Connectivity metrics for a converged era

A report for
Telekom Austria Group

June 2012

Brian Williamson
Thomas Punton

About Plum

Plum Consulting offer strategy, policy and regulatory advice in the telecoms, media and online sectors; and on radio spectrum as a key sector input. We draw on economics, our knowledge of the sector and our clients understanding and perspective to shape and respond to convergence.

Plum Consulting, 26-27 Southampton Street, Covent Garden, London, WC2E 7RS
T: +44(20) 7047 1919, **www.plumconsulting.co.uk**

Table of Contents

Executive Summary 1

1 What do we mean by convergence? 3
1.1 Drivers of convergence 4
1.2 Smart mobile devices – rising fast & catalysing convergence 4
1.3 Conclusion 5

2 Impact of convergence on existing metrics 6

3 Framework for developing and measuring metrics 7
3.1 Inputs vs. outcomes vs. impacts 7
3.2 Prices vs. quantities 8
3.3 Proxies vs. direct measures 9
3.4 Judgement vs. consumer weights in constructing indices 10
3.5 Transparency 10
3.6 Data sources 11

4 The art of the possible 12
4.1 Comment on the use of indices 12
4.2 Choice of metrics 13

5 Future development 15
5.1 High level direction for future development of metrics 15
5.2 Specific proposals in relation to metrics 15

6 Conclusion 17

Appendix A: Survey of existing indices 18

Appendix B: Alternative data sources 19

Executive Summary

The communications market is changing fast and today's landscape will have changed substantially by 2020. This rapid pace of change is a relatively new phenomenon with fixed line voice telephony having been relatively stable as a service for around a century and terrestrial and satellite broadcast TV dominant for video distribution for around half a century.

We use convergence as a broad label to cover recent developments impacting on behaviour and markets driven by Internet Protocol "IP" and advances in computing (Moore's law) including multiservice two-way access platforms, over-the-top applications and personal mobile connectivity and apps. These developments follow a period of 50-100 years in which entertainment and communication were delivered to the household via dedicated platforms and constrained in their capabilities to one-to-many broadcasting and voice telephony respectively.

It is important to consider whether the way we have been thinking about the communications market, the way we measure it and the way we compare outcomes over time and across countries is still relevant and robust, or whether a different approach is required to measurement and policy.

These issues are under active consideration by a number of agencies. For example the OECD are considering possible new benchmarks and performance measures in relation to broadband and the internet economy,[1] whilst the Australian Communications and Media Authority (ACMA) have raised fundamental questions regarding the impact of convergence on the market and on the policy framework.[2]

The European Digital Agenda targets have focussed attention on specific targets for broadband access to premises by 2020 – universal availability of 30 Mbps and take-up by at least 50% of households of 100 Mbps broadband. The European Commission is monitoring progress against these and other Digital Agenda targets and reports the results annually in the Digital Agenda scoreboard. However, before answering the question of where we stand it is important to take a step back and ask two questions:

- First, do the current measures of progress – which tend to rely on the availability of specific technologies rather than actual measurement of performance – provide reasonably proxies against which to measure progress?
- Second, do the current targets provide a balanced assessment of the elements of connectivity most closely linked to economic and social value?

In answering the first question we find that existing Digital Agenda scorecard measures are, in some instances, poor proxies for outcomes. Broadband coverage is reported as 100% for countries where it is known that not everyone has access to broadband. Further progress towards achievement of the speed targets appears to be based on technology availability rather than actual performance.

In answering the second question we looked at how technology, behaviour and markets are evolving and therefore what connectivity metrics appear appropriate in terms of economic and social relevance. We conclude that the recent and exponential rise of mobile devices and mobile data connectivity

[1] OECD. June 2011. "A broadband and internet economy metric checklist – a new approach." http://www.oecd.org/dataoecd/24/4/48255721.pdf

[2] ACMA. August 2011. "Broken concepts – The Australian communications legislative landscape." http://engage.acma.gov.au/wp-content/uploads/2011/08/ACMA_Broken-Concepts_Final_29Aug1.pdf

raises a fundamental question about the value of an exclusive focus on high speed connectivity to the premise.

Measuring broadband speeds at the premise is no longer adequate or even meaningful in isolation. We are moving rapidly from an era of connectivity to the premise to reliance on connectivity anytime anywhere. A parallel focus on mobile data connectivity as a key indicator of current and future mobile capability is therefore proposed. Given the pace of change in mobile connectivity, availability of spectrum inputs (which are inherently scarce) may also be a good leading indicator of mobile connectivity speed, capacity and coverage.

Demand-side behaviour including measures of the intensity and value of different uses of connectivity deserve greater attention. The development of service agnostic networks and services and applications that are network independent (or "over-the-top") is shifting us from a single service quality world which has persisted for the past 50-100 years (traditional voice and broadcast TV) to a profusion of services, service quality levels and behaviours – from homogeneous to heterogeneous. It is no longer possible to simply compare apples with apples.

Network centric measures such as switched minutes are no longer meaningful, and supply side availability is a poor proxy for outcomes. A greater emphasis on behaviour and use, including intensity of use, is required. Surveys will be increasingly important, as will analysis of very large data sets reflecting granular behaviour. Adequately capturing, representing and comparing "connectivity" in a meaningful manner will become more difficult and nuanced. We take a first step, setting out metrics based on available measures which we believe more closely reflect economic and social value and which rely on actual measurement and improved proxies.

