WIK-Consult • Report

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Applications and networks: the chicken or the egg

The role of digital applications in supporting investment and the European economy

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Management summary

A particular focus of the political debate in Europe in recent years is how to reap the benefits of the evolving Internet eco-system both in broadband infrastructure deployment and the provision of services and applications. Two issues are prominently addressed in this context: (1) Against the backdrop of the inter-relationship of different players in the digital 'value chain' do some actors benefit at the expense of others?[1] (2) Is Europe losing ground to other regions of the world, in particular the U.S., by permitting light touch rules for digital services and applications - largely supplied by US companies - that are less stringent than those which apply for telecommunications services?[2]

The present study focuses both on the (perceived) network-application trade-off as well as on the (perceived) Europe-U.S. stress-field. To this end, the study addresses: (1) key trends in digital services and applications, in particular the role of cloud services; (2) the impact of digital services and applications on the economy at large; and (3) the interrelationship of supply side and demand side factors regarding NGA investment. Thus, the key interest is in whether there is a virtuous and/or vicious circle in the digital value chain.

A summary of our primary findings follows:

ICT provides a major opportunity for economic growth in Europe

There are considerable benefits that could be gained if Europe better leveraged ICT to support its economy. Estimates suggest that ICT has contributed around twice as much to US productivity labour growth compared with the EU[3].

Enterprise Cloud is one of the key applications that could enable productivity gains. IDC[4] estimated that cloud computing could contribute to an increase in EU GDP of €957 bn as well as creating 3.8 mill. jobs, by 2020. Surveys[5] as well as interviews conducted for this study (see Section 4) highlight that it enables corporations to focus

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1 It has been claimed that the bandwidth required to use online content and applications is creating an additional cost burden on telecommunication providers, which is not being adequately shared by those 'causing' those costs. See for example AT Kearney (2010): A viable future model for the Internet; available at: http://www.atkearney.co.uk/documents/10192/557848/Viable_Future_Model_for_Internet.pdf/4b98dac5-0c99-4439-9292-72bfcd7a6dd1; CERRE (2014): Future Regulation in Electronic Communications Markets; available at: http://www.cerre.eu/content/cerre-new-report-future-regulation-electronic-communications-markets.

2 The idea of a 'Google tax' has also been floated in some jurisdictions and referenced in press reports eg WSJ http://www.wsj.com/articles/eu-considers-taxing-google-other-u-s-internet-firms-1421699055?autologin=y.

3 Strauss, H. and B. Samkharadze (2011): ICT capital and productivity growth; in: EIB Papers, Volume 16, No2. Data available since 1980.

4 IDC (2012) Quantitative estimates of the demand for cloud computing in Europe and the likely barriers to take-up http://cordis.europa.eu/fp7/ict/ssai/docs/study45-d2-interim-report.pdf.

5 In a survey conducted by IDC (2012) – 41% of respondents cited 'high productivity' as a core benefit of cloud computing. Other benefits cited by more than one third respondents included a better ability to enter new business areas, more use of standard processes and more effective mobile working.

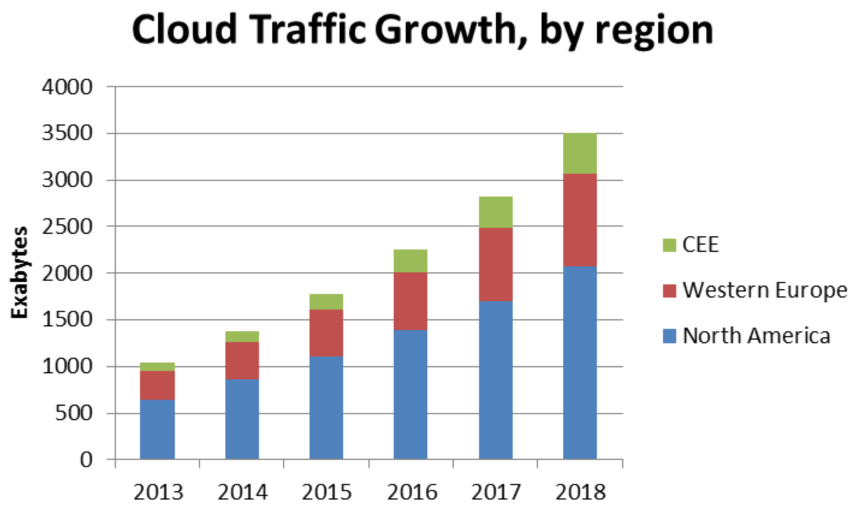
on their core business, streamline their operations, mobilise their workforce and more rapidly scale up – including to new markets. Cloud could also provide a catalyst for other ICT applications, providing a hub for the Internet of Things and the processing of 'Big Data' (see Section 3).

Europe lags the US on effective ICT use

Europe's underperformance in ICT-driven productivity compared with the US is in large part due to the lack of effective diffusion of ICT across the wider (non-digital) economy. Differences in capital alone do not seem to explain the different economic outcomes[6].

The quality of broadband connections available to European consumers and businesses matches that in other regions including the US. Data suggests that it is mostly sufficient for advanced high bandwidth applications[7] (see Figure 21 and following), and the enterprise customers interviewed for this study tend to agree. However, there are and are projected to remain – significant gaps in the use of applications in most European countries. This applies generally (US customers use more bandwidth than European customers) and also in the economically important case of cloud. For example, Eurostat data suggests that just 19% of corporations made use of cloud services despite near universal take-up of broadband by companies in the EU[8].

Figure 1: Cloud traffic growth, by region - projections



Source: WIK based on data from Cisco Cloud Index White Paper 2014, Table 4.

6 Inklaar, R. and M. Timmer (2007): Of yeasts and mushrooms: Patterns of industry-level productivity growth; in: German Economic Review, (8:2), pp. 174-187. Strauss and Samkharadze (2011), op. cit..

7 There are clearly gaps in high speed infrastructure availability in Europe, especially in rural areas – Digital Agenda Scoreboard data shows that 10% of EU rural households lacked fixed broadband availability at 2013. However, these rural gaps, while deserving attention, are not unique to Europe, and therefore are unlikely to explain different outcomes in ICT-driven productivity growth. Mobile speeds may provide a constraint on EU high bandwidth services, but this may equally apply in the US.

8 Eurostat Dec 2014; http://ec.europa.eu/eurostat/documents/2995521/6208098/4-09122014-AP-EN.pdf.

This is not a battle of the regions

Although European players are active in providing cloud services[9], it is a fact that most of the largest global suppliers of cloud services today (and also other digital applications) are US-based[10].

However, this does not mean that Europe is exporting the benefits gained from digital applications to the US. A key feature of cloud services is that they enable companies - independent of the sector they are active in - to be more productive, e.g. by focusing on their primary areas of specialisation, as also highlighted in end-user interviews. Greater cloud diffusion in Europe, even if using US-based resources, could therefore help European companies (and global companies with operations in Europe) to reach more efficient allocations along their value chain, to internalize productivity gains, and to develop and export their own goods and services, including many non-IT goods, within the single market and globally.

This is not about networks vs applications

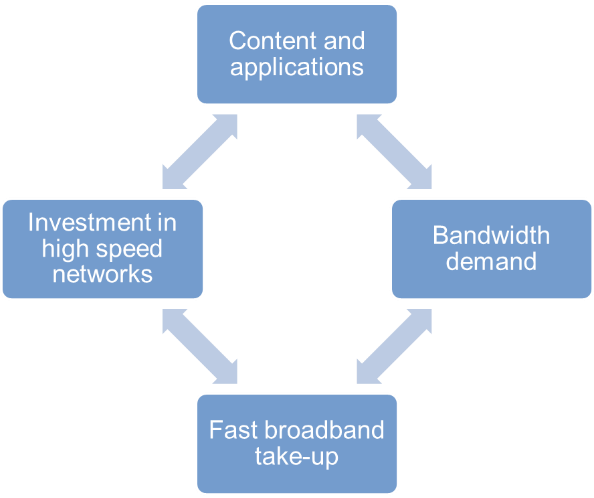
Arguments around who should pay more in the value chain may be overly simplistic. Our research finds that, while applications benefit from presence of broadband networks, those networks also benefit from increased demand for bandwidth driven by applications. For example, mobile broadband take-up is more prevalent amongst businesses using cloud applications (see Figure 31). Many of the countries which have achieved higher take-up rates for superfast broadband (some with price premiums), are also those countries with higher usage of bandwidth-intensive applications such as cloud (see Figure 32). Equally, higher demand (and potentially willingness to pay) are key in enabling profitable investment and reducing risks for telecommunications providers.

It is not possible to say whether the chicken or the egg came first, but it is likely that applications and networks operate in a virtuous cycle with mutual benefits from the success of each.

9 For example, the 'European Cloud Partnership' includes several EU-based providers on its steering board.

10 See for example Talkin' Cloud (2014): Top 100 Cloud Services Providers, 2014 edition; available at: http://talkincloud.com/TC100/datasheet/2014-talkin-cloud-100-report.

Figure 2: The virtuous cycle of networks and applications



Source: WIK.

A joined up policy approach could provide a 'win win' for Europe

In the past, policy-makers have pursued largely parallel policies concerning telecommunications investment (the supply-side)[11] and support for applications such as cloud (the demand-side)[12]. Recent policy debates combining the two, have on the other hand often involved corrosive exchanges with network operators and applications providers in opposing corners battling as to which confers greater value.

Considerable benefits, especially also in the long run, could be gained from a more joined-up approach. The idea is to create a virtuous circle to foster growth and competitiveness of European companies. A refreshed policy should embrace the inter-linkages between broadband infrastructure and applications and content. It should acknowledge the investments made on both sides of the value chain and the important role that cloud and other applications play in driving demand for fixed and mobile broadband connectivity, as well as knock-on effects across the wider economy. In this context, a key focus for policy-makers should be to support ICT diffusion across other diverse industries to bridge the gap between European and US productivity.

Measures which could support such an approach include:

- Highlighting the significance of demand-side measures in the digital economy and their inter-relationship with supply

11 For example, the activities undertaken to support achievement of the 'Digital Agenda' broadband connectivity objectives.
12 See for example the European Cloud Computing Stratregy http://ec.europa.eu/digital-agenda/en/european-cloud-computing-strategy.

- Promoting a consistent approach across Europe to foster supply and usage of applications within the single market
- Identifying targets for business ICT use
- Understanding the reasons for low usage of productivity-enhancing applications by European corporations, and finding the best means to address these, including standardisation strategies where appropriate
- Fostering an open and competitive market for applications, and not raising barriers to global competition in this space
- Minimising administrative and bureaucratic hurdles to providing and using digital applications of all kinds. In this context, perhaps a distinction could be made between connectivity, which is typically locally provided, and services and applications – which may form part of a wider, EU or even global market. A simplified, pan-European approach to services and applications could support enterprises as end-users of services, traditional suppliers[13] as well as 'new' players in the market.

In turn, creating a single European market in which digital applications can flourish could help to support not only European businesses which use these services, but also expand the market as a whole, creating further room for emerging European providers of cloud and other digital applications to find their niche. For example, more intensive use of cloud services could provide a stimulus for other important European initiatives e.g. in the field of industry, Internet of things, and mobility, as illustrated in the case studies in Section 4.

A rising tide lifts all boats.

13 Voice and SMS could in some respects be considered as applications going forwards.

1 Introduction

The European Commission has been pursuing twin track policies to encourage the deployment and take-up of high speed broadband networks[14] on the one hand and to foster usage of cloud services on the other[15]. However, discussions on the relationships between actors within the digital value chain have in recent years tended to be adversarial – with debates as to whether certain actors – largely US-based providers of digital applications and content providers – have benefited at the expense of largely EU-based providers of telecommunications networks and services[16].

In this context, WIK-Consult was commissioned by Microsoft to examine the nature of the digital value chain, the usage of applications in Europe and the US and consequences for productivity and network investment. A key aim of the study is to better understand the reasons for Europe's relative weakness in ICT-driven productivity, and the role digital applications can play in supporting demand for high speed broadband as well as stimulating the European economy as a whole.

A particular focus of this study is 'enterprise cloud' services. Cloud is of interest both because of its potential to enable business transformation in other sectors in the wider economy, and because of the high bandwidths (sometimes both upstream and downstream) required for cloud services, and therefore the relevance of these services to discussions over the quality and speed of Internet infrastructure in the EU.

- Chapter 2 assesses trends in digital applications and their role within the digital value chain;
- Chapter 3 homes in on cloud computing, describing the different types of services offered and the main players in the market;
- Chapter 4 discusses the feedback gained from four interviews with current and potential users of cloud-based services;
- Chapter 5 assesses through a review of relevant literature, drivers of ICT-based productivity and the reasons for the gap between the EU and the US. It further reflects on the specific role of cloud in delivering benefits;
- Chapter 6 looks at trends in bandwidth usage, and the linkage between usage and demand for high-speed connectivity;
- Chapter 7 looks at the policy context and draws key conclusions for Europe's Digital Single Market priorities.

The analysis is based on literature reviews, data analysis and interviews with enterprises as end-users of cloud-based services.

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14 The Digital Agenda for Europe (DAE) envisages targets of full availability of 30Mbit/s broadband and take-up by 50% of the population of 100Mbit/s broadband by 2020.

15 See European Cloud Strategy.

16 See AT Kearney (2010), op. cit. and CERRE (2014), op. cit.

2 Trends in digital applications

Key findings

- A core development with the advent of the Internet has been the breakdown in the traditional telecoms value chain towards a new digital value chain that incorporates many new players, especially in digital services and applications.
- Product lifecycles in the applications segment tend to be very short compared to the diffusion of fixed telephone services (more than 100 years), and the replacement cycle for physical infrastructure (ducts and access wires) which is still measured in decades.
- Indeed, the fastest developments have come with the take-up of fixed and mobile broadband, and associated applications: Certain applications have become mainstream in 5 years or even less; reflecting the dynamism in this sector.

2.1 The digital value chain

In the past, telecommunication services were inherently linked to the underlying networks. Customers purchased a telephone connection to use telephone services provided by the network operator often with equipment supplied by the same operator[17].

A key disrupting factor in the digital age has been the breakdown of this simple tied value chain. Instead of a one-to-one relationship with an infrastructure operator, which also controls equipment and services, modern customers can use their broadband connection to access a myriad of services from content and applications providers through multiple devices; see next Figure. New value can be created without the permission, control or involvement of the network owner.[18]

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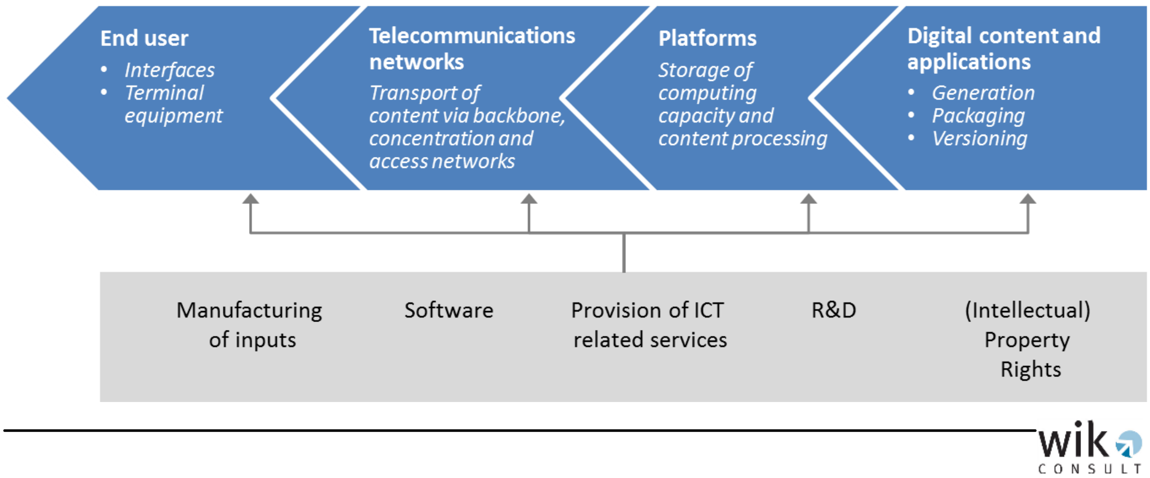
17 Traditional voice communication (and fax) requires a circuit switched network capable of providing just this service. Over time, telecommunications networks evolved enabling to transmit also “data”. But, it is fair to state that the “functions that may be added to the network are defined by the owners of the network and limited by the nature of the network.” Moreover, "...the telephone company’s value proposition is governed by the simple idea that services are added to the network’s repertoire *exclusively* (italics by Denton) by the telephone company." See Denton, T.M. (1999): Netheads vs. Bellheads - Research into Emerging Policy Issues in the Development and Deployment of Internet Protocols, Report prepared for the Canadian Federal Department of Industry.

18 See Denton (1999), op. cit.; p. 16.

Figure 3: Value chain of provision of Internet based services and applications



Source: WIK-Consult.

At the platforms and applications layer, the new value chain involves many players which were not previously associated with telecommunications in Europe, with implications for innovation, investment and competition that are discussed further in Section 4.

