced business applications in Korea, since software and applications are a major component of changing comparative advantage at the firm level.

Figure 5: Contributions to Market Economy GDP Growth



Source: EU KLEMS Database, March 2007, http://www.euklems.net.

[10] The University of Groningen database reports that GDP per hour worked measured in International dollars was 15.91 in Korea in 2006 compared to 37.72 in France and 35.29 in the U.S.Groningen Growth and Development Centre, University of Groningen

5 Next steps

The following section highlights three likely next steps in developing The Connectivity Scorecard and updating it in future years.

Expanding the list of countries

Ideally, future iterations of the Scorecard would substantially add to the list of countries currently included. While the existing selection of 25 countries is sufficient to draw a number of interesting conclusions relating to global Connectivity, the Scorecard coverage would need to be expanded before it would be adopted more widely as the authoritative measure of Connectivity.

As discussed elsewhere, the major obstacle to including a larger sample of countries has been data availability, particularly in terms of usage and skills measures. Infrastructures measures are for the most part readily available, but the usage measures which help to differentiate this Scorecard from other indices are simply not available for a large number of countries. We would expect this situation to improve in future, however, as many of the indicators we have included are of interest to other researchers.

The Scorecard currently covers Western and Northern Europe, North America and the Far East fairly comprehensively. Additionally the two most important emerging markets, namely China and India, are covered along with other prominent emerging economies such as Brazil, Mexico and South Africa. A major aim of the Scorecard in future should be to extend coverage of the regions currently underrepresented in our sample, including Sub-Saharan Africa, North Africa and the Middle East.

Expanding and refining the list of indicators

The second area in which the Scorecard can and should be developed in future years is in terms of the actual indicators used for both the Innovation driven and Resource and Efficiency driven indices.

The European Commission's i2010 programme already provides a comprehensive collection of usage data for all the EU states. We would have liked to have included more of these indicators as they capture important aspects of the extent to which ICT has been adopted and can be effectively utilised by the populace. Unfortunately comparable data is not currently being collected for other Innovation driven economies. It is a goal of the i2010 programme however to collect such data for countries such as the U.S. and Japan for the purposes of comparison. Once this data is made available a greater range of usage measures could be included in the Scorecard.

Another point to consider is that particular indicators which are currently included in The Connectivity Scorecard may lose relevance in future years or be superseded by new indicators that more accurately track the elements of Connectivity that we are interested in capturing in the Scorecard. An example of the former is the fixed-mobile substitution currently taking place in Finland. Consumers in Finland can already subscribe to an ADSL service without having to subscribe to a fixed line telephone service. This, combined with falling mobile tariffs, has enabled a significant number of people to give up their fixed line in favour of mobile services for their voice requirements. As a result, the number of main telephone lines per 100 inhabitants has fallen in recent years. Under our existing Scorecard design this trend would tend to have an unfairly negative impact on Finland's Connectivity score. At present this anomaly is largely confined to Finland, but is expected to become prominent in other markets like Portugal and Austria in future years.

Similarly, the selection of indicators we have been able to include in the Resource and Efficiency driven economy Scorecard is driven largely by data availability. In Sub-Saharan Africa particularly, innovative ways of utilising mobile infrastructure such as airtime transfers as a form of payment and more formal m-banking systems are being developed all the time. These are important examples of how Connectivity is aiding economic development and should be reflected in the Scorecard as soon as suitable data is available. A second aspect of ICT usage in the Resource and Efficiency driven economies that should be captured where possible is shared usage. Anecdotal evidence suggests that mobile phones and internet access points are shared extensively in some communities and as a result traditional counts of lines and so on may understate the actual level of access to ICT infrastructure.

Country groupings

It is very conceivable that over the slightly longer term, countries currently classified as Efficiency driven by the WEF will be reclassified as Innovation driven (Russia and Malaysia are two good examples). This would necessitate collecting a different set of indicators for those countries. It would also result in such countries being assessed against a different peer group. As we have created two distinct indices, comparisons of a country's Scorecard score before and after being reclassified will not strictly speaking be possible.

Perceptions survey

For this first version of the Scorecard, we commissioned a survey of perceptions of Chief Technology Officers, IT Managers and Chief Information Officers across a range of countries. While a number of respondents were U.S.-based, they also did significant amounts of business in other nations (sometimes more than in the U.S. itself), and provided responses for these other nations also. These managers were asked to provide their assessment of the relative importance of technologies such as mobile, fixed-line and broadband for countries in which they operated. They were also asked to rate their perceptions of the state of the infrastructure (measured by such metrics as availability, reliability, affordability) and of usage and people skills for the same countries.