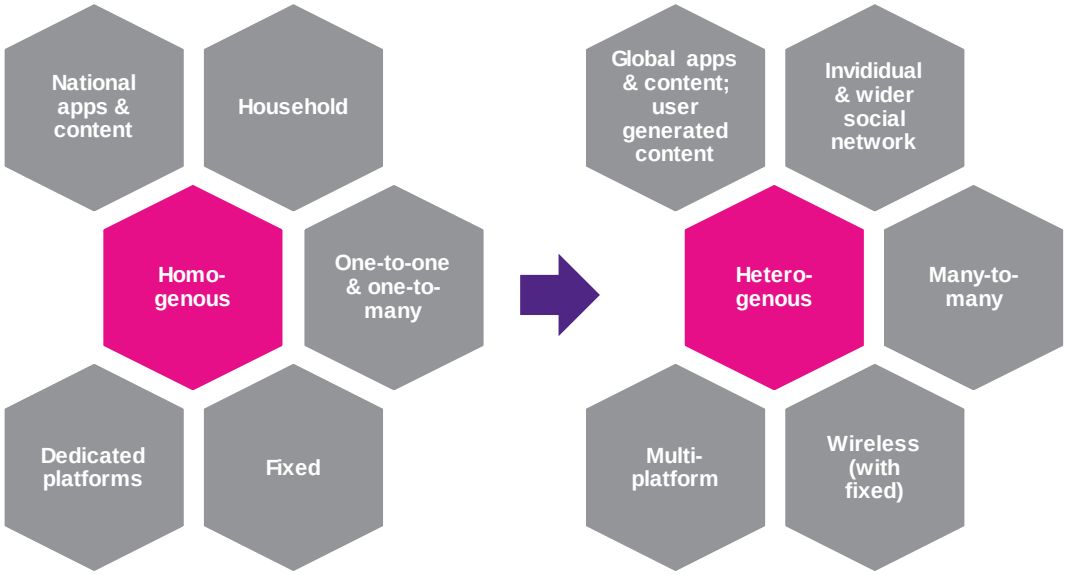
In this paper we focus on issues in relation to broadband connectivity and internet use. This is driven in part by the focus of the European Digital Agenda on connectivity and digital inclusion. It is also driven by a desire to consider the implications of convergence within a focussed scope. The general lessons should be applicable to a wider set of measurement issues. This paper is also the companion framework paper for a separate paper which uses available metrics to begin to construct metrics robust to convergence. We conclude that metrics should be:

- Transparent in terms of their definition and data sources which should be publicly available.
- Technology neutral or frequently updated to reflect the changing mix of technology.
- Based on actual measures rather than indirect proxies.
- Adjusted over time to reflect the value consumers place on different outputs.

1 What do we mean by convergence?

We use convergence as a broad label to cover developments impacting on behaviour and markets driven by Internet Protocol "IP" and advances in computing (Moore's law) including multiservice two-way access platforms, over-the-top applications and personal mobile connectivity and apps. These developments follow a period 50-100 years in which entertainment and communication were delivered to the household via dedicated platforms and constrained in their capabilities to one-to-many broadcasting and voice telephony respectively.

Figure 1-1: Impact of "convergence"



The above involves the following transformations which impact on required metrics and measurement:

Changes in production and consumption behaviour

- A shift from homogenous to heterogeneous applications and content production, distribution and consumption. This requires finer grained metrics and makes comparisons across countries or over time more difficult.
- A shift from applications and content that was predominantly national to global over-the-top applications and content; alongside user generated content.
- A shift from household consumption to individual consumption and sharing across extended social networks.

Reflecting changes in underlying technology

- A shift from dedicated platforms including fixed and mobile telephony and broadcasting to multiservice broadband access platforms.
- A shift from fixed access to mobile and wireless (Wi-Fi) access.
- A shift from one-way (broadcast) to two-way (broadband) platforms allowing interaction and sharing.

1.1 Drivers of convergence

Three broad drivers of convergence are shown in Figure 1-2. These can be expected to have a profound impact on communications and content markets by 2020, particularly given the pace of change and synergies involved the two more recent developments – over-the-top and mobile connectivity, devices and apps.

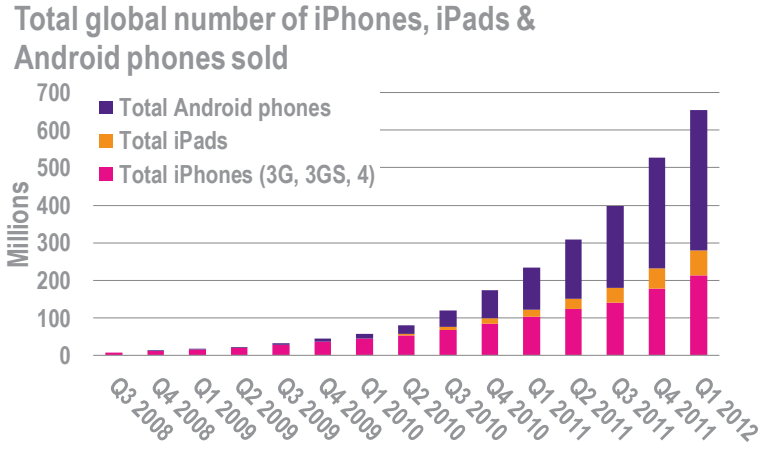
Figure 1-2: Three underlying drivers of convergence

Multiservice broadband platforms (from around 2000)	• Broadband supports two-way, higer speed IP based applications. • Enabled rise of over-the -top content & applications including VoIP, VoD, IM etc; and content sharing.
Over-the-top applications (from around 2005)	• Steady rise driven by broadband access, web standards peer-to-peer, cloud computing and service innovation. • More heterogenious consumer behaviour driven by choice, growth of free services and substitution for homogenous services.
Smart mobile & apps (from 2008)	• Improved wireless connectivity, smart mobile devices and apps have fueled rapid adoption. • Reinforcing personalisation, over-the-top (via apps) & wireless-fixed substitution in some markets .