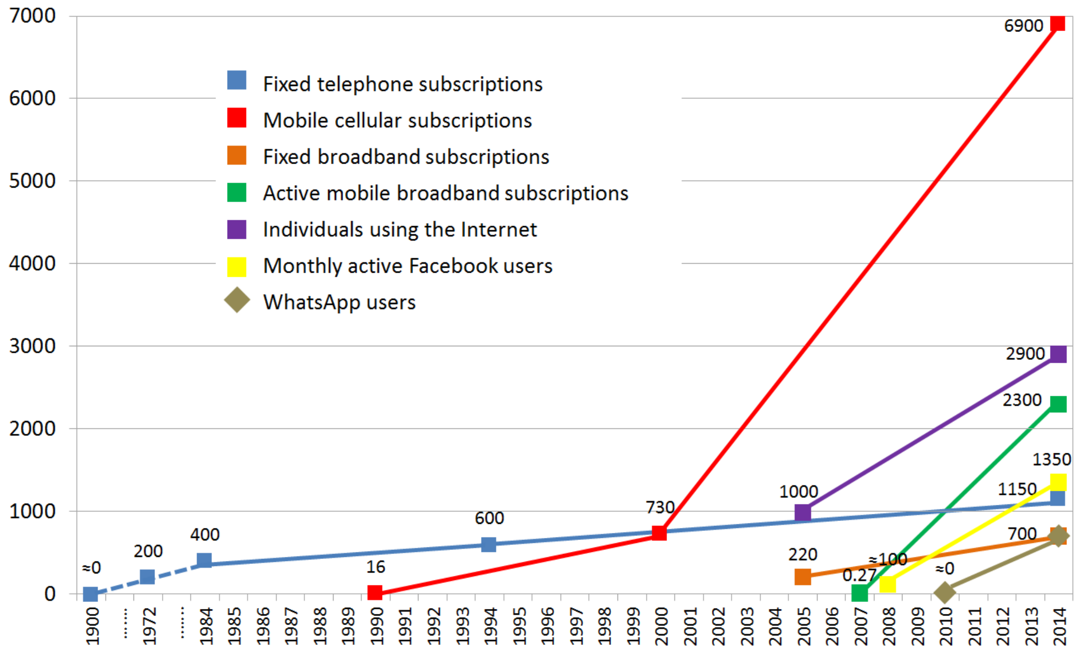
The Internet has also made proximity less relevant. While connectivity is and is likely to remain local, customers can access services provided in any location which has suitable connectivity. This means in theory that businesses can focus efforts on their core business, whilst making use of a global market for computing power, applications and content from specialized ICT providers.

2.2 Product life-cycles and innovation in the new value chain

Migration from a telecom-centric world to the digital Internet based world has provided substantial potential for innovation. The decoupling of “network” and “service provision” allows the development and provision of new ICT based applications offering significant additional capabilities compared with traditional ‘telecom’ services. For example, while plain two-way voice is still the norm for standard fixed telephone services, the Internet has brought affordable multi-way videoconferencing to a wider audience including SMEs.

Evidence for the dynamism enabled by the Internet economy comes from the faster pace of adoption and diffusion of applications at the service layer, compared with traditional telecom services, prior to the advent of the Internet. The following Figure provides a rough overview of the diffusion behaviour of different telephony and Internet based services over time.

Figure 4: Worldwide diffusion patterns of different telecommunications and Internet based services[19]



Source: WIK-Consult based on ITU statistics (http://www.itu.int/ict/statistics); http://www.statista.com/statistics/260819/number-of-monthly-active-whatsapp-users/ (WhatsApp); http://de.statista.com/statistik/daten/studie/37545/umfrage/anzahl-der-aktiven-nutzer-von-facebook/ (Facebook).

The Figure shows that POTS took more than a century to reach a level of around 1.2 bn subscribers worldwide. Cellular Mobile diffusion was already much faster: it took around 25 years to reach current level of 6.9 bn mobile subscriptions (SIM-cards) in the world.

However, the fastest developments have come with the take-up of fixed and mobile broadband, and associated applications. Fixed broadband subscriptions were introduced around 15 years ago and have reached a level of about 700 mill. subscribers today. Mobile broadband needed less than 10 years to increase from zero to the current level of 2.3 bn subscribers.

Most of the growth dynamic for Internet usage today is observable in the past decade, and may have been stimulated by the increasing diversity of applications. Facebook started in 2009 and today has more than 1.3 bn (monthly) active users. WhatsApp launched around 2010 and achieved more than 700 mill. users in four years.

19 Of course, in reality the development of each service taken into account is not linear over time, rather, it follows more or less sophisticated S-curves. The Figure aims at illuminating only (at minimum 2) different points on each diffusion curve.

In all likelihood, the future development of cloud services will become much more dynamic. Cisco predicts[20] that by 2018 53 % (2 bn) of the consumer Internet population will use personal cloud storage, up from 38 % (922 mill. users) in 2013. Globally, consumer cloud storage traffic per user will be 811 Mb. per month by 2018, compared to 186 Mb. per month in 2013.

In contrast to the fast pace of change in applications where new services can grow into global businesses within 5 years or less, the pace of renewal in the physical materials used in networks – and particularly access networks – is comparatively slow. Accounting records and cost models prepared by National Regulatory Authorities in the telecom sector (NRAs) estimate the lifetime of ducts at around 40 years, while access wires (copper and in future fibre) are estimated to have a useful life of 15 years or more.[21]

This results in a value chain in which different elements have different characteristics and business models.

20 Cisco Global Cloud Index: Forecast and Methodology, 2013-2018.

21 See e.g. the cost model the Spanish NRA (CNMC) is using; go to: http://telecos.cnmc.es/consultas-publicas/-/asset_publisher/4TGbQ55LnXPi/content/20130528_modeloscostes?redirect=http%3A%2F%2Ftelecos.cnmc.es%2Fconsultas-publicas%3Fp_p_id%3D101_INSTANCE_4TGbQ55LnXPi%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview%26p_p_col_id%3Dcolumn-3%26p_p_col_count%3D1; click: modelo di costes BU-LRIC+; and go to “Module 3 cost calculation”; then go to the sheets fi_invest_renewals, Cu_invest_renewals, ws_duct_invest_renewals.

3 The role of cloud computing

Key findings

- Cloud computing is still at an early phase of adoption in Europe, but analyst projections suggest it will become amongst the most economically significant online applications by 2018, with a value of more than $200 bn globally.
- Enterprise cloud may constitute up to 40% of total cloud volumes worldwide. Enterprises use cloud for email, file storing, office applications and supporting internal and external business processes.
- There are a large number of players in the market for cloud services globally. Some are EU-based. However, the largest cloud providers today are mostly US-based firms.
- Cloud services play a key supporting role in other digital developments, including trends towards smart devices (IoT), mobility and the processing of 'Big Data'.

3.1 What is cloud computing?

"Cloud computing", is still at a relatively early stage in the adoption path in Europe. The concept has been defined in various ways. According to the U.S. National Institute of Standards and Technology (NIST),[22] cloud computing is a means to enable ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. Examples of such computing resources are networks, servers, storage, applications, or services.

Essential characteristics of cloud computing, are:

- *On-demand self-service:* Computing capabilities, such as server time and network storage, can be provisioned and dimensioned by a customer according to their needs. This can be carried out automatically without requiring human interaction with the service provider(s) involved.
- *Broad network access:* Cloud capabilities can be accessed through standard connectivity and by means of different forms of terminal equipment such as mobile phones, tablets, laptops, and workstations.

22 This section is based on information retrieved from on the one hand National Institute of Standards and Technology (2011): The NIST Definition of Cloud Computing, NIST Special Publication 800-145, September; available at: http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf; and on the other hand of European Commission (2010): The Future of Cloud Computing, Expert Group Report, public version 1.0; available at: http://ec.europa.eu/digital-agenda/en/cloud-computing-expert-group-research.

- *Resource pooling:* Computing resources can serve multiple consumers using a multi-tenant model. This means that different physical and virtual resources are dynamically assigned and reassigned according to consumer demand. Examples of resources encompass storage, processing, memory, and network bandwidth. In general, a customer has no control or knowledge over the exact location of the provided resources. Yet, it may be possible to specify requirements e.g. as to the country and/or a specific data center.
- *Rapid elasticity:* Computing capabilities can be provisioned and released elastically, often automatically. Thus, a rapid scaling in accordance with demand is possible. From the customer perspective, capabilities appear to be available in any quantity at any time, usually without limitation.
- *Measured service:* Resource usage within cloud systems can be monitored, controlled, and reported, providing transparency for both the provider and customer of the utilized service. Resource use is automatically controlled and optimized. Metering is carried out depending on the type of the specific service demanded (e.g. storage, processing, bandwidth); it is often based on a pay-per-use basis.

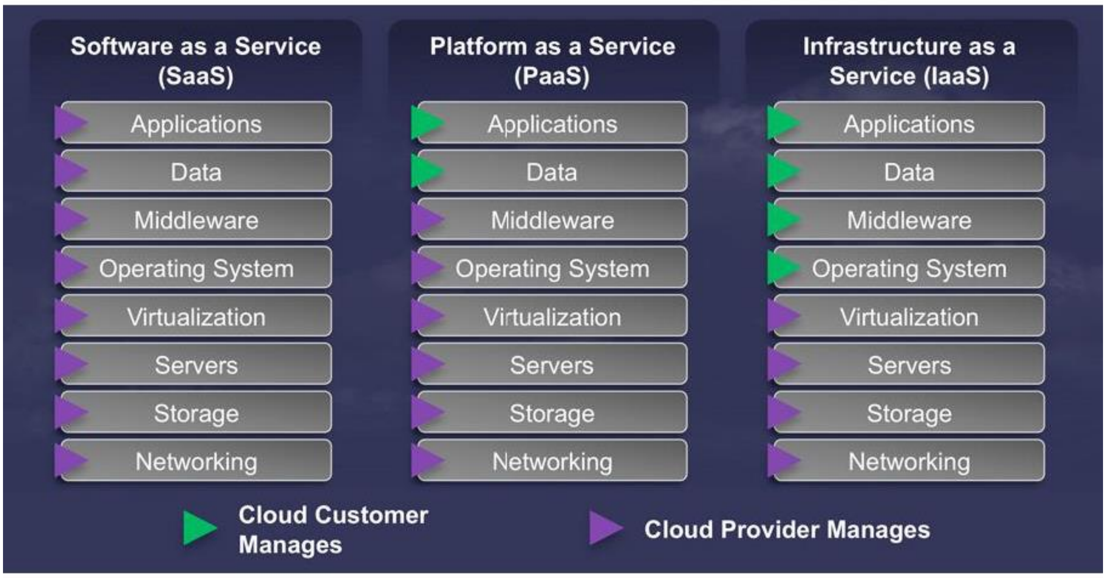
Cloud systems can provide different kinds of capabilities. It is common to distinguish the following three different service models of cloud computing.

- *Software as a Service (SaaS):* In this case, specific business functions and processes are offered to customers through standard applications running on cloud infrastructure.
- *Platform as a Service (PaaS)***:** In this case, computational resources are provided to the consumer via a platform on which consumer-created or acquired applications and services can be developed and hosted. The customer may use programming languages, libraries, services, and tools supported by the provider to develop their own applications.
- *Infrastructure as a Service (IaaS)):* The services delivered to the user are (managed and scalable) resources providing enhanced virtualisation capabilities. Examples are "Data and Storage Clouds" providing reliable access to data of potentially dynamic size or "Compute Clouds" providing access to computational resources (CPUs).[23]

The division of labour between the cloud customer and the cloud provider across these three types of cloud service models is visualized in the following Figure.

23 To put it another way: "Infrastructure as a Service (IaaS) is a form of cloud computing that provides virtualized computing resources over the Internet. In an IaaS model, a third-party provider hosts hardware, software, servers, storage and other infrastructure components on behalf of its users. IaaS providers also host users' applications and handle tasks including system maintenance, backup and resiliency planning. IaaS platforms offer highly scalable resources that can be adjusted on-demand." See http://searchcloudcomputing.techtarget.com/definition/Infrastructure-as-a-Service-IaaS.

Figure 5: Management sovereignty of cloud customers and cloud providers regarding key elements of SaaS, PaaS, and IaaS solutions



Source: Cisco Global Cloud Index 2013-2018.

Overall, the cloud infrastructure can be provided in different settings distinguished by the specific entities having usage rights:

- In a *private cloud* the infrastructure is provisioned for exclusive use by a single organization comprising multiple users (e.g. business units)[24].
- In a *community cloud,* the infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns.[25]
- In a *public cloud* the infrastructure is provisioned for open use by the general public.[26]
- *A hybrid cloud* is a composition of two or more distinct cloud infrastructures (private, community, or public).[27]

24 It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.

25 It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.

26 It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.

27 The cloud infrastructures remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability. An example is cloud bursting for load balancing between clouds.

Many consumers and businesses have already used ‘cloud computing’ without knowing it. For example, online email services involve centralised storage. Other, growing usages for cloud include storing and/or sharing digital content. Indeed, the Eurostat evaluation on the use of cloud services[28] comes to the conclusion that photos currently are the most popular type of file for storing or sharing via cloud services. Among those who used internet storage space, 82 % saved or shared photos whilst 54 % reported saving or sharing text documents, spreadsheets or electronic presentations. Around a third of EU cloud users saved or shared music, a quarter video files and one in seven e-books.

A survey carried out by Talkin’ Cloud[29] identified the most commonly offered SaaS-based cloud services of the companies queried as ‘Backup/Disaster Recovery’ (70%), ‘Email’ (69%), ‘Email Security’ (62%) and ‘Storage’ (62%). Other services mentioned were ‘Collaboration’ (hosted SharePoint, etc.); ‘Security’; ‘Network Operation Center/Service Desk’; ‘Virtual desktop infrastructure (VDI)’; ‘File sharing, syncing (Box, Dropbox)’; ‘Desktop as a Service’; ‘Mobile Device/App Management’; ‘Endpoint Security’; ‘VoIP/unified communications’; and Customer Relationship Management (CRM).

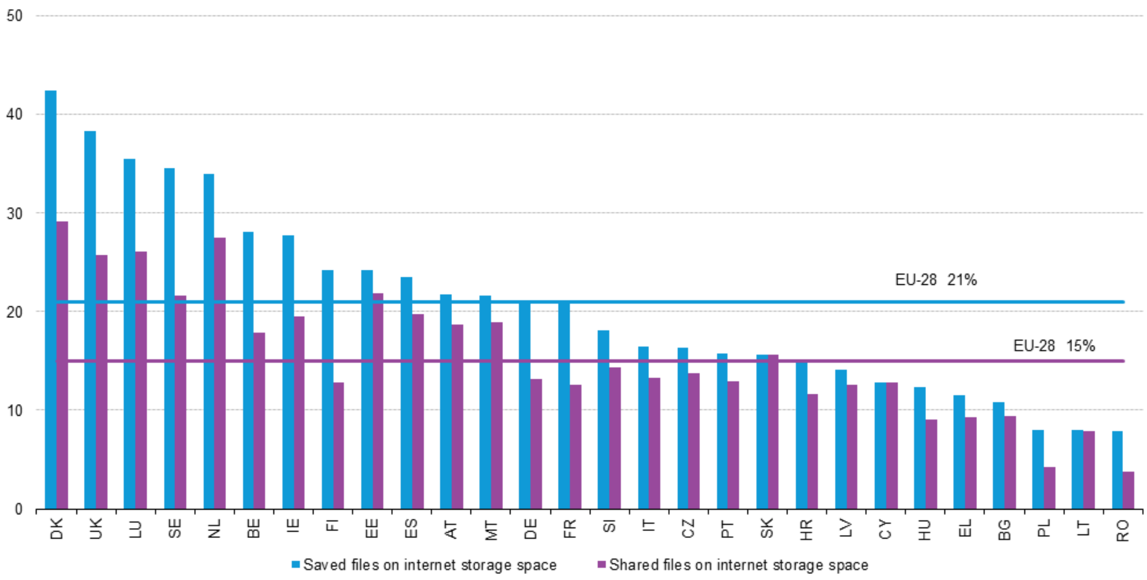
3.2 Use of cloud services

Residential use

As to cloud based services Eurostat data shows[30] (see next Figure) that in 2014 on average one in five individuals (21 % of the EU population aged 16-74) reported having used internet storage space to save documents, pictures, music, videos or other files. Moreover, the percentage of individuals in the EU who additionally used internet storage space for sharing files was 15 %.

28 See Eurostat: Internet and cloud services, op. cit.
29 Talkin’ Cloud (2014): Top 100 Cloud Services Providers, 2014 edition; available at: http://talkincloud.com/TC100/datasheet/2014-talkin-cloud-100-report. The Talkin’ Cloud 100 ranks cloud services providers, cloud aggregators, cloud brokers, VARs and MSPs based on a survey that ran from January through May, 2014. Overall, the 100 companies generated $23.4 billion in 2013 recurring cloud services revenue.
30 See Eurostat: Internet and cloud services - statistics on the use by individuals; available at: http://ec.europa.eu/eurostat/statistics-explained/index.php/Internet_and_cloud_services_-_statistics_on_the_use_by_individuals.

Figure 6: Use of internet storage space for saving and sharing files, 2014 (% of individuals), EU 28



Source: Eurostat: Internet and cloud services, op. cit.

The Figure shows that Denmark (42 %), United Kingdom (38 %), Luxembourg and Sweden (35 %) and the Netherlands (34 %) account for the highest proportion of individuals using cloud services for saving files. The same countries, plus Estonia, also registered the highest levels of usage of cloud services for sharing files (between 22 % and 29 %).