This was a pilot survey, designed to elicit responses that were statistically significant at the level of the country tiers defined previously. Based on these responses, we constructed a perceptions scorecard (see Appendix 2) which we decided not to include as part of the overall Connectivity Scorecard for this release. However, the perceptions scorecard generally showed that managers were quite satisfied with the quality of infrastructure and level of support that was available to them. Interestingly, the satisfaction level was very high (scores of 7 out of 10 or more) even among managers responding for Resource and Efficiency-driven economies.

These findings are at odds with the low scores that countries receive on The Connectivity Scorecard, suggesting either that the scoring criteria are too stringent for The Connectivity Scorecard, or that managers' expectations are perhaps too low. The latter suggestion is supported by the singular fact that the only "below average" responses received were from American managers rating American infrastructure and service. This suggests that these managers' expectations of the U.S. infrastructure and support base are significantly higher than their expectations from their overseas operations.

In future releases of The Connectivity Scorecard, we will endeavour to incorporate perceptions into the Scorecard more thoroughly. The first step in doing so will be to achieve statistical significance at the country level for the survey responses. The initial pilot study generated ample response, and with appropriate attention to question framing, we may choose to work with national Chambers of Commerce to achieve statistically significant respondent counts in individual countries. If we achieve statistically significant respondent counts for each country then we will adjust the overall Scorecard for perceptions. This can be done by constructing a perceptions scorecard (see Appendix 2) and assigning this scorecard a small weight (say 10 percent) in the larger Connectivity Scorecard.

Appendices

Appendix 1 – List of primary sources and indicators

Innovation driven economies – primary sources

Source name	Description	Location
i2010	European Commission collection of comparable ICT data from across Europe	http://ec.europa.eu/information_society/eeurope/i2010/index_en.htm
Digital Planet (published by WITSA), LECG calculations		Digital Planet (published by World Information Technology and Services Alliance)
Wireless Intelligence		
ICT Opportunity Index (Published by ITU)	Large collection of cross country ICT indicators	Available for order from the ITU online at http://www.itu.int/ITU-D/ict/publications/ict-oi/2007/index.html
Gartner	Data provided by Gartner, an information technology research and advisory company on a subscription basis. We have used two sets of publications: Gartner Dataquest: Fixed Public Network Services and Gartner Dataquest: Enterprise Network Services. These publications are provided on a country by country basis	Provided to LECG by Nokia Siemens Networks
World Bank HDI - 2005 data	World Bank collection of Human Development Indicators	http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,menuPK:232599~pagePK:64133170~piPK:64133498~theSitePK:239419,00.html
Nokia Siemens Networks Pulse, LECG calculations	Nokia Siemens Networks proprietary data covering mobile phone usage across a sample of countries	Nokia Siemens Networks
Brown University	Global e-Government Report compiled annually by Brown University and based on an analysis of government websites	www.insidepolitics.org/egovt05int.pdf

Efficiency and resource driven economies – primary sources

Source name	Description	Location
ICT Opportunity Index (Published by ITU)	Large collection of cross country ICT indicators	
UNDP		http://hdr.undp.org/en/statistics/
Digital Planet (published by WITSA), LECG calculations		Digital Planet (published by World Information Technology and Services Alliance)
ITU		http://www.itu.int
Nokia Siemens Networks Pulse, LECG calculations	Nokia Siemens Networks proprietary data covering mobile phone usage across a sample of countries	Nokia Siemens Networks
World Bank HDI 2005	World Bank collection of Human Development Indicators	http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,, menuPK:232599~pagePK:64133170~piPK:64133498~theSitePK:239419,00.html
Gartner, LECG calculations	Data provided by Gartner, an information technology research and advisory company on a subscription basis. We have used two sets of publications: Gartner Dataquest: Fixed Public Network Services and Gartner Dataquest: Enterprise Network Services. These publications are provided on a country by country basis	Provided to LECG by Nokia Siemens Networks
Barro-Lee database	International Panel dataset of educational attainment	Available from several locations online including http://www.nber.org/pub/barro.lee/
Brown University	Global e-Government Report compiled annually by Brown University and based on an analysis of government websites	www.insidepolitics.org/egovt05int.pdf