1.2 Smart mobile devices – rising fast & catalysing convergence

Focussing on the most recent development – smart mobile and apps – Figure 1-3 shows cumulative global iOS and Android mobile wireless devices and iPad sales (iOS and Android account for the majority of smart device data and app use at present).

Figure 1-3



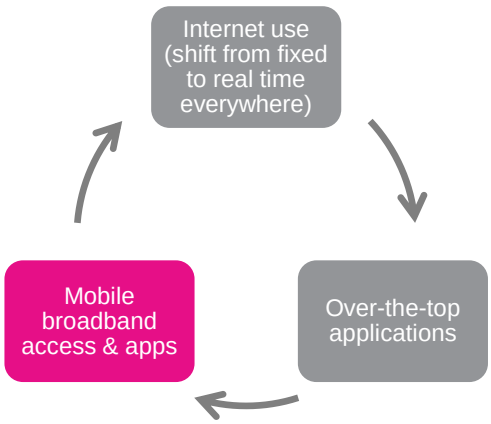
Source: Plum Consulting, Apple quarterly financial results, Gartner

An alternative measure based on survey data and using a broader definition of "smart phone" shows that in three countries in Europe – Norway, Sweden and the UK – penetration now exceeds 50%, yet less than 10% of people in those countries have owned a smart phone for more than 2 years[3]. Adoption is very rapid and it seems reasonable to expect a substantial majority of people in Europe to have a smart phone by 2015. This is a more rapid technology shift than the adoption of fixed broadband. The introduction of LTE and additional spectrum for mobile will reinforce this trend by improving capacity, connection speed and lowering the cost of data.

Smart mobile device adoption is also important since it is reinforcing earlier developments including adoption of multiservice broadband platforms and over-the-top applications for the following reasons:

- Mobile broadband extends broadband access beyond the premise – a spatial extension and an extension into real time applications – and facilitates internet adoption by those who may otherwise be offline.[4]
- Over-the-top applications, for example, instant messaging applications such as WhatsApp, VoIP applications such as Skype and music streaming applications such as Spotify are easier to adopt and more versatile on mobile device than via a PC.

Figure 1-4: Mobile catalyses other drivers of convergence



1.3 Conclusion

Convergence is driving a shift from network specific homogenous to network agnostic heterogeneous service provision and consumption, and the growth in smart mobile devices and applications is catalysing this transformation. However, many existing metrics are network specific and implicitly assume a single homogenous service. New measures and new means of comparing outcomes are required.

[3] Our mobile planet. May 2012. http://www.ourmobileplanet.com/en/

[4] Pew Internet. April 2012. Digital differences. Page 14. http://pewinternet.org/~/media//Files/Reports/2012/PIP_Digital_differences_041312.pdf

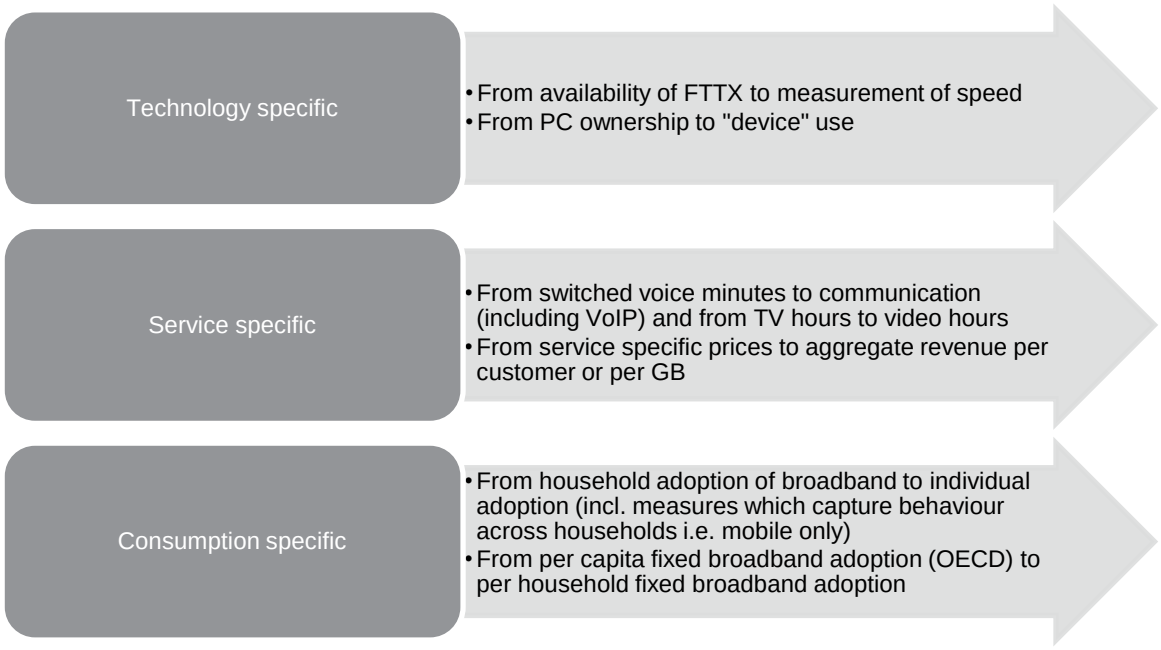
2 Impact of convergence on existing metrics

It is arguable that convergence is bringing communications and entertainment more in-line with other markets where heterogeneous service provision and consumption behaviour is the norm. It is also arguable that convergence is removing constraints peculiar to the technologies that have dominated communication and entertainment over the past century or so and returning us to modes of behaviour – mobile, two-way and social – that are more natural.[5] [6]

However, the shift underway is rendering established metrics and comparisons meaningless. For example, switched voice minutes as a measure of communication[7], fixed broadband access as a measure of connectivity and hours of TV viewing as a measure of video consumption are no longer adequate metrics of market outcomes and behaviour. A shift from homogeneous to heterogeneous production and consumption also renders a simple comparison of apples with apples impossible.