Business use

Eurostat also provides information on the use of cloud computing by enterprises.[31] The next Figure shows that on average 19 % of EU enterprises used cloud computing in 2014.

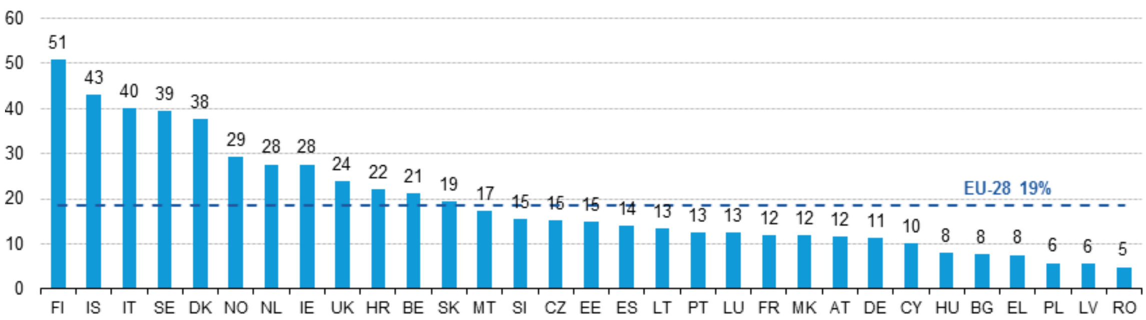
Eurostat furthermore concludes:

- Enterprises use cloud computing mostly for hosting their e-mail systems and storing files in electronic form.
- 46 % of the firms used advanced cloud services relating to financial and accounting software applications, customer relationship management or to the use of computing power to run business applications.

31 See http://ec.europa.eu/eurostat/statistics-explained/index.php/Cloud_computing_-_statistics_on_the_use_by_enterprises.

- In 2014, almost twice as many firms used public cloud servers (12 %) as private cloud servers (7 %), i.e. infrastructure for their exclusive use.
- 42 % of those *not* using the cloud reported insufficient knowledge of cloud computing as the main factor that prevented them from using it.

Figure 7: Use of cloud computing services, 2014 (% of enterprises)



Source: http://ec.europa.eu/eurostat/statistics-explained/index.php/Cloud_computing_-_statistics_on_the_use_by_enterprises.

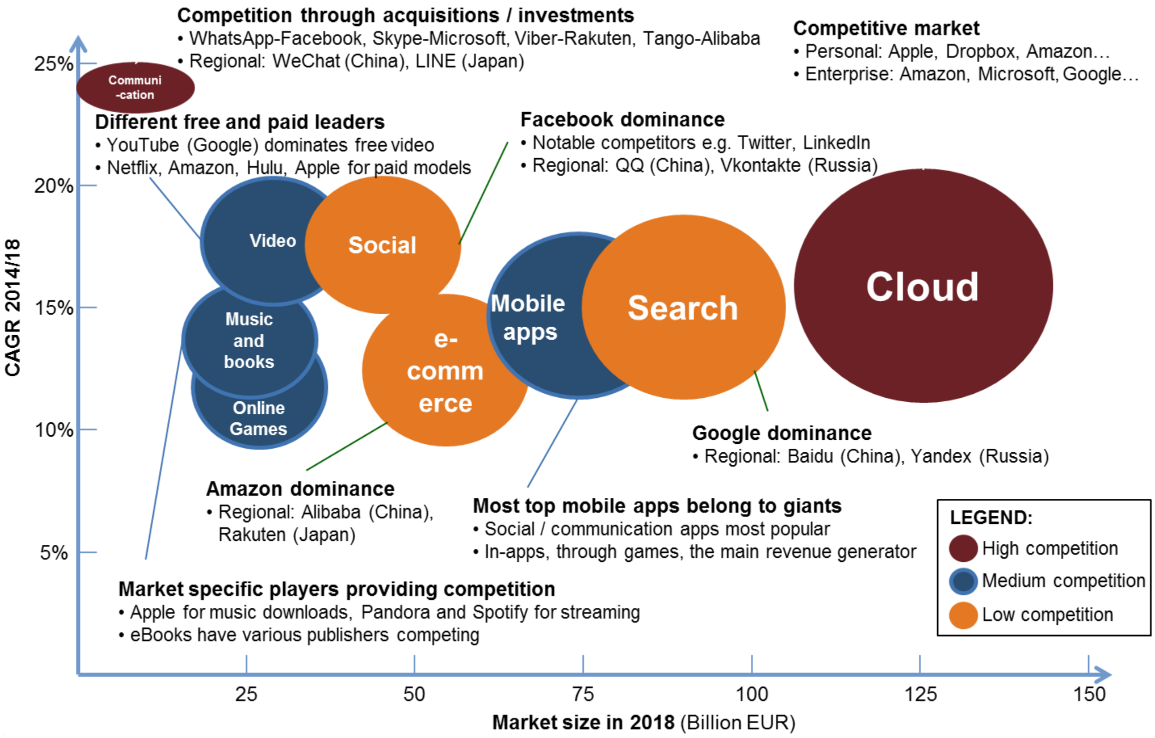
3.3 The cloud-services market

Market size

Data on market size is widely available only for public cloud services, as private cloud is often provided as part of wider bespoke services. Estimates on the value of the cloud market vary but most sources project a value well in excess of €100 bn within the next 5 years.

Projections made by IDATE (see figure below) suggest that cloud services are likely to play a leading role in the online economy in the coming years, potentially overtaking search to reach a value of €125 bn by 2018.

Figure 8: Online services and applications: Market size in 2018 (bn Euro), CAGR 2014-2018 and degree of competition

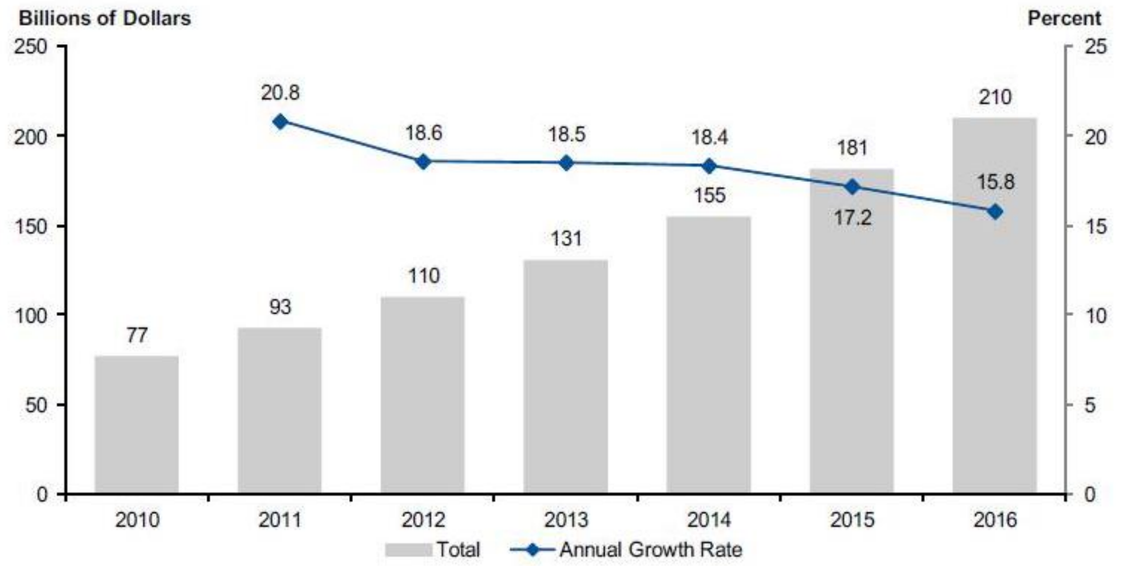


Source: IDATE (2014): State of Internet services worldwide, December.

Gartner has predicted in 2013 that global spending on public cloud services will grow from $76.9 bn in 2010 to $210 bn in 2016, achieving a CAGR of 17.7% from 2011 through 2016; see next Figure.[32]

32 Gartner has slightly lowered the numbers shown in the Figure in an update published in Q3_2014: The growth rate in 2014 is calculated as 17.9% and the total market size as $153 bn. The five-year CAGR through 2018 is expected to equal 17.1%.

Figure 9: Public cloud service market and annual growth rate, 2010 – 2016

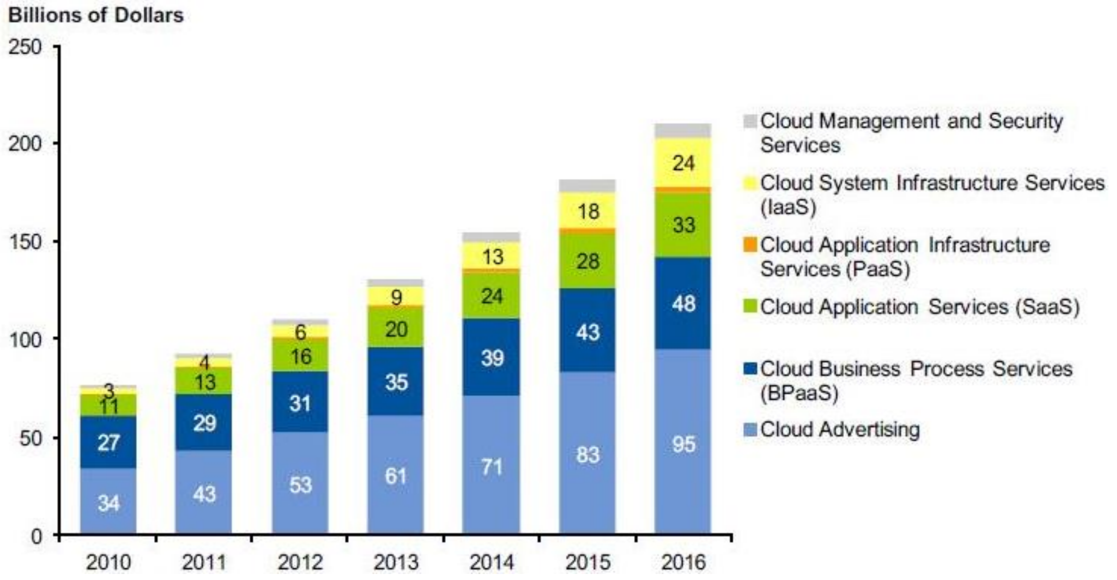


Source: Gartner; Forecast Overview: Public Cloud Services, Worldwide, 2011-2016, 4Q12 Update Published: 8 February 2013.

The Gartner figures for the public cloud market include SaaS, PaaS, and IaaS services and incorporate cloud management and security services, cloud business process services, and cloud advertising[33]. The following Figure provides an overview of the expected development of the relative size of these different services in the period 2010-2016.

33 Cloud advertising are cloud-based services that support the selection, transaction and delivery of advertising and ad-related data in which content and price are determined at the time of end-user access, usually by an auction mechanism that matches bidders with advertising impressions as they become available. This applies to search, display, mobile, social and video ad formats.

Figure 10: Public cloud service market by segments, 2010 – 2016



Source: Gartner; Forecast Overview: Public Cloud Services, Worldwide, 2011-2016, 4Q12 Update Published: 8 February 2013.

The Figure shows that Gartner expects cloud advertising services to account for the biggest share in the public cloud service market, followed by cloud business process services. The market volume of SaaS and IaaS services, respectively, is expected to be considerably lower. However, Gartner predicts that IaaS will be the fastest growing area of public cloud computing with a five-year CAGR of 31.7% through 2018.[34]

The importance of business process support confirms the significance of cloud to enterprises. The Cisco Global Cloud Index, 2014, puts business usage of cloud (in terms of traffic) at more than 40% of total volumes by bandwidth, see the following Table.

34 Contrary to these findings, Forrester expects SaaS services to account for a much higher market volume: roughly $36 bn already in 2013 and more than $100 bn in 2010. See http://www.zdnet.com/article/forrester-public-cloud-market-will-reach-191b-by-2020/.

Table 1: Cloud IP traffic by segment, 2013-2018

Cloud IP Traffic, 2013–2018							
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**CAGR 2013–2018**
By Segment (EB per Year)							
Consumer	979	1,398	1,914	2,555	3,331	4,288	34%
Business	669	880	1,136	1,438	1,800	2,208	27%
Total (EB per Year)							
Total cloud traffic	1,647	2,277	3,050	3,994	5,131	6,496	32%

Source: Cisco (2014): Global Cloud Index, Forecast and Methodology, 2013–2018; available at: http://www.cisco.com/c/en/us/solutions/collateral/service-provider/global-cloud-index-gci/Cloud_Index_White_Paper.pdf.

INSEAD[35] research also confirms the economic significance of enterprise cloud. Globally, INSEAD expects that the percentage of total ICT budgets dedicated to cloud-based services will increase from 11% to 26%. In Europe, INSEAD expects the average investment in cloud as a percentage of the total ICT budget will almost double from 12% to 23%.

In a 2012 study for the European Commission, IDC[36] concludes that cloud computing, mobile devices and apps, social technologies, Big Data analytics in 2012 represented around 20% of global IT spending, but that this spending would grow 6 times faster than traditional IT and would represent 80% of the market by 2020.

The study underlines that many businesses are already using cloud services of some kind. However, it also concludes that cloud adoption is not even across firms with different sizes. Rather, micro-SMEs lag (substantially) behind in cloud adoption.

Suppliers of cloud computing

The IDATE study notes that cloud services are provided to consumers and businesses in a competitive market. There are several information sources that try to identify the key suppliers in the cloud computing markets. The following Table summarizes results from Talkin' Cloud[37].

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35 INSEAD (2013): Building Competitiveness and Business Performance with ICT – How investments in new technologies can make companies more competitive; available at: http://www.google.de/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCEQFjAA&url=http%3A%2F%2Fec.europa.eu%2Finformation_society%2Fnewsroom%2Fcf%2F%2Fdocument.cfm%3Fdoc_id%3D1665&ei=dEuIVMb2HsbWPP2agYAO&usg=AFQjCNHnNUf4BouVjZG70eTeKGs9oE5wyQ&bvm=bv.81456516,d.ZWU.

36 IDC (2012): Quantitative Estimates of the Demand for Cloud Computing in Europe and the Likely Barriers to Up-take; Final Report; study conducted on behalf of the European Commission; July 13; available at: http://ec.europa.eu/digital-agenda/futurium/en/content/quantitative-estimates-demand-cloud-computing-europe-and-likely-barriers-take.

37 Talkin' Cloud (2014): Top 100 Cloud Services Providers, 2014 edition; available at: http://talkincloud.com/TC100/datasheet/2014-talkin-cloud-100-report. The Talkin' Cloud 100 ranks cloud services providers, cloud aggregators, cloud brokers, VARs and MSPs based on a survey that ran from January through May, 2014. Overall, the 100 companies generated $23.4 billion in 2013 recurring cloud services revenue.

Table 2: Key players in the cloud computing markets

Rank	Talkin Cloud's list of 'Top 20 Cloud Service Providers'; home location
1	IBM (Blue Cloud); USA
2	Salesforce.com (SaaS – CRM); USA
3	Amazon (Amazon Web Services – AWS); USA
4	Microsoft (PaaS – Azure); USA
5	Oracle (cloud IaaS); USA
6	SAP; Germany
7	Google (SaaS, PaaS); USA
8	Citrix Systems; USA
9	Workday; USA
10	Rackspace (IaaS); USA
11	NetSuite; USA
12	Arkadin; USA
13	DropBox; USA
14	D+H; USA
15	LogMeIn; USA
16	Claranet Ltd.; UK
17	Intermedia; USA
18	Computer Services, USA
19	Carbonite; USA
20	Iomart Group plc; UK

Source: WIK-Consult based on Talkin' Cloud (2014), op. cit.

Another data source, Transparency Market Research, identifies the "current cloud computing services market leaders who are defining the growth path"[38] to be

- Amazon (Amazon Web Services – AWS), USA,
- Google (SaaS, PaaS), USA,
- VMware (vCloud), USA,
- Rackspace (IaaS), USA,
- Salesforce.com (SaaS – CRM), USA,
- Microsoft (PaaS – Azure), USA,
- Joyent (3*aaS), USA,
- IBM (Blue Cloud), USA,
- Net Suite (SaaS - SuitCloud), USA,
- 3Tera (CloudWare), USA.

38 See Transparency Market Research; Cloud Computing Services Market - Global Industry Size, Share, Trends, Analysis and Forecasts 2012 – 2018; available at: http://www.transparencymarketresearch.com/cloud-computing-services-market.html.

Moreover, Transparency Market Research identifies newcomers in the market to be e.g. Enomaly (services to cloud providers), GoGrid (IaaS), and AT&T.

These two information sources are only partly consistent as to the key players. However, the table does consistently identify that the primary players in the cloud services market are companies headquartered in the USA:

- the Transparency Research list exclusively contains U.S. based companies;
- the Talkin' Cloud list includes 1 non-U.S.company among the top 10 companies (SAP, Germany) and another 2 companies from the UK (Claranet, iomart Group) among companies ranked 11-20. Out of the companies ranked as 21-100 15 companies are not headquartered in the U.S. (5 from the UK; 3 from Canada and Australia, respectively; 1 from Colombia, Germany, Norway, and Spain, respectively).

The following Figure provides Gartner's assessment of the key players specifically in the IaaS market. The Figure also assesses their completeness of vision (x-axis) and their ability to execute (y-axis). Apparently, Amazon Web Services and Microsoft are the clear leaders in this field.