Innovation driven economies – primary indicators

Indicator	Primary source	Description of calculations involved in constructing the indicator
Number of 3G subscribers per 100 inhabitants	i2010	None
Main telephone lines per 100 inhabitants	ICT Opportunity Index (Published by ITU)	None
Broadband subscribers per 1,000 inhabitants	ICT Opportunity Index (Published by ITU)	None
Internet users per 1000 people	World Bank	None
Internet banking	i2010	None
Adjusted Software spending by Consumers	Digital Planet (published by WITSA), LECG calculations	The total value of consumer spending on software was estimated by assuming that the proportion of spending on software by consumers was equal to the proportion of total ICT spending by consumers. This value was then further adjusted by dividing by the total population to create a per capita measure
% of mobile revenue from data services	Wireless Intelligence	Due to lack of comparable data the exact calculation of the indicator varies from country to country. We have in general calculated an average across all of the operators that provide data to Wireless Intelligence based on subscriber numbers. Depending on data availability we have either calculated the average across the whole of 2006 or using the latest available quarterly data.

SMS Messages per User per Month	Wireless Intelligence	Due to lack of comparable data the exact calculation of the indicator varies from country to country. We have in general calculated an average across all of the operators that provide data to Wireless Intelligence based on subscriber numbers. Depending on data availability we have either calculated the average across the whole of 2006 or using the latest available quarterly data. For some countries, where Wireless Intelligence did not provide data we have gathered equivalent metrics from Frost & Sullivan.
PCs per 1,000	ICT Opportunity Index (Published by ITU)	None
Business data access lines per 1,000	Gartner, LECG calculations	Total number of business data access lines divided by 1,000 head of population
Ratio of Bus VoIP/Bus PSTN Lines	Gartner, LECG calculations	Total number of Business VoIP lines divided by the total number of Business PSTN Lines
Adjusted Business software and hardware spending per capita	Digital Planet (published by WITSA), LECG calculations	The total value of business spending on hardware and software was adjusted by dividing by the total population to create a per capita measure
Application secure internet servers per million	World Bank HDI - 2005 data	None
E-commerce as % of total turnover of enterprises	i2010	None
Adjusted Total Managed Data Services Revenue per capita	Gartner, LECG calculations	Total managed data service revenues converted to a per capita figure and then further adjusted by LECG using GDP per capita at PPP relative to the USA
Adjusted Web-Hosting Revenue per capita	Gartner, LECG calculations	Total Web-Hosting revenues converted to a per capita figure and then further adjusted by LECG using GDP per capita at PPP relative to the USA

Adjusted Value-Added IP Services Revenue per capita	Gartner, LECG calculations	Total Value-Added IP Services revenues converted to a per capita figure and then further adjusted by LECG using GDP per capita at PPP relative to the USA
% of persons employed with ICT user skills.	i2010	None
% of persons employed with ICT specialist skills	i2010	None
Mobile e-mail composite (Business users)	Nokia Siemens Networks Pulse, LECG calculations	Composite measure created by LECG by multiplying the percentages of business mobile phone users that i) are aware of mobile e-mail ii) make use and mobile e-mail and iii) their average level of mobile e-mail usage per month. This variable was then further adjusted multiplying through by the ratio of fixed line to mobile calls made in that country to control for mobile usage as a consequence of under developed fixed line networks.
Mobile internet composite (Business users)	Nokia Siemens Networks Pulse, LECG calculations	Composite measure created by LECG by multiplying the percentages of business mobile phone users that i) are aware of mobile internet ii) make use and mobile internet and iii) their average level of mobile internet usage per month. This variable was then further adjusted by multiplying through by the ratio of fixed line to mobile calls made in that country to control for mobile usage as a consequence of under developed fixed line networks.
e-Government ranking	Brown University	None
Online services provided by Government	Brown University	None
Number of computers connected per 100 pupils	i2010	None
% of schools with broadband access	i2010	None
Adjusted Government software and hardware spending per capita	Digital Planet (published by WITSA), LECG calculations	The total value of government spending on hardware and software was adjusted by dividing by the total population to create a per capita measure

% of population using e-Government services	i2010	None
% of enterprises using e-Government services	i2010	None
Adjusted computer services spending by Government per capita	Digital Planet (published by WITSA), LECG calculations	The total value of government spending on computer services was estimated by assuming that the proportion of spending on computer services by government was equal to the proportion of total ICT spending by government. This value was then further adjusted by dividing by the total population to create a per capita measure