Specific legacy measures – based on technology, unit of consumption or service – will in general need to be adapted or abandoned (Figure 2-1). This mirrors the drives of convergence (in previous Figure 1-2), namely the move to multi-service platforms, over-the-top applications and the rise of mobile which blurs the distinction between household and individual consumption.

Figure 2-1: Impact of convergence on metrics



[5] *"[Pervasive mobile will]...bring us back to behaviour patterns that were natural to us and destroy behaviour patterns that were brought about by the limitations of technology"* http://www.wired.com/wired/archive/7.09/nokia_pr.html

[6] *"Interactivity. Many-to-many communications. Pervasive networking. These are cumbersome new terms for elements in our lives so fundamental that, before we lost them, we didn't even know to have names for them."* http://www.douglasadams.com/dna/19990901-00-a.html

[7] For example, Skype was launched in 2003, introduced video communication in 2005 and accounted for almost 25% of all international calling minutes during 2010 (and 42% of all Skype calls were video calls). http://blogs.skype.com/en/2011/01/international_calling.html

3 Framework for developing and measuring metrics

Existing measures are typically based on integrated applications and specific services such as switched voice minutes and TV viewing hours. Also common are proxies, such as advertised broadband speeds and DSL enabled exchanges for fixed broadband availability, complemented by survey data, for example, on internet adoption and use. Price indices for specific legacy services are prominent. Inputs, outcomes and impacts are not always clearly delineated. Finally, the precise definition and basis for measurement of existing metrics is not always clear.

Almost everything therefore needs to change for metrics and comparisons to remain relevant and inform policy and business decisions. Below we consider conceptual and measurement issues at a general level, propose specific measures and then assess these against available data. In a companion paper on comparative connectivity metrics we report the outcome of analysis using metrics available today.

3.1 Inputs vs. outcomes vs. impacts

We are ultimately interested in the social and economic impact of connectivity rather than connectivity per se (outputs) or inputs such as capital expenditure (Figure 3-1).

Figure 3-1: Inputs vs. outcomes vs. inputs

We focus on the left hand figure above rather than the right hand governance framework in this paper. Market governance is nevertheless key to the efficiency of markets including the relationship between outputs produced and the value associated with them ("allocative efficiency"), the efficiency with which inputs are transformed into outputs ("productive efficiency") and the adoption of welfare enhancing changes in technology over time ("dynamic efficiency"). We note that appropriate output measures can help inform policy and market governance, whereas poor measures may lead to inappropriate policy choices.

Ultimately we are concerned with impacts. Inputs and outcomes are means rather than ends. However, we are interested in outcomes for a number of reasons:

- We wish to judge progress against sectoral policy and regulatory objectives.
- We wish to pursue particular outcomes in the belief that they will have a positive impact, before waiting for evidence to accumulate (as Nobel winner Robert Solow said in 1987 "You can see the computer age everywhere but in the productivity statistics.").

- We should test our beliefs in order to learn and improve policy and regulation. To do so we need information on impacts, outcomes and inputs.

However, it is important to be clear about what we are measuring and its fitness for purpose. Particular caution is also required in interpreting inputs since, for a given outcome or impact, more of a given input (say capital expenditure) implies inefficiency and lower productivity. For example, if fibre to the cabinet can deliver broadband access speeds in the 50-100 Mbps range it may be preferred to fibre to the premise which will involve, in many but not all circumstances, substantially higher capital expenditure.

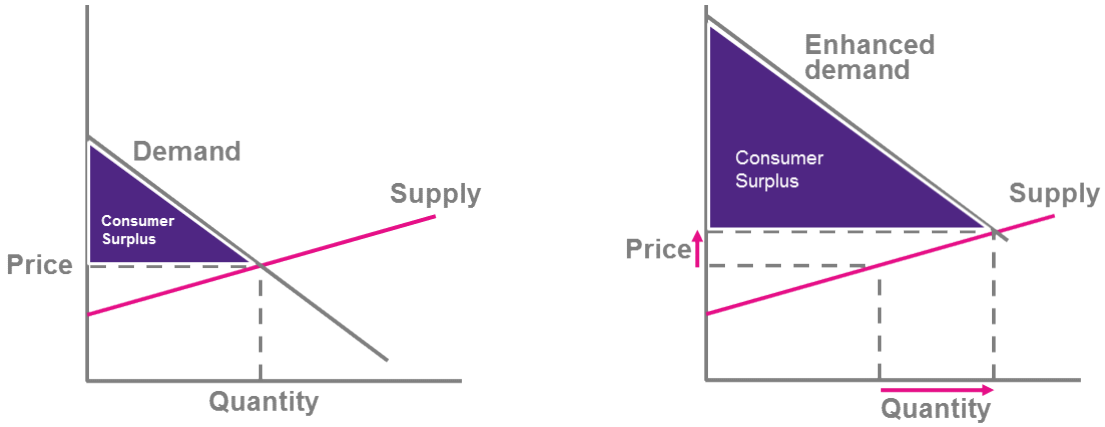
3.2 Prices vs. quantities

Considerable emphasis has been placed on prices and price changes as a comparative measure. For a given homogeneous service this is reasonable. However, as services become more varied and differentiated, lower prices may not indicate higher levels of welfare. Consumers may rather pay more to do more, as the growth of smartphones illustrates.