Figure 11: Gartner Magic Quadrant for Cloud Infrastructure as a Service

Source: Gartner (May 2014) Magic Quadrant for Cloud Infrastructure as a Service.

3.4 Cloud as an enabler for other services

An important aspect when looking at cloud services is the role cloud plays in supporting other technological and commercial developments in the ICT value chain, including the 'Internet of Things' (IoT), Machine to Machine communications (M2M) and 'Big Data', each of which are significant developments in their own right.

The International Telecommunication Union (ITU) first described IoT in its 2005 report[39] as "*a technological revolution that represents the future of computing and communications… its development depends on dynamic technical innovation in a number of important fields, from wireless sensors to nanotechnology.*" The ITU explained that the combination of developments in four main areas - item identification, data collection, power of the network, and miniaturization - was about to create an Internet of Things that connects the world's objects in a sensory and intelligent manner. Since then as IoT has evolved, further definitions have emerged. For example, the IERC (European Research Cluster on the Internet of Things) describes IoT as "a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual "things" have identities, physical attributes, and virtual personalities and use intelligent interfaces, and are seamlessly integrated into the information network."[40]

IoT encompasses Machine to Machine communication (M2M), which "describes devices that are connected to the Internet, using a variety of fixed and wireless networks and communicate with each other and the wider world. They are active communication devices." [41]

There are various estimates about the future adoption and diffusion of smart devices. Cisco e.g. projects that out of 20 bn connected devices in 2018, 35% will be based on M2M; see next Figure.

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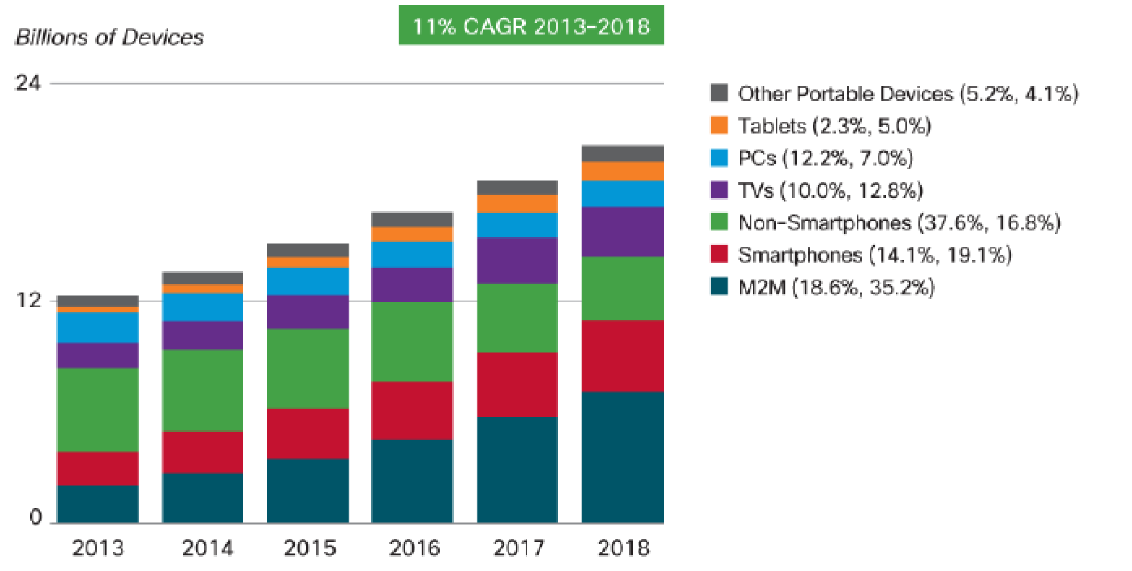
39 See http://www.itu.int/osg/spu/publications/internetofthings/InternetofThings_summary.pdf.
40 See http://www.internet-of-things-research.eu/about_iot.htm.
41 See OECD (2012): Machine-to-Machine Communications: Connecting Billions of Devices", OECD Digital Economy Papers, No. 192, OECD Publishing; available at: http://dx.doi.org/10.1787/5k9gsh2gp043-en.

Figure 12: Global Devices and Connections Growth[42]



Source: Cisco (2014): VNI Service Adoption Forecast, 2013–2018, White Paper; available at: http://www.cisco.com/c/en/us/solutions/collateral/service-provider/vni-service-adoption-forecast/Cisco_VNI_SA_Forecast_WP.pdf.

Other forecasts are much higher; Ericsson e.g. projects 50 bn smart devices by 2020.[43]

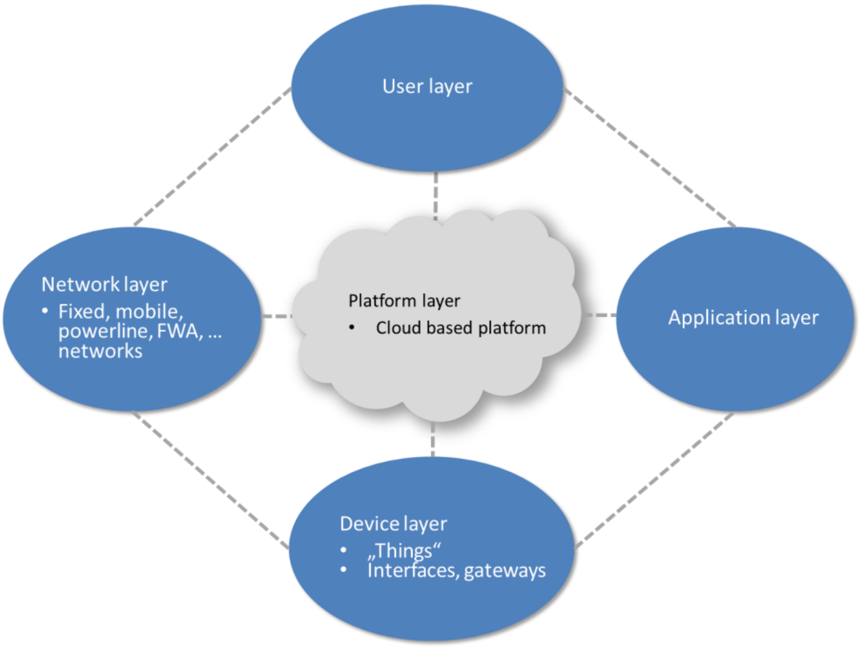
As to “big data” Gartner terms it as “high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision-making”.[44] Indeed, companies today are able to bundle data collected from their internal CRM and ERP[45] systems, respectively, with data from external data sources like e.g. web services. The rationale is an intelligent combination of the different data strands in order to set up a comprehensive data pool which enables analysis and interpretation of information about customers and products, brands, markets and competitors, processes and systems. This structured big amount of data might in turn be “translated” into new processes, applications and services which can be used both internally within the company but also externally e.g. with respect to B2C and/or B2B processes. Such a collection of “big data” is increasingly carried out across all economic sectors and irrespective of the size of the companies.

Overall, it is increasingly recognized that there will be an expanded role for cloud computing in this connected ecosystem in which the cloud acts as an intelligent hub, gathering and processing data from various sources including connected (and often

42 The percentages in parantheses next to the legend denote the device share for 2013 and 2018, respectively.
43 See the discussion in OECD (2012), p. 8, why the figures are varying that much.
44 See http://www.gartner.com/it-glossary/big-data/.
45 CRM denotes “Customer Relationship Management; ERP denotes “Enterprise Resource Planning”.

mobile) devices as well as from CRM and ERP systems, which are increasingly being migrated to the cloud. This is visualized in the next Figure.

Figure 13: Cloud computing as the basis of the connected ecosystem (stylized facts)



Source: WIK-Consult.

The Figure shows the main (functional) elements of the likely future connected ecosystem:

- *Device layer*: „Things“ able to collect data; the device layer also includes interfaces and gateways with specific capabilities;
- *Network layer*: Communications network infrastructures (fixed, mobile, powerline, FWA, …) with specific networking and transport capabilities;
- *User layer*: Entities in charge of the devices, systems etc. by which data are collected; examples are companies with their production facilities, CRM and ERP systems, B2C and B2B processes, etc.; automobile companies collecting data from the smart cars used by their customers; utilities managing drains via specific sensors; entities collecting data from smart meters; entities collecting data via devices monitoring a medical patient; etc.
- *Application layer*: the myriad of applications that might be provided via the connected ecosystem.
- *Platform layer*: a cloud based platform providing for service and application support, business operation support, APIs, central processing capabilities, data analytics, etc.

The OECD argues that the inherent need for ‘things’ to transmit data anytime, anywhere to a central processing facility is likely to be a major driver of cloud usage. If M2M communication is combined with the logic of cloud services, remote operation and interaction then a multitude of applications become “smart”. If devices are able to communicate e.g. status and information, this can be aggregated, enriched and communicated internally or onwards to other units. This in turn allows the use of and analysis of these data in new and useful ways.[46] Thus cloud services offer also and in particular the means for IoT to contribute to ‘Big Data’ developments.

Likewise Cisco[47] notes that “cloud-based services are essential for most IoE (Internet of Everything) applications”, and that the “rapid growth in the adoption of multiple devices by end-users, consumers and businesses is a major factor in the transition to cloud-based services that can provide ubiquitous access to content and applications through any device at any location.”

More specifically, cloud is likely to play a role in the shift towards ICT-enabled industrial production (sometimes termed „industry 4.0“)[48]. In this modernized environment, real time data may be collected at numerous places providing an image of the real physical world which is then processed via cloud-based services in order to use it e.g. for autonomous control processes.

There are a multitude of examples in which cloud, IoT and big data may support traditional industries and public services including health (e.g. healthcare monitoring), energy (e.g. smart meters), cars/mobility (e.g. onboard computer of an automobile as part of the traction control system to tell cities where the roads are slippery), transportation (e.g. package and asset tracking) and smart cities (e.g. video surveillance), etc..

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46 See OECD (2012); op. cit.; p. 7-8.
47 Cisco Cloud Index White Paper (2014).
48 See e.g German National IT-Summit (2012): Machine-to Machine communication – A chance for the German industry (in German); available at: https://www.it-gipfel.de/IT-Gipfel/Redaktion/PDF/it-gipfel-2012-machine-to-machine-kommunikation-eine-chance-fuer-die-deutsche-industrie-ag-2-m2m-initiative-deutschland,property=pdf,bereich=itgipfel,sprache=de,rwb=true.pdf.

4 Customer case studies in cloud computing

Key findings

- A key reason given by corporate end-users for using cloud services is the ability it gives them to *focus on their core (often non-IT) business*, while enabling cloud providers as IT specialists to focus on their area of expertise, and accelerate innovation in that field.
- Speed and flexibility are cited as core cloud benefits. Some interviewees noted that the ability to switch services on and off supported them in expanding their business in Europe and elsewhere.
- One of the interviewed companies has adopted cloud solutions to support its IoT strategy. Another interviewee is not using cloud for IoT currently, but continues to review costs.
- The interviewed companies have not found bandwidth availability in Europe to be a constraining factor for cloud uptake and usage. Although some companies required additional bandwidth for cloud, they found this was available at a reasonable price.
- Concerns around security and privacy were noted by all interviewees, and were the main barrier to cloud uptake in the organisation yet to migrate to cloud.

In order to better understand the role played by cloud computing within European industry and the public sector, we conducted interviews with four businesses making use of or considering migrating to the cloud. Interviewees were selected based on an approach to the International Telecommunications User Group (INTUG) and volunteered to take part in this exercise. The organisations each differ in scale and business models, as shown in Table 3.

Table 3: End-user interviews – company details

	TomTom	CocaCola Europe	TVH	Syntra
Business	Navigation solutions	Marketing	Distributor of industrial spare parts, rental of industrial equipment	Regional Government agency - training
Headquarters	Netherlands	US	Belgium	Belgium
Turnover	€950bn (>50% EU)	€47 bn globally	~€1 bn (two thirds in Europe)	€140 mill.
Cloud usage	CRM, software testing – plans to migrate communication and collaboration	'Cloud first' strategy – 70% applications, including Office	Extensive. E-invoicing, Collaboration, marketing, technical library, IoT and data processing	None as yet – exploratory phase

Source: WIK-Consult.

Based on interview questions shown in Annex I, the four organisations were asked about their usage of cloud, the benefits and disadvantages they experienced from cloud use, and its impact on their demand for bandwidth. Lastly, they were asked what were the main barriers to expanding cloud usage. A complete transcript of the interviews is shown in Annex II. A summary of their responses to each of the questions follows.

4.1 Reasons for using the cloud

Although cost-reductions were cited as the main potential benefit of cloud-use by Syntra, a regional Government agency that is considering, but has not yet adopted cloud solutions, the companies that have had experience in using cloud over several years cite other benefits as being as if not more important.

A common response amongst interviewees was that they relied on cloud for IT partly in order to be able to *focus on their own core business*. For example TomTom's VP for Infrastructure Services noted that "freeing up resources that were used for internal IT could allow headcount to be shifted to real production". Kalman Tiboldi, Chief Business Innovation Officer at TVH similarly noted that "Many functions of IT can seen as a commodity and cloud helps it to be a commodity", while Laurent Bonherbe, Technology Platform Director at Coca Cola Europe observed that "We are not in the business of designing software or managing infrastructure. We want to focus on what we do best, which is to put our service in front of internal and external users."

A further advantage of outsourcing IT to IT specialists was the potential for cloud providers to innovate on behalf of their clients. For example, Mr Bovijn noted that as IT was the core business of cloud providers, they could 'aggregate' requests from clients and innovate to deliver on customer needs faster and more cheaply. Mr Bonherbe noted that as the applications landscape is moving all the time, cloud helps to reduce engineering cycles, making life faster."

Another benefit experienced by TomTom was speed and flexibility. Mr Bovijn noted that it was easier for his business to establish operations in a new country using infrastructure in the cloud as "people can start working immediately". Equally, capacity could just as easily be 'switched-off' if the business did not work out. Kalman Tiboldi, of TVH also cited the 'flexibility and availability' as a key benefit of cloud in supporting a growing business. The increasing relevance of applications, had also allowed business-people (rather than just IT-people) to be become more directly involved in choosing solutions which increased productivity, according to Mr Tiboldi.

Being able to hire infrastructure by the hour was also cost-effective for applications requiring peak capacity – such as stress-testing, according to TomTom, while Mr Bonherbe from Coca Cola also cited 'paying for what you use' as reducing costs.

In addition to cost-saving, Mr Bonherbe from Coca Cola found that one important business advantage they gained from moving to their chosen cloud-based solution was greater service reliability. "As a communication-oriented organisation, email outage was one of the biggest problems that could happen in this company, and it was frequent – around once every 2 months," he says. Following migration to the cloud-model, outages were markedly reduced.

The ability of cloud to support a 'multi-device' model was also considered an advantage by TomTom, while Mr Tiboldi noted that 'mobility was another business requirement that has been supported by the cloud". The cloud has enabled TVH's technical library to be mirrored across the world, giving ready access wherever they need it. Mr Bonherbe also noted the advantage in being able to use a multitude of different mobile devices after moving to a cloud-based platform.

4.2 Case studies in cloud as an enabler of the Internet of Things

A particularly interesting application of cloud computing was its use to support Machine to Machine communications and the processing of 'Big data'. A particularly interesting aspect of TVH's cloud usage is its use of the cloud to collect and process data from more than 5,000 connected vehicles and other equipment such as fork-lift trucks – leased through the rental business.

Kalman explains: "Our equipment is able to produce a tremendous volume of data. We want to use that to achieve more efficient fleet management. One of the most exciting goals is moving from corrective maintenance to predictive maintenance, where we maintain our vehicles based on need, and can understand immediately if things go wrong. The equipment used for the Internet of Things does not itself have the capacity for storage and computing – so this is where the cloud comes in."

TomTom is also highly active in the growing field of M2M. TomTom creates traffic profiles by gathering anonymised data from more than 70m mobile devices and analysing how fast devices are moving in order to estimate traffic patterns. “Each second we receive millions of entries, which allows us to process the data in real-time,” explains Mt Bovijn. However, TomTom has chosen not to pursue cloud strategies for M2M at this time, largely for cost reasons, he explains. “Because this is a process that never stops, it makes more sense for us currently to use our own data centre. If we paid on a usage-basis, it would cost a lot more.” Ronny notes however that TomTom keeps their IT support constantly under review and that the decision could change if cloud prices keep falling.

4.3 Main challenges with cloud

Although feedback from the three companies using cloud services was broadly positive, they noted some technical challenges associated with the cloud migration. A challenge noted by all companies was ‘loss of control’. Mr Bovijn of TomTom observed that this could cause issues with troubleshooting, and called for more transparency from cloud providers in this respect.

Another common theme amongst respondents was the requirement when migrating to cloud to ‘standardise’ services. This was seen both as a challenge, and once initial hurdles had been overcome, as an advantage. For example, Mr Bonherbe notes that “Losing control and the ability to tailor to our exact needs was difficult at first. We had become complacent about customisation, and used to love to change stuff. However, the consequence was that – pre-cloud – our systems had become complex and costly to maintain. We discovered that despite short term difficulties the benefit of cloud-based services was that it simplified and standardised applications and forced us to adapt to a simpler more consistent mode of operation.”

Nonetheless, Mr Bovijn noted as a remaining disadvantage that he had lost some functionality after moving to a cloud-based solution, as systems were no longer as closely integrated with each other as they had been previously.