Efficiency and resource driven economies – primary indicators

Indicator	Primary source	Description of calculations involved in constructing the indicator
Public telephones per 1,000 people	ICT Opportunity Index (Published by ITU)	None
Total telephone lines (per 100 people)	ICT Opportunity Index (Published by ITU)	None
Broadband subscribers (per 1000 people)	ICT Opportunity Index (Published by ITU)	None
Mobile subscribers (per 1000 people)	ICT Opportunity Index (Published by ITU)	None
Mobile population coverage	World Bank	None
Internet users (per 100 people)	ICT Opportunity Index (Published by ITU)	None
Literacy rate	UNDP	None
Adjusted Software spending by Consumers	Digital Planet (published by WITSA), LECG calculations	The total value of consumer spending on software was estimated by assuming that the proportion of spending on software by consumers was equal to the proportion of total ICT spending by consumers. This value was then further adjusted by dividing by the total population to create a per capita measure
Female home internet users	ITU website	None
Mobile e-mail composite (Private users)	Nokia Siemens Networks Pulse, LECG calculations	Composite measure created by LECG by multiplying the percentages of business mobile phone users that i) are aware of mobile e-mail ii) make use and mobile e-mail and iii) their average level of mobile e-mail usage per month. This variable was then further adjusted multiplying through by the ratio of fixed line to mobile calls made in that country to control for mobile usage as a consequence of under developed fixed line networks.
Mobile internet composite (Private users)	Nokia Siemens Networks Pulse, LECG calculations	Composite measure created by LECG by multiplying the percentages of business mobile phone users that i) are aware of mobile internet ii) make use and mobile internet and iii) their average level of mobile internet

		usage per month. This variable was then further adjusted by multiplying through by the ratio of fixed line to mobile calls made in that country to control for mobile usage as a consequence of under developed fixed line networks.
International bandwidth per capita	World Bank HDI 2005	None
Business PSTN Lines per 1,000	Gartner, LECG calculations	Total number of business PSTN lines divided by 1,000 head of population
Business data access lines per 1,000	Gartner, LECG calculations	Total number of business data access lines divided by 1,000 head of population
Personal computers (per 1,000 people)	World Bank	None
Adjusted Business software and hardware spending per capita	Digital Planet (published by WITSA), LECG calculations	The total value of business spending on hardware and software was adjusted by dividing by the total population to create a per capita measure
Application secure internet servers per million	World Bank HDI 2006	None
International outgoing telephone traffic (per capita)	ICT Opportunity Index (Published by ITU)	None
Percentage of population with at least primary school complete in the 15 and over workforce	Barro-Lee database	Various elements of the Barro-Lee database were aggregated to arrive at a measure of the percentage of the population with at least primary school complete in the 15 and over workforce
Mobile e-mail composite (Business users)	Nokia Siemens Networks Pulse, LECG calculations	Composite measure created by LECG by multiplying the percentages of business mobile phone users that i) are aware of mobile e-mail ii) make use and mobile e-mail and iii) their average level of mobile e-mail usage per month. This variable was then further adjusted multiplying through by the ratio of fixed line to mobile calls made in that country to control for mobile usage as a consequence of under developed fixed line networks.
Mobile internet composite (Business users)	Nokia Siemens Networks Pulse, LECG calculations	Composite measure created by LECG by multiplying the

		percentages of business mobile phone users that i) are aware of mobile internet ii) make use and mobile internet and iii) their average level of mobile internet usage per month. This variable was then further adjusted by multiplying through by the ratio of fixed line to mobile calls made in that country to control for mobile usage as a consequence of under developed fixed line networks.
e-Government ranking	Brown University	None
Schools connected to internet	World Bank HDI, World Bank ICT at a Glance documents	None
Adjusted Government software and hardware spending per capita	Digital Planet (published by WITSA), LECG calculations	The total value of government spending on hardware and software was adjusted by dividing by the total population to create a per capita measure
Government services online	Brown University	None
Adjusted computer services spending by Government	Digital Planet (published by WITSA), LECG calculations	The total value of government spending on computer services was estimated by assuming that the proportion of spending on computer services by government was equal to the proportion of total ICT spending by government. This value was then further adjusted by dividing by the total population to create a per capita measure

Appendix 2 – Survey data

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Purpose of survey data:

As part of our analysis, we also conducted a survey aimed at IT decision makers (such as Chief Technology Offices and Chief Information Officers) in multinational firms. LECG designed a questionnaire for this purpose, in consultation with Ketchum and Nokia Siemens Networks. This questionnaire was implemented by Braun Research. The questions were designed to solicit these decision-makers' perceptions of the Connectivity infrastructure and Connectivity-related workforce skills in the countries in which they did business.