Indeed, quantity may be a better measure of welfare than price as convergence proceeds. If people are willing to buy more of something then they must value it more – whether the price is somewhat higher or not. Quantities reflect quality and price and may therefore provide better transitional measures of success until applications, quality and the value consumers place on them are better understood.

Figure 3-2 illustrates how enhanced demand due to improved quality of service might be viewed through the lens of price alone as negative, but is associated with a higher quantity of consumption (and welfare gains as measured by the change in the area between the demand and supply curves – consumer surplus is indicated) even though the price is higher. In the absence of a welfare measure, quantity demanded can be a superior proxy for progress to price.[8]

Figure 3-2: Price versus quantity as a measure of improvement



[8] If the supply curve has moved up the net change in consumer surplus would be ambiguous. However, consumers can be expected to only choose higher quality at a higher price over lower quality at a lower price if they are better off, so in a market with choice the conclusion that demand is superior to price as a proxy for welfare changes with incomplete information holds.

Should prices be considered, then disaggregated measures are almost certainly misleading. It does not matter to a household if their broadband charge is low when their line charge is high. Explicit mobile data charges and revenues may also differ simply because of the structure of prices, for example, if consumers pay a premium for a smart device contract including broadband connectivity a data charge is implicit.

High level aggregate price measures may however be informative, for example, the price of fixed connectivity to a premise (line charge plus incremental broadband charge)[9] or the implied price per gigabyte for mobile (total revenue divided by total gigabytes).

3.3 Proxies vs. direct measures

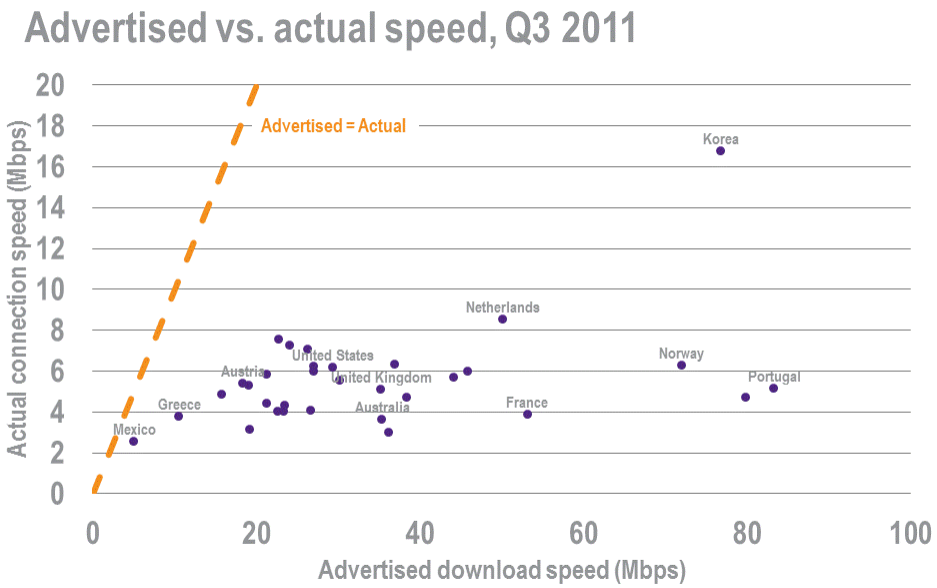
A number of proxies are used in the Digital Agenda scorecard and elsewhere, for example, in OECD broadband statistics. Proxies include the presence of a specific access technology or advertised speed as a proxy for actual speed, availability of DSL enabled exchanges as a proxy for DSL availability etc. We examined a number of existing proxies and found them to be poor:

- Fibre to the cabinet is not counted as fibre access in OECD broadband statistics but is instead grouped with DSL. Yet it can now offer speeds that approach or even exceed those commercially available over fibre to the premise.
- The Digital Agenda scoreboard measures progress towards universally available 30 Mbps connectivity at the premise based on specific technology availability rather than a measure of actual speed.
- The Digital Agenda scoreboard indicates that fixed broadband is universally available in certain countries where in reality it is not. This is because DSL exchange enablement may exceed availability of functional broadband due to line lengths and quality (e.g. in the UK 14% of households with broadband had speeds of less than 2 Mbps in 2011, yet the UK scores 100% in the Digital Agenda scorecard for availability)[10].
- Advertised speeds are used as a proxy for speed and in relation to pricing associated with speed. Yet advertised speeds typically greatly exceed delivered average speeds and with considerable variation across countries (see Figure 3-3 where the dotted line indicates a one-for-one relationship).

[9] Price measures should take into consideration consumer behaviour and the opportunity cost of service, as opposed to simply reporting the standalone price. Historically fixed broadband has been considered an incremental service to fixed line telephony and the price of the broadband element alone is considered in comparisons. However, with the rise of mobile only or potentially mobile only households in terms of voice service the fixed line rental price should increasingly be attributed to fixed broadband rather than considered separate.

[10] Ofcom. November 2011. Infrastructure report. http://stakeholders.ofcom.org.uk/binaries/research/telecoms-research/bbspeeds2011/infrastructure-report.pdf

Figure 3-3



Source: Plum Consulting, OECD, Akamai

Where direct measures are available proxies should not be used. In particular progress towards the digital agenda targets should be assessed on a technology neutral basis where possible. Where proxies are used they should be used with caution and appropriately caveated.

3.4 Judgement vs. consumer weights in constructing indices

Apples need to be compared with oranges for indices and benchmarks involving aggregation, for example, a measure of connectivity involving both fixed and mobile broadband access. Ideally the weights applied to different metrics for the purpose of aggregation should reflect consumers' valuation of different forms of connectivity or applications – based perhaps on time or money expenditure or surveys to estimate willingness to pay based on how consumers rank different applications.[11] In the near term judgement and transparency are likely to be required in the creation of indices.