4.4 Impact of cloud on bandwidth demand

Interestingly, companies responded differently to questions about the impact of cloud on their bandwidth consumption and willingness to pay for broadband connectivity. While two companies observed increased demands for capacity, another expected that technological developments might counteract the need to expand bandwidth significantly.

TVH has seen increasing demand for fixed and especially mobile capacity, the latter driven by IoT, which can generate as much as 200 Terrabytes per year for the company. “The Internet is critical for our company,” says Mr Tiboldi. “85% of our daily commerce goes through Internet, We have a good SLA for service availability from Google, but if my Internet provider is down, I don’t have any cloud.” In order to address these issues, TVH is investing in capacity – building up three different Internet paths and pursuing ‘local Internet break-out’ solutions so that each corporate centre has a direct connection. Mr Tiboldi notes that “having good capacity and availability for the Internet has become very important. Every single company would be ready to pay money to have those elements.”

Similarly Coca-Cola Europe found that one of the biggest side-effects of the adoption of cloud was increased demand for bandwidth. Coca-Cola responded by significantly increasing its Internet connectivity bandwidth by up to 5 times, while aiming to maintain a relatively flat budget. On the positive side, it found that Internet bandwidth in Europe was both available and relatively cheap. This view was echoed by Syntra which considered that although there were other barriers to cloud-uptake, bandwidth was not one of them.

Conversely, Mr Bovijn at TomTom considers that despite the company’s increased cloud focus, it is likely to have a neutral effect on TomTom’s demand for bandwidth, unless significant new applications emerged. Mr Bovijn noted that “A 1G switch is cheaper than a 100M switch of 10 years ago. In the past VoIP required >300Kbit/s, but new technology means it now requires fractions of that speed. Demand and new technology will balance out,” he concludes. “So fears that cloud will ‘overwhelm’ telecommunications operators’ networks may be overblown.”

One area however on which all three companies agree is that increasing use of public cloud has changed the nature of their demand for connectivity. Whereas in the past, most attention (and budget) went towards secure MPLS networks to support connectivity between corporate sites, increasingly companies are able to save costs by moving towards hybrid structures in which some services are provided over the Internet.

4.5 Barriers to cloud uptake and potential solutions

The four interviewees were very consistent as regards their views on which were the main barriers preventing further cloud uptake in the EU. Security and data protection issues were the over-riding concerns. Mr Bovijn noted that “in some situations we are not allowed to export map data to be processed elsewhere”. He called for action to align policies so that all personal-related and other information could be held anywhere in the EU. Mr Bonherbe concurred that it would be better to have a harmonised approach to data protection.

Mr Bovijn noted that there was often a lack of transparency about how cloud-based data was secured. He encouraged cloud providers to offer greater disclosure, to enable customers to have a better view of the risks. Mr Tiboldi of TVH has a similar perspective. “You have the feeling that being surveyed is easier to do in cloud than in your own data centre,” he said. “If you let security concerns govern your decisions, you cannot take full advantage of the cloud”. Privacy and security are two areas which Mr Tiboldi considers could benefit from the attention of policy-makers. This is also an area which is highlighted by Syntra, the regional Government agency which has yet to make full use of cloud services, in large part due to their concerns over security and privacy. Syntra would like to see guidance on where data is stored and the jurisdiction over that data. They would also appreciate action from cloud provider to offer ring-fenced European services and to make greater commitments around security.

Another area in which Mr Tiboldi would like to see policy leadership is in enabling IoT to be able to communicate with cloud in a more efficient and cost-effective way. These are not traditional ‘broadband’ questions, but rather how to enable cost-effective mobile narrowband communication for billions of connected devices.

Mr Tiboldi also highlights concerns about compatability between different cloud providers and challenges integrating in-house with cloud-based systems. He would welcome further standardization efforts within t he industry.

Lastly, Syntra highlights an important issue that has more to do with people than policies. A key challenge for them as a small organization which has not yet migrated to the cloud is the need to train their staff and communicate with them about changes in software.

5 Economic impacts of cloud and other digital applications

Key findings

- *Europe lags the US in ICT-driven productivity growth.* Estimates suggest that ICT has contributed around twice as much to US productivity labour growth as the EU.
- A core reason is Europe's failure to achieve ICT diffusion across the wider economy. Differences in capital do not seem to explain the gap in themselves.
- IDC estimates suggest cloud could contribute up to €957 bn to the European economy by 2020, but these benefits depend on achieving effective uptake and diffusion of cloud services in Europe. The total economic benefits of a widespread adoption of cloud computing in the five biggest EU countries alone (France, Germany, Italy, Spain, UK) are estimated at more than 700 bn Euros.
- *There is no sense in creating a battle of regions.* Raising barriers to foreign (US-based) applications providers is unlikely to address the underlying reasons for Europe's productivity gap. Conversely, cloud usage might support EU businesses as to their competitiveness and help to expand in Europe and beyond.Direct investments by CAPs (mostly US-based) in Europe (eg in data centres and connectivity) were the highest out of all global regions in 2013.
- There does not seem to be a compelling case that Europe would benefit from higher capital investment or increase productivity if it sought to raise barriers to digital market entry from outside Europe's boundaries.

Cloud and other digital applications can have both a direct and indirect effect on the European economy. Direct investments refer to investments in infrastructure made directly by content and applications providers. Indirect effects include productivity gains made possible by the use of applications across the wider economy.

5.1 Direct effects of the provision of digital applications

A recent study by Analysys Mason has quantified the investments made by Content and Application Providers (CAPs).[49] The study finds that CAPs' activities require investments in physical equipment for:

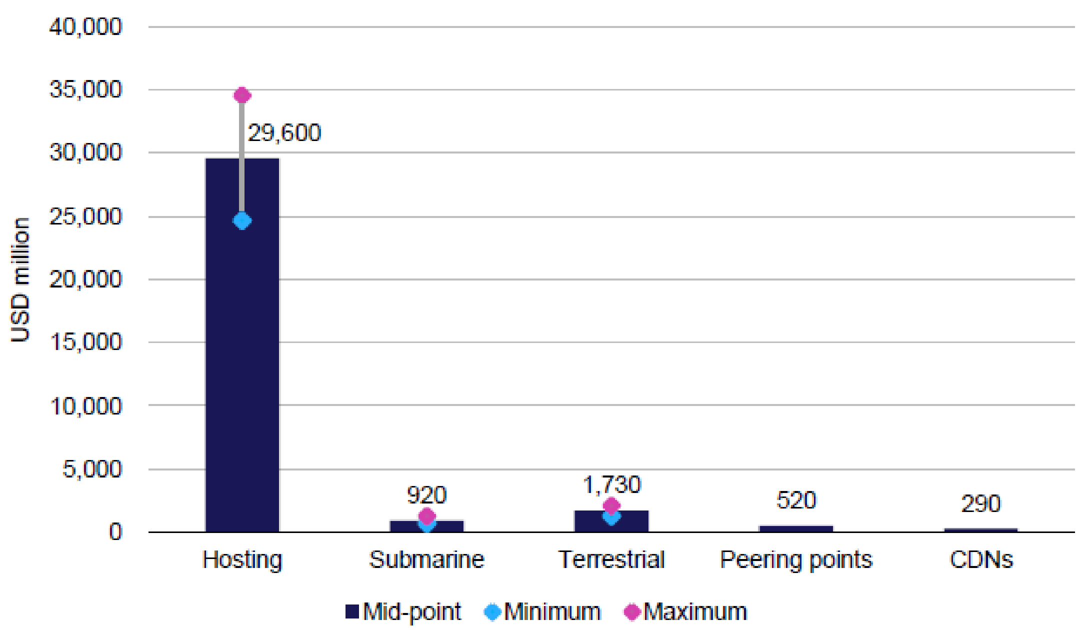
49 See AnalysysMason (2014): Investment in networks, facilities, and equipment by Content and Application Providers; September; study for Google; available at: http://www.analysysmason.com/CAP-Internet-Sept2014.

- Data centres e.g. power connection and distribution, cooling equipment, servers and storage devices as well as racks to house them, and operational equipment relating to e.g. physical security, monitoring and maintenance systems;
- Long distance transport links (in order to transport content from a CAP's data centre to an Internet Access Provider's network);
- Interconnection facilities at private peering points and/or Internet Exchange Points; and
- Content Delivery Networks (CDN).

These investments are either directly carried out by CAPs ("direct investments") or by service providers on their behalf (e.g. Internet backbone providers in the long distance transport link segment) ("indirect investments").

Analysis Mason underlines that both direct and indirect CAP investments have increased in recent years approaching an average annual level of 33 bn US$ in the period 2011-13. Hosting is by far the largest category for CAP related investment, but investments in communications infrastructure in order to bring content closer to customers were also not insignificant, see next Figure.

Figure 14: CAP investment by category, averaged over the period 2011-13[50]

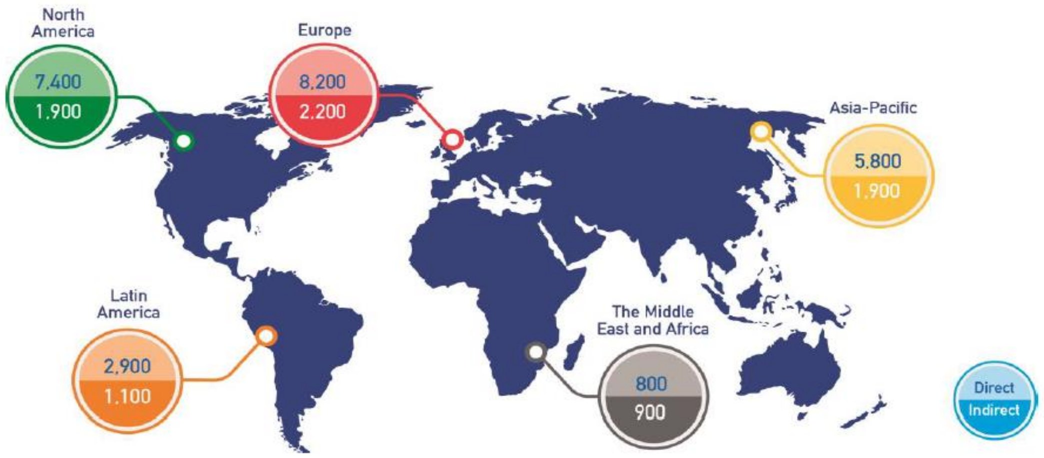


Source: AnalysysMason (2014).

50 In order to cope for the uncertainty of estimating global figures, Analysys Mason has put a range on each of the investment categories; i.e. there is a minimum, maximum, and midpoint estimate.

The next Figure is devoted to a regional split of direct and indirect investments by CAPs.

Figure 15: Regional split of direct and indirect investments by CAPs

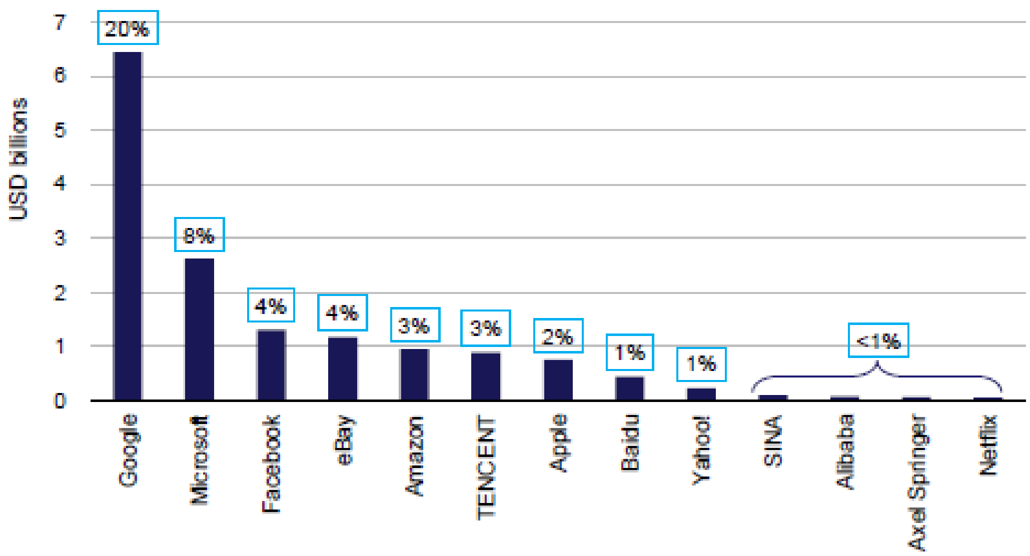


Source: AnalysysMason (2014), based on DCDi, Telegeography, Informa, company data, Sandvine, op. cit.

The Figure underlines that from a geographical perspective, total infrastructure investments by CAPs is highest in Europe (US$10.4 bn) followed by North America (US $9.3 bn) and Asia-Pacific (US$ 7.7 bn).

According to the Analysis Mason study growth of CAP related investments is in large part driven by increases in the capital expenditure of the largest companies, see next Figure. The Figure provides an overview of the absolute value of infrastructure capex for main CAPs as well as the percentage share of the CAP in question relative to the total investment of US$ 33 bn.

Figure 16: Infrastructure capex for main CAPs and respective share of total 2013 capex



Source: AnalysysMason (2014), op. cit.

The Figure shows that the investments in networks, facilities, and equipment are concentrated amongst the largest Content and Applications Providers. Ín 2013 Google alone was responsible for approximately 20% of direct investments, followed by Microsoft with 8 %. Thus, these companies alone accounted for nearly 30% of total investments by CAPs globally.

5.2 Indirect benefits from ICT

Even though the direct contributions from CAPs towards investment are not insignificant, the greatest economic benefits come from the indirect effects of ICT use on productivity. Moreover, it is in the translation of ICT sector investment into economic growth across all sectors that the greatest gap can be seen between the EU and the US.

5.2.1 The EU - US productivity gap

Empirical evidence on the productivity gap

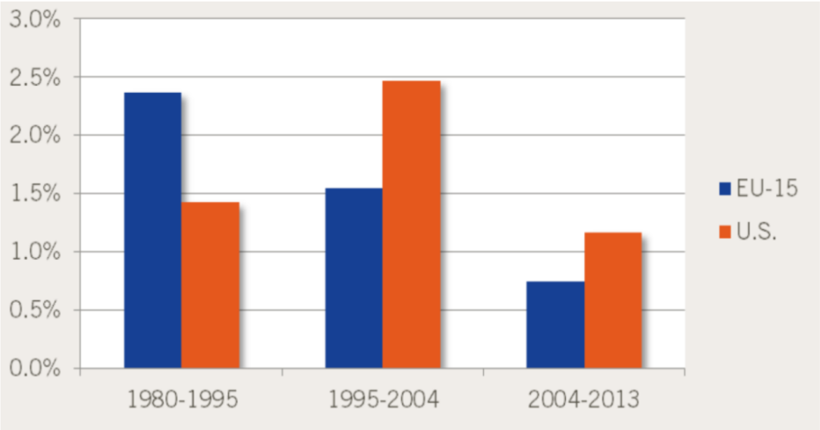
Productivity is a measure for the output produced from each unit of input[51], and, thus, is a key factor for the development of a firm, a sector, and the economy at large. Usually,

51 See EUROSTAT, Real GDP growth rate – volume, 2014, available at: http://publications.europa.eu/code/en/en-250500.htm.

a distinction is made between labour productivity[52], capital productivity[53], and total factor productivity[54].

There is widespread empirical evidence that there is a wide productivity gap between the U.S. and Europe. The next Figure shows that since 1995 the EU-15 is falling behind the U.S. in labour productivity.

Figure 17: Annual labour productivity growth: Comparison EU 15 – U.S., 1980-1995, 1995-2004, 2004-2013



Source: Atkinson, R.D. (2014): The Role of ICT in Driving EU Productivity Growth; presentation at Building Blocks of the Ubiquitous EU Digital Single Market Workshop; November.

ICT as a crucial factor explaining the productivity gap

Strauss and Samkharadze[55] have tried to identify empirically the main sources of this EU - US discrepancy in labour productivity. One of the key results of their analysis is that Information and Communications Technology (ICT) both with respect to investment in ICT and to use of ICT is a crucial distinguishing factor in explaining these differences.[56]

52 Labour productivity is defined as output per unit of labour input, where the unit of input is labour measured for example by "no. of full time equivalent employees" or "no. of hours worked" per unit of time (e.g. a year).