The underlying goal behind gauging these perceptions was to: (a) inform the weighting of individual indicators that made up the sub-categories, and (b) to inform a preliminary assessment regarding the potential discrepancy between the hard data and the perceptions of business people in the relevant countries. In future iterations of the Scorecard we intend to include a "Perceptions" dimension to the Scorecard score, but this will be done if we can obtain statistically sufficient samples for each country that we survey.

Braun Research was responsible for the online implementation of the survey. They report:

> *[W]e contracted with several online panel companies who assembled an invited panel of IT decision makers (manager level responsibility and higher) who conduct business and live world wide. This consortium of panel companies who have lists of available IT managers, directors and senior executives was necessary to bring together a group who could provide a world wide snapshot of the opinions among IT professionals.*
>
> *The study was conducted from 11/9-11/11/2007. All surveys were conducted with verified Chief Technology Officers, or Managers, Directors, Vice Presidents, or Senior Vice Presidents if they reported to the Chief Technology Officer, or CEOs or Presidents if they performed IT functions for their companies. All respondents were required to have a direct role in IT strategy development or purchasing.*
>
> *A total of 160 respondents from many countries rated 218 countries based on their experiences. In addition, quotas were kept on country tiers. The countries included in each tier were defined by LECG and grouped in a manner consistent with their analysis needs. Other groupings included transitional tiers which were also defined by*

LECG and represented countries that were considered to have aspects of neighbouring tiers.

A "first cut" Perceptions Index

As mentioned previously, one reason for conducting the survey was to investigate the feasibility of supplementing the main Scorecard score with a "business perceptions scorecard" score. This scorecard could be assigned a small weighting (a maximum of 10 percent was suggested to us by experts in the area), but may provide a sanity check on whether our numerical calculations match with business perceptions in the various countries surveyed.

Two cautionary notes must be struck in this regard. First, the current survey does not provide statistical significance at the level of individual countries, as it was essentially a pilot survey. This means that we could not provide individual perceptions scores for each country. Second, the perceptions score might be highly influenced by expectations. Thus, we found that respondents who completed the survey for the U.S. were among the most likely to express disappointment at the U.S. performance on infrastructure, affordability and choice, even more so than respondents in some of the Resource driven economies.

However, we believe that with future iterations of the Scorecard, and given the success of the survey questionnaire format that we used, we will be able to roll out the survey at the individual country level. This roll-out could be achieved through co-ordination with local Chambers of Commerce, for example. Once we obtain sufficient sample size for individual countries, we will be better positioned to add in a perceptions dimension to the Scorecard. Further, given the patterns encountered in the responses to the current survey, we will be able to add in questions that control for the role of expectations in influencing responses, so that we obtain greater comparability between countries and tiers of countries.

However, we have computed a "perceptions" Scorecard for Tier 1, 2 and 3 economies, and individually for the United States and Korea. This scorecard is interesting to study since it shows the gap between the hard quantitative findings suggesting much room for improvement, and the generally rather satisfied perceptions of IT managers and Technology Officers. The findings from this perceptions scorecard either suggest that our scoring and measuring criteria for the overall Connectivity Scorecard are too punitive, or that expectations of those surveyed are too low (in other words, businesses tolerate service levels and infrastructure that could be improved upon dramatically).

The perceptions scorecard was constructed by the following method:

- We excluded from consideration responses to questions that did not provide an actual rating of individual aspects of infrastructure, usage and/or skills and complementary capital. Thus we did not consider questions such as "which of the following do you rate as most important….";

- We then grouped the remaining responses into seven sub-indicators: Fixed Telephony (FPS), Business-oriented Fixed Solutions (BFPS), Broadband (BPS), Mobile (MPS), IT Infrastructure (ITIP), IT Usage (ITUP), and Skills and Complementary Capital (SCCS);

The grouping of indicators and the construction of scores for each of the seven categories was made possible by the fact that in most cases, respondents provided answers in the form of a 1-6 numerical scale (1 representing worst performance, and 6 best performance):

These sub-indicators were then assigned weights based on Principal Components Analysis. They were then combined into a single scorecard score, based on the weights. The score for each tier was computed as the weighted average (weighted by respondent count) for the countries that comprised the tier, and for which responses had been provided.

Table 6 shows the "perceptions scorecard" ratings for each of the tiers and countries. The individual country scores are not statistically robust.