3.5 Transparency

We found during our research that the precise definition and basis for measurement in relation to a significant number of existing metrics are unclear. It is crucial that definitions and the methodology for measurement are transparent in order that information can be interpreted correctly and the limitations of any given measure understood.

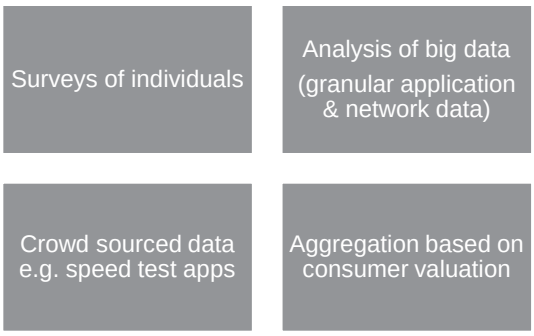
[11] For an assessment of willingness to pay for higher speed fixed access see: Rosston, Savage and Waldman. 2010. "Household Demand for Broadband Internet Service".
http://siepr.stanford.edu/system/files/shared/Household_demand_for_broadband.pdf

Transparency in relation to methodology and sample characteristics will become more important as increasingly reliance is placed on surveys, analysis of big data sets and crowd sourced information, as discussed below.

3.6 Data sources

As discussed in Section 2 convergence is reducing the validity of existing measures and new measures are required. Considering the nature of the changes underway the focus in terms of new data sources will need to be the following.

Figure 3-4: Broad data sources



Greater reliance on surveys, big data and crowd sourced data will be required because we can no longer rely on network dependent service measures to provide a meaningful indication of behaviour and outcomes.[12] For example:

- Surveys to collect information on individual internet use.
- Crowd sourced data based on user opt in to online or app based measurement, for example, OpenSignalMaps collect app based data on the type and quality of mobile connection by location. Crowd sourced speed test data, for example speedtest.net, is also available.
- Big data (Facebook, Google etc.) might be used to obtain information on application use and online behaviour.

A number of the relevant data sources are commercial rather than collected by regulators or government agencies. However, increasing amounts of such data are being made publicly available. Detailed network data might also allow new metrics to be developed, for example, mobile data consumption by country.

With the rise of a multiplicity of apps and consumption (almost) anywhere anytime, granularity and greater transparency about what is measured and the measures' limitations is necessary. Measurement of consumption of a particular service at home is no longer adequate.

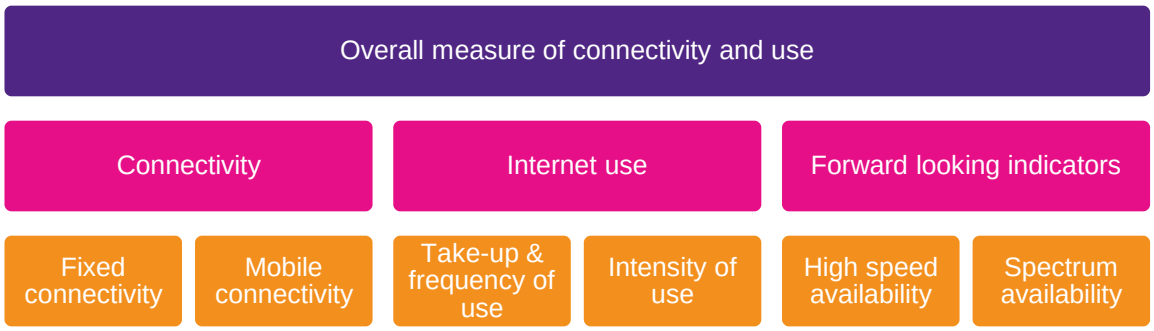
[12] William Lehr. April 2012. "Measuring the Internet – the data challenge." OECD Digital Economy Papers, No 194. http://www.oecd-ilibrary.org/science-and-technology/measuring-the-internet_5k9bhk5fzvzx-en

4 The art of the possible

Our goal was to not only consider what should be measured, but to utilise available measures to measure connectivity in a more converged way. We also constructed indices to facilitate high level comparison across countries and potentially, in future, over time. Whilst indices involve compromises we felt, on balance, that they can add value provided the basis for aggregation is clear and explicit.

We have focussed on impacts and outcomes in relation to broadband connectivity and use, and on one input – spectrum availability for mobile use – as a forward indicator.[13] We consider metrics individually and grouped – first alongside other closely related metrics – then into a more aggregate index of connectivity as illustrated in Figure 4-1.

Figure 4-1: Overall structure of metrics in relation to connectivity and use



We focussed on countries in Europe, but also sought external comparators. In practice data availability limited the number of countries that could be assessed and compared, particularly in relation to indices since different metrics are available for different countries. The only external comparators for which a sufficient range of comparable metrics were available were the US and Korea.

4.1 Comment on the use of indices

The nature of the converging ICT world and increasingly heterogeneous consumption behaviours mean that it is no longer possible to measure outcomes and progress with a simple narrow set of indicators, in particular indicators of network integrated applications.

All three of the convergence trends identified in Section 1 mean that existing indicators may often overlap or provide an incomplete picture. Comparing countries across multiple indicators makes it very difficult to rank countries and establish an overall gauge of performance. To overcome these problems new measures are required including those grounded in surveys of consumer behaviour. Further indices involving multiple related measures may be more informative as consumption behaviour shifts over time and differs across countries.