53 Regarding capital productivity, the unit of input is "the capital stock".

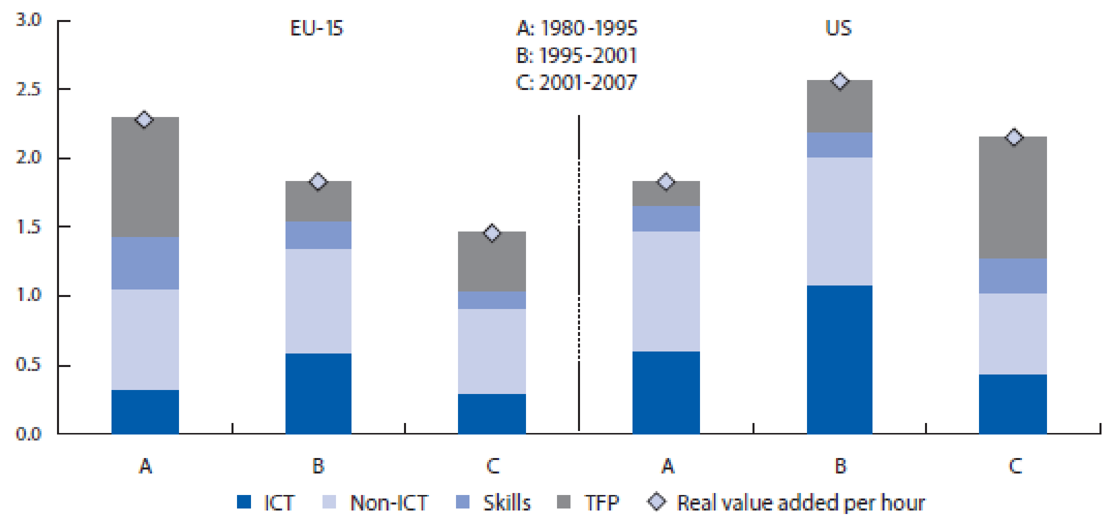
54 Total factor productivity is a concept that measures "by how much output grows at unchanged quantities of inputs because production becomes more efficient." See Strauss, H. and B. Samkharadze (2011): ICT Capital and Productivity Growth; in: EIB Papers 16, no. 2; available at: http://www.eib.org/attachments/efs/eibpapers/eibpapers_2011_v16_n02_en.pdf. Empirically, it is a ratio between an "index for output" and an "index for inputs." See e.g. Biagi, F. (2013): ICT and Productivity: A Review of the Literature; Institute for Prospective Technological Studies, Digital Economy Working Paper 2013/09; available at: http://ftp.jrc.es/EURdoc/JRC84470.pdf; Chapter 3.

55 See Strauss and Samkharadze (2011), op. cit.

56 Taking on a different angle, Oxford Economics have stated that by 2007 ICT capital stock in the US was worth about 30% of its GDP, compared to approximately 20% in many European countries. See Oxford Economics (2011): "Capturing the ICT Dividend: Using Technology to Drive Productivity and Growth in the EU", White Paper, produced in collaboration with AT&T, September; available at: http://fi3p.eu/assets/pdf/Oxford_economics_capturing_the_ict_dividend_0911.pdf.

The authors decomposed the development of labour productivity into contributions from ICT-capital, non-ICT capital, an effect from the changing skill composition of the workforce, and TFP growth.[57] The result is visualized in the following Figure.

Figure 18: Contributions to labour productivity growth in the EU-15 and the US; total economy, average annual contribution (percentage points), 1980-2007



Source: Strauss and Samkharadze (2011), op. cit.; p. 11.

The left half of the Figure shows results for the EU-15 and the right half the corresponding results for the US economy.

The Figure shows that in the EU15, ICT capital contributed more than 0.5 percentage points to annual productivity growth during the second period 1995 – 2001 (i.e. spanning the ICT boom) before falling back to 0.25 percentage points. Moreover, there was a sharp drop in TFP growth during the second half of the 1990s (compared to the period 1980 – 1995). Overall, however, this drop in TFP growth could not be compensated by the temporary acceleration in ICT capital-deepening during the second half of the 1990s. The Figure also shows that TFP did not recover during the 2000s.

From the right half of the Figure it is apparent that the increase in the US labour productivity growth during the 1990s was mainly due to rapid increases in ICT capital. ICT contributed a full percentage point to annual productivity growth in the second period, twice as much as in Europe. Moreover, unlike Europe, the US has seen a remarkable increase in TFP growth after 2000 (i.e. after the end of the ICT boom).

57 This decomposition is only possible for the period 1980 – 2007 due to lack of suitable data for later periods.

Inklaar and Timmer[58] show that the increase in TFP in the US economy was sectorally more broad based than in the EU, where dynamic TFP developments were a matter of a few sectors.[59]

Potential reasons for the differences between the United States and Europe as to ICT development

Strauss and Samkharadze focus on the drivers for investments in ICT equipment and identified the following key factors: (1) good ICT network infrastructure, (2) a competition-friendly regulatory framework, (3) high levels of co-investment in intangibles and (4) sufficient availability of skills. The authors underline that each of these three elements also has a direct influence on productive efficiency and therefore on TFP growth, too. Moreover, *they emphasize that although significant attention has been paid in Europe to boosting ICT investment, it is not ICT capex per se that explains the gap in performance between the EU and the US or the performance of the telecoms sector specifically, but rather the diffusion of ICT across all sectors*.

5.2.2 What is needed to foster ICT use in Europe?

A recent study by the IPTS[60] argues that there is convincing evidence that ICT, to be truly productive, require investment in complementary assets, such as human, organizational and managerial capital. The size of the complementarity effects, however, tends to vary among countries and datasets and tends to be higher for the US and the UK. These findings are corroborated by Strauss and Samkharadze.[61] Their argument is that *firms that re-organize business processes, train their workers on new ICT applications and implement new ICT-enabled ways of interacting with suppliers and customers reap larger productivity effects from ICT.[62] In turn, this creates incentives for those firms to invest in ICT for those firms, creating a virtuous circle of greater ICT use and greater ICT investment.*[63]

Other studies underline the concern that Europe is not investing enough in R&D to remain fully competitive with other regions of the world, and in particular that Europe's

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58 Inklaar, R. and M. Timmer (2007): Of yeasts and mushrooms: Patterns of industry-level productivity growth; in: German Economic Review, (8:2), pp. 174-187.

59 Strauss and Samkharadze (2011), op. cit. underline that this finding is in keeping with their results, namely, that ICT diffusion in the US has not only been more intense for the economy as a whole but also for most individual sectors, including in sectors using ICT less intensively.

60 See Biagi, F. (2013): ICT and Productivity: A Review of the Literature; Institute for Prospective Technological Studies; Digital Economy Working Paper 2013/09; available at: http://ftp.jrc.es/EURdoc/JRC84470.pdf.

61 Strauss and Samkharadze (2011), op. cit.

62 Brynjolfsson et al. argue that most successful firms are those which, following large-scale ICT investments, also devote significant resources to reorganizing their businesses. These efforts often cost a multiple of the new ICT equipment and the resulting efficiency gains may take years to materialize. See Brynjolfsson, E., Hitt, L.M. and S. Yang. (2002): Intangible Assets: Computers and Organizational Capital; in: Brookings Papers on Economic Activity, vol. 1, pp. 137-199.

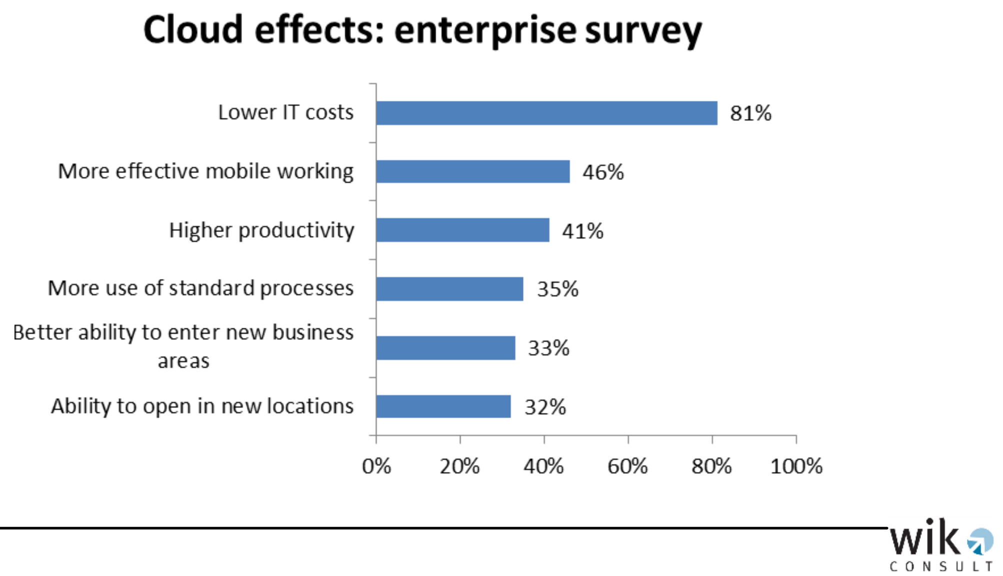
63 Countries like the US, Japan, Sweden and the UK have the highest expenditures on intangibles and are also among the countries with the highest ICT-investment-to-GDP ratios.

ability to absorb ICT innovation is in some respects not on a par with that of other regions. Moreover, it is argued that Europe's investment and regulatory climate does not foster innovation. This may have created barriers to the international competitiveness of the European Internet industry, including inflexibility and relatively high levels of regulation, fragmentation of labour and product markets, deficient venture capital markets, and lagging investment in organisational capital.[64]

5.3 The potential contribution of cloud to European productivity

Cloud is amongst a number of ICT applications that have been identified as having the potential, if absorbed within core business processes, to transform European industry. In a survey of 479 businesses carried out by IDC for the European Commission[65] cloud users identified several perceived benefits as shown in Figure 19.

Figure 19: Perceived benefits of firms using cloud services (percentage share of respondents)



Source: IDC (2012), op. cit.

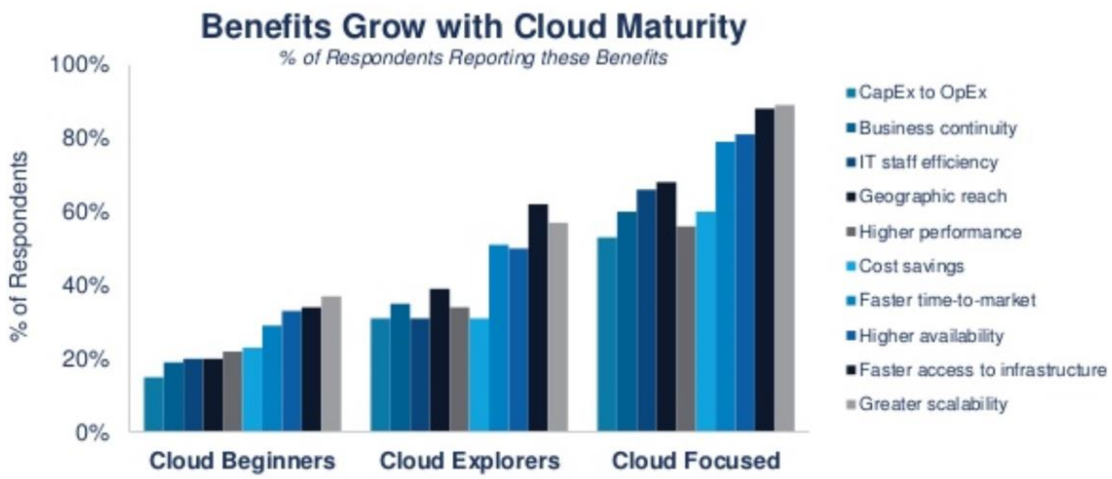
64 See e.g. Aho, E. et al. (2006): Creating an Innovative Europe, Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit and chaired by Mr. Esko Aho, No. EUR 22005; available at: http://ec.europa.eu/invest-in-research/pdf/download_en/aho_report.pdf;
Cave, J., Carter, K.R., Elixmann, D., Marcus, J.S. and S. Simmons (2008): Tuning the Innovation System; Final Report of the Study of the Impacts of IST-RTD on Key Strategic Objectives Related to Growth and Jobs, Prepared for DG Information Society and Media of the European Commission http://ec.europa.eu/smart-regulation/evaluation/search/download.do;jsessionid=kJnSTTWT9hS9N2XrcBXC5YkW9fsJ5C9QwXVJGwyhDVydtwXsptD7!1601440011?documentId=1466.

65 IDC (2012): Quantitative Estimates of the Demand for Cloud Computing in Europe and the Likely Barriers to Up-take; Final Report; study conducted on behalf of the European Commission; July 13; available at: http://ec.europa.eu/digital-agenda/futurium/en/content/quantitative-estimates-demand-cloud-computing-europe-and-likely-barriers-take.

Lower IT costs were identified as a benefit by most respondents: More than 50 % of all cloud users surveyed expect cost savings of more than 10 % due to the use of cloud services with a peak between 10 and 20%. However, higher productivity, increased use of standard processes and better ability to enter new business areas and open in new locations were also identified as benefits by more than one third. These findings are largely in keeping with the results of our interviews (see Section 4).

A survey conducted in the more mature US cloud market (see Figure 20)[66] suggests that users have gained increased benefits as their experience with cloud increases.

Figure 20: US enterprise perception of cloud benefits, by level of cloud experience



Source: Rightscale 2014 State of the Cloud Report.

Bearing in mind Europe's historically poor diffusion of ICT services, a key challenge will be in transforming today's perceptions in an immature EU cloud market into the more significant real benefits that are being experienced by mature users in the US.

What is the potential gain?

If effective cloud diffusion can be achieved within Europe, research on the potential economic benefits suggests that the rewards could be significant.

A study conducted by CEBR concludes on the basis of an analysis of the five largest European economies (France, Germany, Italy, Spain, and UK), that widespread adoption of cloud computing has the potential to generate over €763 billion of cumulative economic benefits in Europe, Middle East and Africa over the period 2010 to 2015. The following Table provides an overview of the key empirical results of this study.

66 Rightscale 2014 State of the Cloud Report.

Table 4: Economic benefits of a widespread adoption of cloud computing in specific industry sectors and countries, respectively; 2010-2015

Industry sector	France	Germany	Italy	Spain	UK	EMEA	Jobs
	€ mil	€ mil	€ mil	€ mil	€ mil	€ mil	('000s)
Banking, financial & business services	43,949	58,503	32,073	18,836	30,204	183,566	207
Government, education & health	25,783	31,838	20,759	14,704	19,455	112,539	801
Distribution, retail & hotels	45,901	55,540	51,688	40,125	40,162	233,418	355
Manufacturing	16,013	39,305	19,735	12,093	11,358	98,504	514
Other sectors [1]	31,103	36,052	26,515	24,792	16,810	135,271	519
Total Economic Benefit	162,749	221,239	150,770	110,550	117,989	763,297	2,396
Direct and Indirect employment ('000s)	469	789	456	392	289	2,396	

Source: CEBR (2011): The Cloud Dividend: Part Two - The economic benefits of cloud computing to business and the wider EMEA economy; comparative analysis of the impact on aggregated industry sectors; report for EMC2; February.

The table shows that overall the greatest benefits of cloud computing are expected in the “distribution, retail & hotels” sector (€233 billion) and in the “banking, financial & business sector” (€184 billion). The table also shows that the benefits in the specific industry sectors varies across the countries covered by the study.

Likewise, in its 2012 study, IDC estimated that cloud computing could attract an additional €45 bn of direct spending in the EU by 2020 as well as contributing to an increase in GDP of €957 bn, and 3.8 m jobs by 2020.

Knock-on effects - Internet of Everything

One of the economically significant effects from cloud, as discussed in Section 3, is its potential to support the diffusion of ICT in other ways – including the use of (potentially mobile) connected devices and the processing of data from a range of sources. It is therefore also worth noting the additional benefits that could be gained from a connected world – termed by Cisco, the “Internet of Everything” (IoE). The authors of the Cisco white paper estimate[67] that the IoE creates $14.4 trillion in value globally deriving from a combination of increased revenues and lower costs that might be achieved among companies and industries from 2013 to 2022. This overall impact is fuelled by five main factors:

- Asset utilization (reduced costs) of $2.5 trillion;
- employee productivity (greater labour efficiencies) of $2.5 trillion;

67 See Radley, J., Barbier, J. and D. Handler (2013): Embracing the Internet of Everything to capture your share of $14.4 trillion more relevant, valuable connections will improve innovation, productivity, efficiency & customer experience; Cisco White Paper; available at: http://www.cisco.com/web/about/ac79/docs/innov/IoE_Economy.pdf.

- supply chain and logistics (eliminating waste) of $2.7 trillion;
- customer experience (addition of more customers) of $3.7 trillion; and
- innovation (reducing time to market) of $3.0 trillion.

Although the precise numbers may be subject to debate, the potential for cloud to contribute towards achieving a wider 'universal' prize is worth bearing in mind.

5.4 Does Europe gain or lose from US applications providers?

Compounding the better diffusion of ICT amongst US companies, it is evident from Section 3, that out of the major cloud providers in the global marketplace, a significant majority are US-based. This global imbalance is also seen in other Internet applications, such as search, e-commerce and social networking, where US-based companies have gained a strong footprint in Europe as well as elsewhere (see for example Table 2).

Some commentators have observed that the EU policy-debate around networks and applications masks a more widespread concern over the potential loss of ICT revenues and investment to companies based outside the single European market – in other words a transfer of ICT benefits to the US[68].

On closer examination however, the effects of US strength in segments such as cloud computing are not so one-directional. An important consideration is that use of cloud services enables greater specialisation and efficiency by European companies in other (non-cloud) industries in which European companies may have a cost or innovation advantage, and may also support exports by EU-based companies to the US and elsewhere. This applies even if the cloud supplier is US-based.

A survey conducted by IDC[69] found that one third of surveyed companies considered that cloud services supported the process of expanding into other markets. One beneficiary could be Europe's own digital sector. For example, BITKOM[70], a trade association representing companies in the digital sector in Germany expects strong growth in cloud computing in Germany reaching an overall market volume of 19.8 bn Euro in 2018. BITKOM's members gain around one quarter of their revenues from the export of high-tech goods and services, which could be supported by applications such as cloud. TomTom, a European-based supplier of navigation solutions, uses cloud to support the testing of its applications.