Table 5: "Perceptions" scorecard

	Number of responses	FPS	BFPS	BPS	MPS	ITIP	ITUP	SCCS
China	19	**0.75**	**0.75**	**0.76**	**0.79**	**0.84**	**0.79**	**0.81**
India	15	**0.65**	**0.65**	**0.61**	**0.68**	**0.68**	**0.66**	**0.81**
Indonesia	10	**0.68**	**0.68**	**0.72**	**0.64**	**0.72**	**0.66**	**0.73**
Kenya	1	**0.80**	**0.80**	**0.85**	**0.60**	**0.68**	**0.61**	**0.78**
Nigeria	4	**0.70**	**0.72**	**0.69**	**0.70**	**0.75**	**0.76**	**0.76**
Thailand	3	**0.91**	**0.87**	**0.99**	**0.80**	**0.91**	**0.84**	**0.89**
Zambia	8	**0.83**	**0.84**	**0.75**	**0.68**	**0.73**	**0.68**	**0.80**
Jordan	5	**0.80**	**0.80**	**0.72**	**0.64**	**0.72**	**0.61**	**0.76**
Brazil	13	**0.70**	**0.73**	**0.80**	**0.75**	**0.83**	**0.80**	**0.85**
Chile	10	**0.82**	**0.87**	**0.81**	**0.76**	**0.75**	**0.71**	**0.83**
Mexico	10	**0.72**	**0.72**	**0.77**	**0.68**	**0.87**	**0.80**	**0.86**
Russia	9	**0.68**	**0.68**	**0.59**	**0.73**	**0.70**	**0.68**	**0.75**
South Africa	10	**0.81**	**0.83**	**0.72**	**0.70**	**0.75**	**0.69**	**0.83**
Korea	11	**0.73**	**0.76**	**0.83**	**0.85**	**0.91**	**0.83**	**0.91**
USA	19	**0.71**	**0.70**	**0.67**	**0.63**	**0.79**	**0.74**	**0.82**
UK	18	**0.75**	**0.75**	**0.71**	**0.73**	**0.84**	**0.79**	**0.84**
Canada	9	**0.70**	**0.69**	**0.71**	**0.69**	**0.75**	**0.73**	**0.81**
France	4	**0.63**	**0.67**	**0.64**	**0.55**	**0.68**	**0.65**	**0.78**
Germany	3	**0.75**	**0.71**	**0.85**	**0.80**	**0.75**	**0.83**	**0.87**
Spain	13	**0.83**	**0.85**	**1.00**	**0.88**	**0.98**	**1.00**	**1.00**
Sweden	1	**1.00**	**1.00**	**0.85**	**1.00**	**0.91**	**0.87**	**0.92**
Italy	6	**0.64**	**0.64**	**0.71**	**0.70**	**0.79**	**0.72**	**0.80**
Japan	5	**0.77**	**0.83**	**0.90**	**0.84**	**0.97**	**0.89**	**0.95**
Hong Kong	4	**0.89**	**0.92**	**0.91**	**0.95**	**1.00**	**0.86**	**0.97**
Weights		**17.4%**	**16.7%**	**28.0%**	**11.7%**	**8.7%**	**10.6%**	**6.8%**

Tier 1	**7.3**
Tier 2	**7.5**
Tier 3	**7.8**

The survey results at the tier level suggest that there is substantial satisfaction with the state of business-oriented mobile, fixed and broadband services. While satisfaction increases with relative wealth, the difference between countries in Tier 1 and countries in Tier 3 seems surprisingly small. It is unclear to us whether this is the result of expectations being different (lower) in the Tier 1 countries relative to the Tier 3 countries. Clearly, the role of expectations is an important one and needs to be controlled for in future assessments of business perceptions.

Glossary

Acronym	Definition
ADSL	Asymmetric Digital Subscriber Line
CEO	Chief Executive Officer
DEA	Data Envelopment Analysis
DOI	Digital Opportunity Index
EIU	Economist Intelligence Unit
EU	European Union
FPS	Fixed Perceptions Score
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
HDI	Human Development Index
ICT	Information Communications Technology
IT	Information Technology
IP	Internet Protocol
ITU	International Telecommunications Union
NSN	Nokia Siemens Networks
OECD	Organization for Economic Cooperation and Development
PCA	Principle Components Analysis
PSTN	Public Switched Telephone Network
PPP	Purchasing Power Parity
SMS	Short Message Service

3G	Third Generation Mobile Services
TFP	Total Factor Productivity
UNDP	United Nations Development Programme
VoIP	Voice over Internet Protocol
WEF	World Economic Forum
WITSA	World Information Technology and Services Alliance
WSIS	World Summit on the Information Society

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