[13] A focus on spectrum inputs is rationalised on grounds that the opportunity cost of allocating additional spectrum for mobile use in relation to agreed IMT bands is likely to be low and because additional spectrum can improve coverage, capacity, speed and lower unit costs. Therefore,up to a point, spectrum reallocation for mobile use is a good proxy for improved outcomes in the sector and in the economy.

By combining a number of indicators you can capture an overarching picture of progress in a selected area (Appendix A reviews a number of existing indices). The index should be designed so that all of the indicators aim to measure the same theme otherwise it can be difficult to establish what the index is actually telling us. Appropriately grouped sub-indices are therefore required. However, there are potential problems in creating indices, in particular:

- Elements of an index may be non-comparable and their combination may cease to be informative. In particular the combination of outcome, output and input measures could arguably be misleading, for example, if outcomes in given country are good, less of an input may be irrelevant or even indicate efficiency rather than relative failure.
- You may lose information about the countries you are comparing since individual countries may involve differing gaps in terms of available data.
- The choice of weights can create bias towards certain indicators and the appropriate weights may change over time as magnitudes shift (which makes the index non-comparable over time).

Our approach is to focus on closely related metrics and to construct indices of connectivity (wireless data and fixed broadband), internet use and a forward looking indicator.

4.2 Choice of metrics

We looked at a wide range of data sources, many of them of necessity beyond those currently collected by national regulators, the European Commission and international bodies such as the OECD. Where we have relied on data available from commercial and private sources we have used only data which is freely and publicly available.

Based on the inevitable compromise between what we sought to measure and existing publicly available data, we adopted the metrics shown in Table 4-1. More detailed definitions of the metrics are available in Appendix A of the accompanying paper "Comparative connectivity metrics for Europe, South Korea and the United States".

Table 4-1: Metrics used in Plum connectivity and use index

Objective of measure	Metric	Source
Fixed connectivity	Coverage	EC Digital Agenda Scoreboard
	Take-up	OECD Broadband portal
	Speed	Akamai – State of the Internet Report
	Quality	Ookla net index
Wireless connectivity	Coverage	EC Digital Agenda Scoreboard
	Take-up	OECD Broadband portal
	Speed	Akamai – State of the Internet Report
	Smart phone adoption	Google - Our global planet
	Wi-Fi use	Eurostat
Internet use	Regular use	Eurostat

Objective of measure	Metric	Source
	Frequent use	Eurostat
	Time online	ComScore
	E-commerce	Eurostat
Forward looking index	Spectrum availability	European Communications Office
	LTE availability	LTE maps
	FTTx/DOCSIS 3.0 coverage	iDATE
	FTTx/DOCSIS 3.0 penetration	iDATE

5 Future development

There are a number of areas where metrics could be improved and extended based on our experience in terms of what we sought to do and what would, in our view, be informative for policy makers, and what was available.

5.1 High level direction for future development of metrics

Metrics should be:

- Transparent in terms of their definition and data sources which should be publicly available.
- Technology neutral or frequently updated to reflect the changing mix of technology.
- Based on actual measures rather than indirect proxies.
- Adjusted over time to reflect the value consumers place on different outputs.

5.2 Specific proposals in relation to metrics

A number of specific proposals for improving metrics have emerged from our work.

5.2.1 Improving existing metrics

- Transparency in relation to existing metrics, in particular the definition and estimation of a number of the metrics reported in the Digital Agenda Scorecard were not publicly available including the measures of broadband speed and coverage.
- Country coverage of existing metrics, for example Wi-Fi use and time online.
- Changing the reporting of the OECD broadband scorecard to report:
  - Fixed broadband access on a per household basis instead of or in addition to the current per capita basis.
  - Fibre to the cabinet VDSL based broadband as a separate category from DSL or include it within the fibre access measure (fibre is currently limited to fibre to the premise) given advances in the capability of fibre to cabinet based VDSL which bring it closely in line with fibre to the premise in terms of the consumer valuation of high speed broadband.
- Changing the basis on which broadband availability is assessed:
  - Wireless broadband availability measures could be extended to include not just population (premise) coverage but to include measures of coverage in areas where mobile broadband is valued highly, i.e. to include places of work and transportation corridors or measures of time spend on different technologies e.g. 3G vs. 2G. This may require analysis of crowd sourced data.
  - Realistic estimates of fixed broadband availability rather than proxies such as DSL exchange enablement.

- Changing the basis on which connection speed and quality is assessed:
  - Actual connection speeds should be measured rather than relying on technology specific proxies. We note however that there is no single 'perfect' measure of connection speed and that both upstream (server and core network) and downstream (terminal equipment and within home constraints) factors may impact on measurement and that different approaches may be subject to different sample biases. A range of measures should be assessed and upload as well as download speeds reported.
  - Other measures of service quality should be assessed alongside speed to capture the quality of connectivity and the ability to support services, such as VoIP, which are sensitive to factors such as latency and jitter. Appendix B discusses some of the measures that we considered but did not include.
- Allowing mobile only adoption at the household level to be assessed in addition to independent data on fixed (a household measure) and mobile (an individual measure) connectivity.

5.2.2 Introducing new metrics

- To capture rapidly emerging technologies and applications, in particular mobile and over-the-top applications, LTE availability measures and broader based surveys of wireless device adoption and use, including nomadic as opposed to mobile use, should be considered.
- Time online and other more fine grained time allocation estimates should be extended since they provide a proxy for value and allow the intensity of use and changes in behaviour to be more clearly identified than yes/no questions regarding application and device use.
- Collection of information on mobile data volumes at a national level should be considered as a measure of use and as a basis for assessing the price per unit of data carried.

6 Conclusion

Convergence, driven by more capable multiservice IP platforms, development of over-the-top applications and reinforced by the rapid rise of smart personal mobile devices and applications, is fundamentally changing the communications market. As a result new metrics and new benchmarks are required to support informed evidence based public policy and to provide a shared data set for market participants.