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68 See for example Economist 29 November 2014 'Should digital monopolies be broken up?' http://www.economist.com/news/leaders/21635000-european-moves-against-google-are-about-protecting-companies-not-consumers-should-digital and FT April 16 2014 Axel Springer accuses Google of seeking digital 'superstate' http://www.ft.com/intl/cms/s/0/41507d26-c575-11e3-89a9-00144feabdc0.html#axzz3QK3psMug.

69 IDC (2012).

70 http://www.bitkom.org/en/.

European industry benefits directly and indirectly by cloud solutions. For example, TVH, a European-based company, is the world's largest supplier of spare parts for industrial machinery. Its spare part services and its fleet of industrial rental equipment are supported by cloud-based solutions which enable tracking and maintenance of equipment across Europe. Coca Cola Europe makes use of cloud services to support its marketing and advisory activities which in turn support demand for its products amongst European customers. These activities are ultimately of benefit for European industry, because demand for Coca Cola's products is fulfilled by a number of EU-based manufacturers such as Coca-Cola Hellenic, an EU-based independent bottler with a turnover of €6.9 bn and a workforce of 38,000.

As noted in Section 4, in addition to providing value to European customers in other sectors, US-based CAPs are also directly investing in and expanding physical infrastructure within Europe. Indeed, according to data compiled by Analysys Mason (see Figure 15) more investments were made by digital applications providers in Europe than in any other region of the world.

Taking these factors into consideration, there does not seem to be a compelling case that Europe would benefit from higher capital investment or increase productivity if it sought to raise barriers to digital market entry from outside Europe's boundaries (distinct from ensuring non-discriminatory treatment amongst companies operating in Europe). The analysis in Section 27 highlights that a core challenge for Europe lies in inadequate ICT *diffusion*. Raising barriers for US ICT players could limit competition and innovation in digital applications. This could raise costs and limit choice for European business users, reducing the significant indirect benefits achievable through ICT use. Raising barriers could also impact levels of foreign investment in the EU by US-based application providers.

6 NGA investment: network push vs applications pull?

Key findings

- It is hard to say whether the 'chicken' or the 'egg' came first. Networks and applications are likely to be mutually supportive, creating a virtous circle across the digital value chain.
- Europe's telecoms infrastructure does not lag the US when it comes to being 'cloud-ready'. However, there is a significant data *usage* gap between the US and Europe for businesses as well as consumers – and for cloud as well as more generally.
- Usage of high bandwidth applications such as cloud may play a role in supporting demand for fixed and mobile broadband. Businesses which use cloud tend to be users of mobile broadband. Countries where consumers have embraced NGA also tend to be consumers of high bandwidth applications.
- Digital applications have introduced new competition with traditional telecommunications services such as voice and SMS. However, there is more limited scope for applications to exert competitive constraints on broadband connectivity.
- Analysis which focuses on the monetary value users place on access vs applications (eg in relation to two-sided markets), may miss the wider knock-on economic benefits that accrue from diffusion of ICT.

In contrast with the widespread acceptance of the potential economic benefits available from cloud computing, a fierce debate in Europe has been raging about whether applications (and in particular high bandwidth applications is a key example) are creating unsustainable burdens on broadband infrastructure which require a re-evaluation of the economic relationships *within* the digital value chain. Proponents of this view argue that as providers of bandwidth-hungry applications such as cloud and video benefit from the deployment of next generation access and core networks, they should pay more towards the investments in telecom infrastructure. This perspective was first described in a report by AT Kearney[71] in 2010, and more recently described in an October 2014 report by CERRE[72].

71 See, for example, AT Kearney Dec 2010 – A viable future model for the Internet http://www.atkearney.co.uk/paper/-/asset_publisher/dVxv4Hz2h8bS/content/a-viable-future-model-for-the-internet/10192.

72 CERRE October 2014 Market definition, market power and regulatory interaction in electronic communications markets http://www.cerre.eu/sites/cerre/files/141029_CERRE_MktDefMktPwrRegInt_ECMs_Final.pdf.

An alternative hypothesis, touched on in several of the studies investigating the gap in ICT diffusion experienced between the US and Europe, is that better usage and absorption of ICT-based services might support further investment in ICT, creating a *virtuous circle* within the ICT sector as well as the economy at large. If this is true, it could mean that there is no trade-off between increasing usage of applications and content on the one-hand and the investment in telecoms infrastructure, but rather that network independent 'killer applications' developed in a free market and supported by appropriate development in human capital, could support demand for and potentially willingness to pay for fixed and mobile broadband infrastructure.

In this section we will explore whether the data on telecoms access, pricing and the usage of applications support the theory of a vicious or virtuous circle within the ICT sector. This question is central to what may be the relative importance of demand-side ("support services and the infrastructure will be built") vs supply-side policies ('build it and they will come'), in achieving the goals set out in the European Digital Agenda.

6.1 Is Europe falling behind in infrastructure?

Proponents for the case that Europe needs a predominant focus on infrastructure investment (the supply-side focus) often claim that Europe is 'falling behind' on infrastructure and that further capital in networks is the key to supporting a vibrant ICT sector and economy. For example, a 2013 report by the Boston Consulting Group[73] states:

Many markets in Asia and North America now enjoy fiber access penetration that is up to 20 times higher and penetration of LTE that is as much as 35 times greater than Europe's. As a result, European consumers and businesses experience slower connections, leading to less value and slower economic growth. Fast connectivity to the Internet is the foundation of a modern digital economy and a key enabler of innovation. Without it, Europe will fall behind on the world stage. There is no doubt that infrastructure gaps still remain in Europe – especially in rural areas, and these deserve attention[74]. However, in comparative terms, as discussed in a Nov 2013 report by WIK/TNO/RAND Europe for the European Parliament[75], available data challenges the premise of an infrastructure 'gap' as it suggests that for the metric of most relevance to customers – the bandwidth and service quality they actually receive – Europe is not significantly behind the US or other regions.

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73 BCG (2013) Reforming Europe's Telecom Regulation to enable the digital single market https://www.etno.eu/datas/publications/studies/BCG_ETNO_REPORT_2013.pdf.

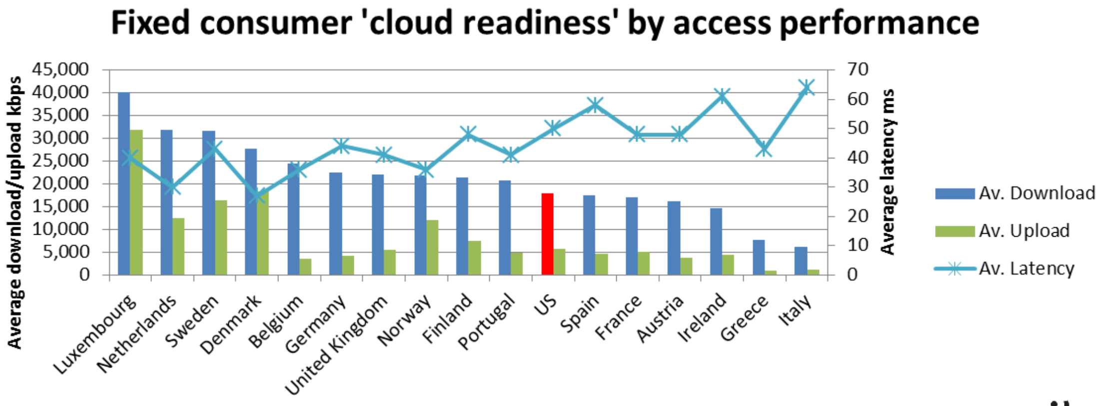
74 Data from European Commission Digital Agenda Scoreboard http://digital-agenda-data.eu/datasets/digital_agenda_scoreboard_key_indicators/visualizations shows that 10% rural households lacked fixed standard broadband coverage in 2013 while 38% households lacked NGA coverage, mainly in rural areas.

75 WIK/TNO/RAND Europe (2013) Entertainment X.0 to boost broadband deployment.

Data from Cisco's recent analysis of 'Cloud readiness' (the Cisco Global Cloud Index[76]), further challenges the view that there is a significant infrastructure-gap between Europe and the US as regards access connectivity (sufficient download and upload capacity and low latency) that would explain why the US would be ahead of Europe in cloud diffusion.

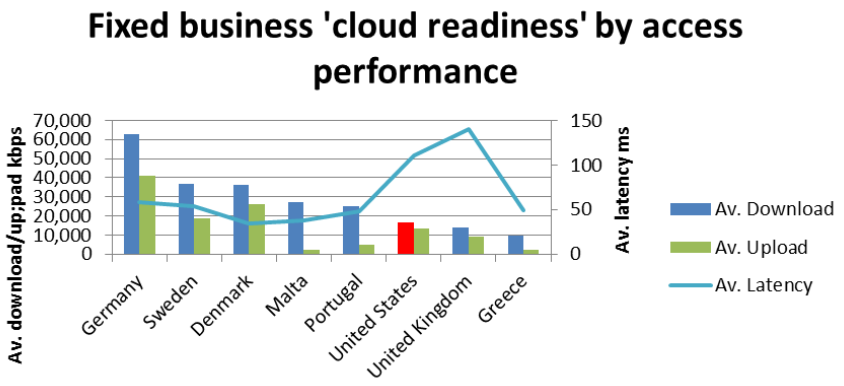
Several EU countries, including the UK and Germany, are considered to be similarly or more 'cloud-ready' than the US as regards the fixed access capabilities available to consumers and businesses (see Figure 21 and Figure 22).

Figure 21: Fixed consumer 'cloud readiness' based on access network performance[77]



Source: WIK based on Cisco Cloud Index Supplement 2014 (data from Ookla).

Figure 22: Fixed business 'cloud readiness' based on access network performance[78]

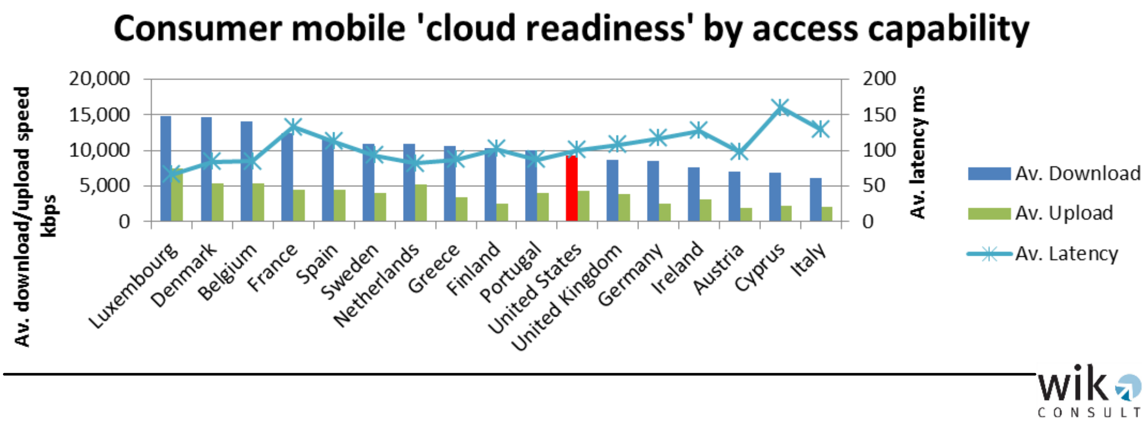


Source: WIK based on Cisco Cloud Index Supplement 2014 (data from Ookla).

76 Cisco (2014) Global Cloud Index – forecast and methodology 2013-2018.
77 Cisco (2014).
78 Cisco (2014).

Equally for mobile, many European countries are considered to offer bandwidths equally or more suited to cloud consumption by consumers (see Figure 23).

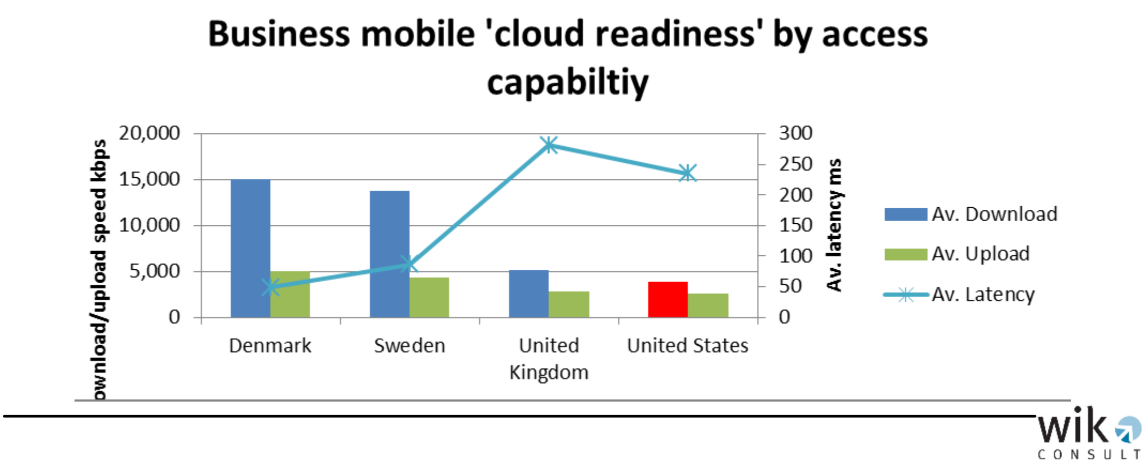
Figure 23: Consumer mobile 'cloud readiness' based on access network performance[79]



Source: WIK based on Cisco Cloud Index Supplement 2014 (data from Ookla).

Business mobile connections are considered in general to present challenges regarding cloud usage (see Figure 24). However, this problem does not appear unique to Europe.

Figure 24: Business mobile 'cloud readiness' based on access network performance[80]



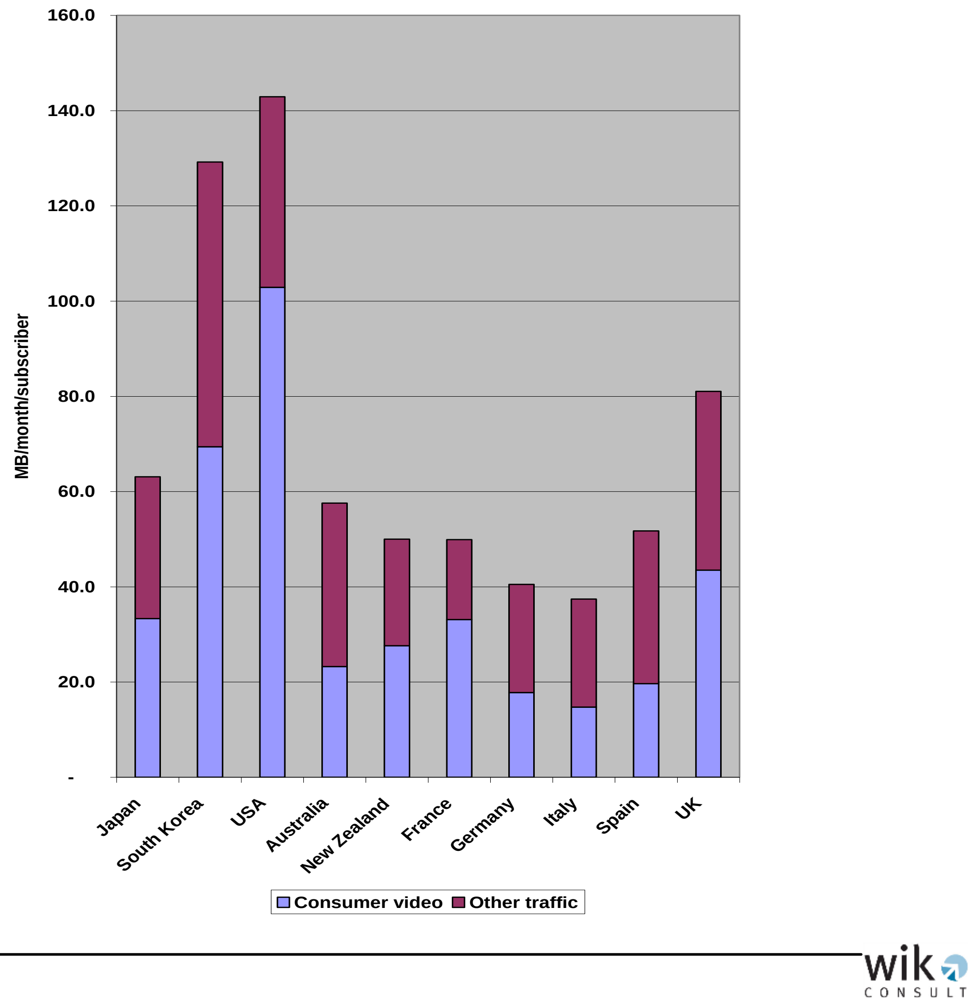
Source: WIK based on Cisco Cloud Index Supplement 2014 (data from Ookla).

79 Cisco (2014).
80 Cisco (2014).

6.2 The ICT usage gap

Where data does show clear shortfalls in Europe – mirroring the 'absorption gap' theory discussed in Section 4 is in the usage of high bandwidth services. One of the key findings of the 2013 WIK study for the European Parliament[81] is that US customers use fixed broadband services more intensively than those in Europe (see Figure 25)[82]. There are also differences in bandwidth usage within Europe – with UK consumers making considerably greater use of their connectivity than those in Germany, Italy and Spain. Similar patterns can be seen for mobile bandwidth usage[83].

Figure 25: Bandwidth used for video and online services (fixed)



Source: WIK, for European Parliament, 2013.