There is a need for metrics to reflect the rapid shifts and growing diversity in terms of what is offered and what is consumed, and for benchmarks to reflect the shifting value consumers place on different forms of connectivity and different applications. What is required differs fundamentally from much of the information gathered historically by regulators and governments from network operators.

A diversity of information sources will have to be tapped in future, with greater reliance on surveys of individuals, crowd sourced data and analysis of big granular data sets. Tapping these data sets will require greater cooperation between those gathering statistics, regulators, national bodies, market participants and specialist firms that have developed expertise and leadership in relation to particular metrics.

Appendix A: Survey of existing indices

There are a number of existing published indices that aim to capture general progress in ICT or in a more specific area. These indices include:

- The ITU **ICT Development Index** (IDI) which aims to capture a countries general progress in the area of ICT.[14] The index has been published annually since 2009 and is composed of 11 indicators in three categories; access, use and skills. The access sub-index measures infrastructure including fixed telephony, mobile telephony, international internet bandwidth, households with computers and the internet. The use sub-index measures ICT intensity including fixed and mobile broadband and internet users. The skills sub-index measures ICT capability including literacy and secondary and tertiary education enrolment. As the index is aimed at a global range of countries it includes many indicators which show very little variation across developed countries, for example fixed telephony.
- The **Connectivity Scorecard** is a global ICT index which ranks countries based on their ICT deployment and extent to which it is used to enhance social and economic welfare.[15] The index aims to capture useful connectivity which measures how the infrastructure is actually used. The scorecard splits up businesses, consumers and governments and indicators aim to capture infrastructure and usage and skills. Countries are split into two categories, resource driven economies and innovation driven economies, allowing the index to include different indicators for each category. After weighting the indicators, based on which pillar (businesses, consumers, government) contributes the most to long term productivity, countries are given a final score out of 10.
- McKinsey have created the **e-3 index** which aims to measure internet connectivity across countries.[16] The index is composed of 3 categories; e-ngagement (40% weighting), e-nvironment (40% weighting) and e-xpenditure (20% weighting). The first category aims to capture the use of the internet by individuals, companies and governments and includes indicators such as number of PCs and number of internet users. The second category measures infrastructure quality and includes indicators of internet speed and number of secure internet servers. The final category measures expenditure on the internet including advertising spend and e-commerce.
- Paul Katz *et al*'s **Digitisation Index**[17] has 21 measures including broadband speed, coverage and reliability, the cost and use of mobile telephones the availability of online shopping, provision of e-government services and the ability of workers to use new digital technologies.

[14] ITU. 2011. "Measuring the information society" http://www.itu.int/net/pressoffice/backgrounders/general/pdf/5.pdf

[15] Nokia Siemens Networks. "Connectivity Scorecard." http://www.connectivityscorecard.org/

[16] McKinsey Global Institute, May 2011, "Internet matters: The Net's sweeping impact on growth, jobs and prosperity" http://www.mckinsey.com/~/media/McKinsey/dotcom/Insights%20and%20pubs/MGI/Research/Technology%20and%20Innovation/Internet%20matters%20-%20Nets%20sweeping%20impact/MGI_internet_matters_full_report.ashx

[17] http://www3.weforum.org/docs/GITR/2012/GITR_Chapter1.11_2012.pdf

Appendix B: Alternative data sources

We considered a number of different metrics to try and capture the impact of convergence, however a number of these metrics were not included for a variety of reasons. The metrics not included are shown in Table B-1.

Table B-1: Metrics not included

Metric	Source	Notes
Download throughput	Ookla Net Index – speedtest.net[18]	There are a number of different sources which try to measure internet connection speed. What is surprising is that different measures often give different results for the same connection. This can be caused by a number of reasons relating to where in the network the problem is. This is discussed in more detail by Bauer et al.[19] We selected Akamai as the data source for connection speed data because they were they only source that had separate data for both fixed and mobile connections.
	Measurement Lab – NDT (Network Diagnostic Tool)[20]	
	Sam Knows	
Mobile connection speed	Cisco – Global Internet Speed Test (GIST)[21]	This metric measures mobile connection speed on cellular and Wi-Fi networks. Data is collected from user tests using an app available on iPhone, Blackberry and Android. Akamai data was chosen instead because the Cisco data covered a smaller section of countries and for some countries the sample size was very small (less than 50).
Median client-to-server Round Trip Time	Measurement Lab – NDT (Network Diagnostic Tool)	This measure of latency is an alternative to fixed quality indicator. However it was not included because the results are highly dependent on the distance to the server and there is a limited number of servers from which the test is run.
Average connection speed / Peak connection speed	Akamai – State of the internet report[22]	This measure tries to capture congestion in the network by measuring differences between peak and average connections. It was not included because over the last few years peak speeds have grown more than average speeds but there is limited evidence congestion has increased.
Homes passed by FTTH/B	OECD – "Fibre access – network developments in the OECD area"[23]	This metric captured coverage of FTTH/B. It was not included because it is not technology neutral and biased towards FTTH. Instead a measure including FTTH, FTTC and DOCSIS 3.0 was included.

[18] http://www.netindex.com/

[19] Bauer, Clark, Lehr. 2010. "Understanding broadband speed measurements." http://mitas.csail.mit.edu/papers/Bauer_Clark_Lehr_Broadband_Speed_Measurements.pdf

[20] http://measurementlab.net/

[21] http://gistdata.ciscovni.com/

[22] http://www.akamai.com/stateoftheinternet/

[23] http://www.oecd-ilibrary.org/science-and-technology/fibre-access_5kg9sqzz9mlx-en