81 WIK/TNO/RAND Europe (2013) Entertainment X.0 to boost broadband deployment.

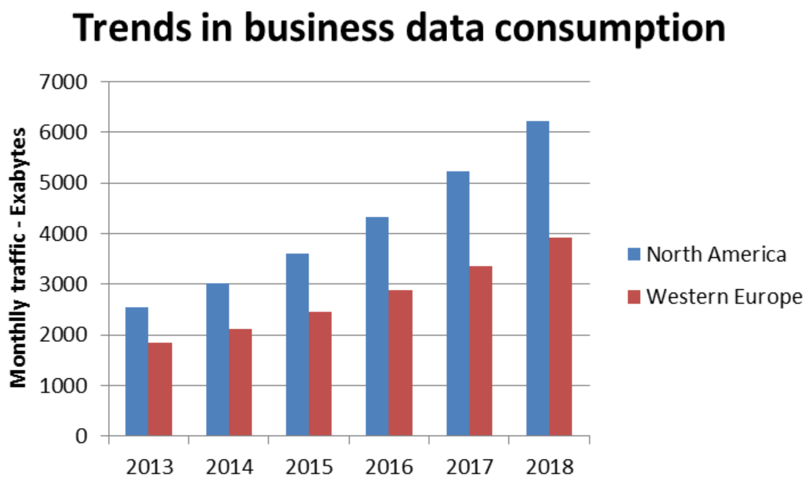
82 Updated 2014 analysis by WIK "The Economic Impact of Internet Traffic Growth on Network Operators" http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2531782 shows a continued gap between US fixed bandwidth consumption (around 200MB per month per user in 2014), the UK (100MB) and Germany, France, Spain and Italy (<60MB).

83 See for example, data from Mobidia Mobile bandwidth usage (LTE users) Q1 2014.

Differences in consumer bandwidth consumption – especially if they largely relate to entertainment video[84], might not be a significant factor influencing wider productivity.

However, of greater concern should be evidence from Cisco projections[85], that the gap in bandwidth consumption between the US and Europe applies also to usage of business connectivity, and is projected to increase (see Figure 26).

Figure 26: Trends in business data consumption – comparing North America and Western Europe

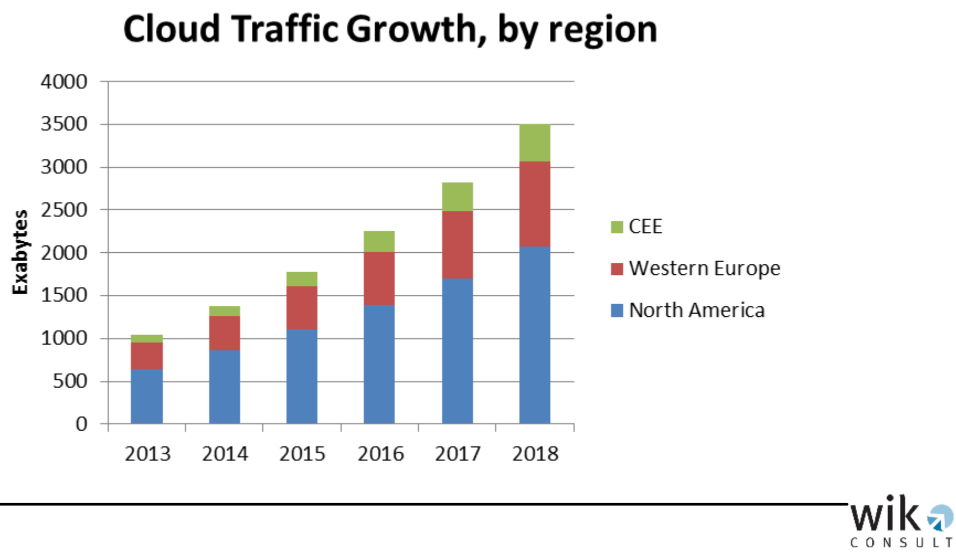


Source: Cisco VNI (2014).

Mirroring this trend, Cisco data[86] suggests that cloud traffic is already significant in North America, but there is a substantial gap between cloud usage in North America and that in Europe, which is expected to persist. Cisco estimates that a substantial part of cloud data (around 40% today) relates to enterprise cloud, recognised as one of the potential drivers of productivity growth (see Section 4).

84 Other video applications include video conferencing, persistent video streams (such as security cameras etc), video used in the marketing process.
85 Cisco VNI (2014).
86 Cisco Global Cloud Index: forecast and methodology 2013-2018.

Figure 27: Estimated cloud traffic growth, by region…



Source: WIK based on data from Cisco Cloud Index White Paper 2014.

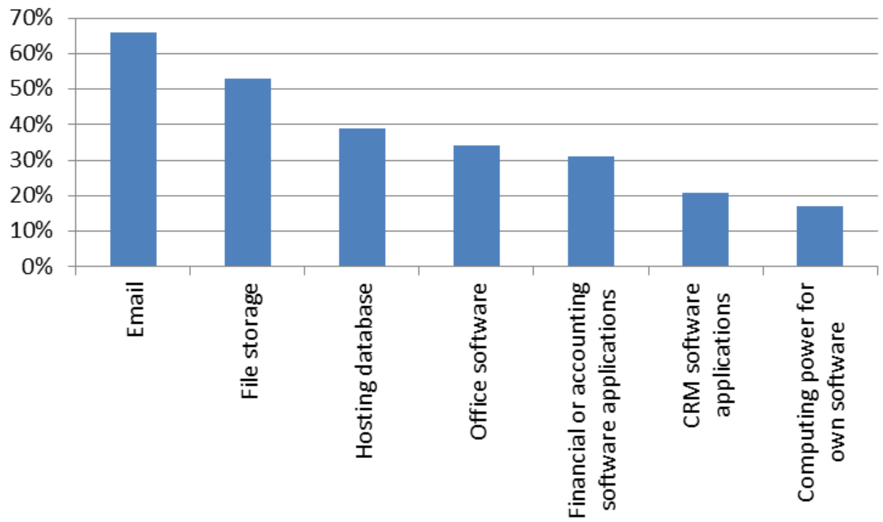
This is consistent with December 2014 data from Eurostat[87] which shows that cloud computing was used by only 19% of EU28 enterprises despite European enterprises having near universal levels of broadband connectivity[88] (see Figure 7).

Of those European businesses using cloud, usage was also limited in many cases to email, rather than outsourcing of office software and other business critical applications (see Figure 28).

87 Eurostat survey – ICT usage in enterprises 2014.

88 According to Eurostat, 97% of enterprises employing 10 persons or more in the EU28 had Internet connectivity.

Figure 28: Uses of cloud computing by EU28 businesses (% of businesses using cloud)



Source: Eurostat 2014.

Usage of cloud services by individuals in Europe is similarly limited, with an average of 21% using Internet story to save documents, pictures, music or other files, according to data published in December 2014 by Eurostat[89].

In contrast to Europe, Forbes reported based on a Neovise study that more than half of US-headquartered businesses were using cloud services in 2013[90], while IDC, observes in an October 2014 briefing note[91] that 81% of US corporations with more than 100 employees were using cloud services.

6.3 Testing hypotheses - do applications drive or destroy value in networks?

Applications such as cloud can be bandwidth intensive – in some cases upstream as well as downstream[92].

Separate from the known benefits, therefore, a question arises as to whether companies which are stimulating usage of bandwidth intensive services (such as cloud as well as video), create costs for network operators which constitute a unfair burden on investors in access and/or core network infrastructure.

89 Eurostat 16 Dec 2014 http://ec.europa.eu/eurostat/documents/2995521/6343581/4-16122014-BP-EN.pdf/b4f07b2a-5aee-4b91-b017-65bcb6d95daa.

90 http://www.forbes.com/sites/reuvencohen/2013/04/16/the-cloud-hits-the-mainstream-more-than-half-of-u-s-businesses-now-use-cloud-computing/.

91 http://cdn.news-sap.com/wp-content/blogs.dir/1/files/InfoBrief_SAP-Cloud-Small-Biz.pdf.

92 For example, see discussion of bandwidth requirements in Cisco Cloud Index.

This hypothesis is at the heart of AT Kearney (2010). It is also raised in a report sponsored by CERRE (2014), which states that

> "*apps replace formerly vertically integrated services by telcos… telcos may suffer from the increased value stemming from OTT apps… ISPs fear that the benefits from investments will be absorbed by consumers and content providers with little benefits left for the investing party… Most delivery is coming from non-traditional operators that do not build the networks they rely on. This is particularly important for Netflix, or cloud services that put pressure on network capacity"*

Although investments are being made in fixed and mobile high speed networks by European telecommunications operators[93] and these would tend to enhance the experience of cloud and other services, it is not clear-cut that applications raise costs for network operators to an unsustainable degree.

- Section 5.1 suggests that bandwidth in the access network, which is the main cost driver for NGA investments, is not a significant differentiating factor in Europe compared with the US. US customers appear to be able to use cloud and other services more intensively than in Europe (and to gain more economic benefits from them) without having significantly higher bandwidths. This raises the question as to whether substantially increased bandwidth is in fact needed in Europe to enable an expansion in cloud, from its currently low base.
- To the extent that increased usage may 'put pressure' on networks, it is the core network which may be affected more than access networks by increases in traffic volumes. However, the 2014 Analysys Mason report[94] as well as a 2011 WIK study[95] illustrate that applications providers have themselves been playing an increasing role in investing in and/or paying for conveyance to deliver content and applications closer to customers. Moreover a 2014 study by WIK[96] suggests that bandwidth availability and reducing unit costs in the core network should enable traffic increases without significantly increasing costs overall.

93 ETNO Annual Economic report 2014 reports investments by telecommunications operators in Europe of €47bln in 2013 with coverage of fixed NGA of 190m households in aggregate (including duplicate lines) https://www.etno.eu/datas/publications/economic-reports/ETNO_Annual_Economic_Report_2014_FINAL_21012015.pdf.

94 Analysys Mason (2014) Investment in networks, facilities and equipment by content and application providers http://www.analysysmason.com/CAP-Internet-Sept2014.

95 WIK (2011) Network Operators and Content Providers: who Bears the Cost? http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1926768.

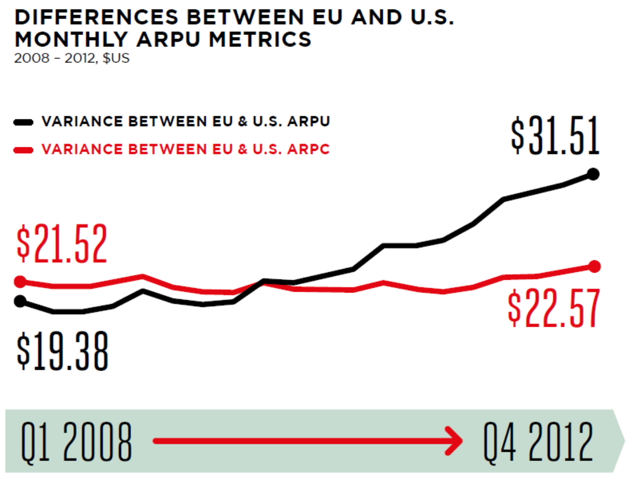
96 WIK (2014) The Economic Impact of Internet Traffic Growth on Network Operators http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2531782.

An opposing hypothesis

Meanwhile, there is an opposing hypothesis that applications which stimulate consumers and businesses to use more bandwidth, might improve the business case for ‘next generation’ access by increasing take-up of superfast fixed and mobile broadband (thereby allowing costs to be recovered over a broader customer-base) and potentially boosting willingness-to-pay.

One case which merits examination in this context is wireless in the US. In a 2013 report[97], GSMA reported that mobile wireless performance in the US was outstripping that in the EU, with the ARPU gap increasing from 2010 onwards. At the same time, mobile data use was expanding[98], resulting in lower unit costs. This is suggestive of a ‘win win’ outcome for both the industry and consumers, and which does not appear to result from a reduction in competition[99].

Figure 29: Mobile ARPU – contrasting the EU and US



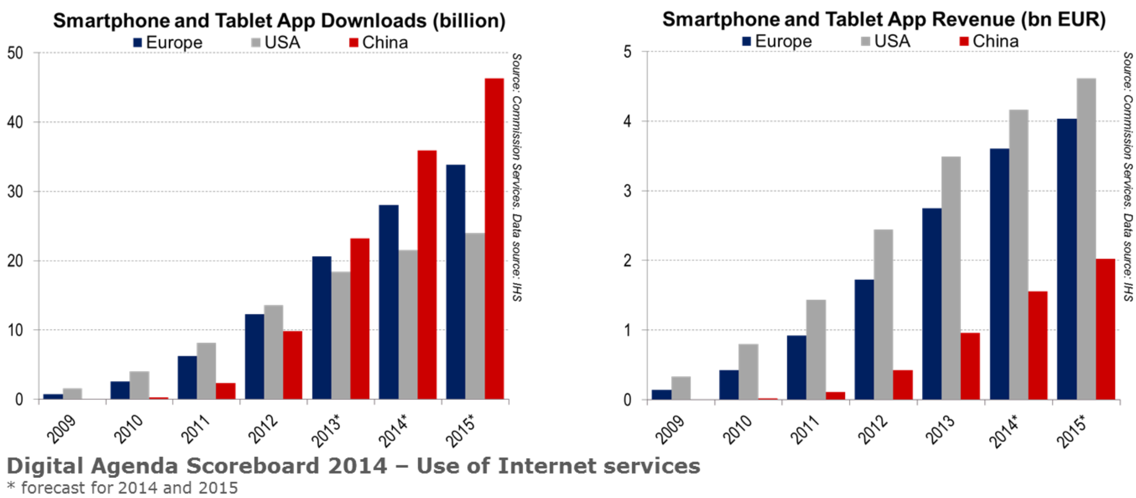
Source: Navigant for GSMA: mobile wireless performance 2013.

It is notable that a major development starting around that period was the increasing popularity of mobile applications, for which revenues in the US continue to outstrip those in Europe (see Figure 30). The implication is that US mobile customers pay more for mobile access on average than in the EU, and spend more on applications. Data from Nielson[100] shows smartphone users paid a premium of 41% over other users for

97 Navigant Economics for GSMA (2013) Mobile Wireless Performance in the EU & the US.
98 Navigant Economics for GSMA (2013) Figure 3 – Navigant reports that US mobile customers were projected to use 810MB per month, increasing from 307MB per month in 2011.
99 If reduced competition had permitted an increase in ARPUs, one may have expected stable or higher prices for bandwidth, rather than the decreasing unit costs actually experienced.
100 The mobile consumer – a global snapshot Feb 2013.

connection fees in the US, 25% in the UK, and only 10% in Italy. Could the applications be supporting the value to end-users of the connectivity?

Figure 30: Trends in applications downloads and revenue – Europe, US and China

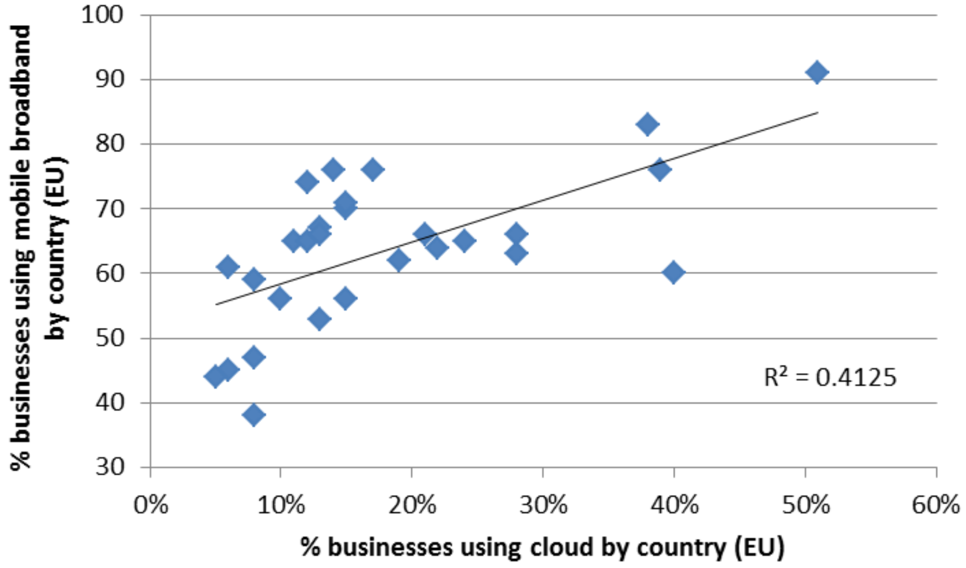


Source: Digital agenda scoreboard 2014.

Looking to the enterprise segment and cloud specifically, we note that mobility and the ability to use multiple devices is considered by businesses to be a key benefit conferred by cloud computing (as discussed in the IDC report for the European Commission[101]). At the same time, data suggests that there might be a relationship between the usage of cloud by businesses and their usage of mobile broadband (see Figure 31). Causality is difficult to prove, but it is at least plausible that there is a virtuous circle between businesses' use of cloud services, their ability to make use of cloud-based applications via mobile broadband, their take-up of mobile broadband and the value they ascribe to mobile broadband.

101 IDC (2012) for European Commission. Quantitative Estimates of the Demand for Cloud Computing in Europe and the Likely Barriers to Take-up. http://cordis.europa.eu/fp7/ict/ssai/docs/study45-d2-interim-report.pdf.

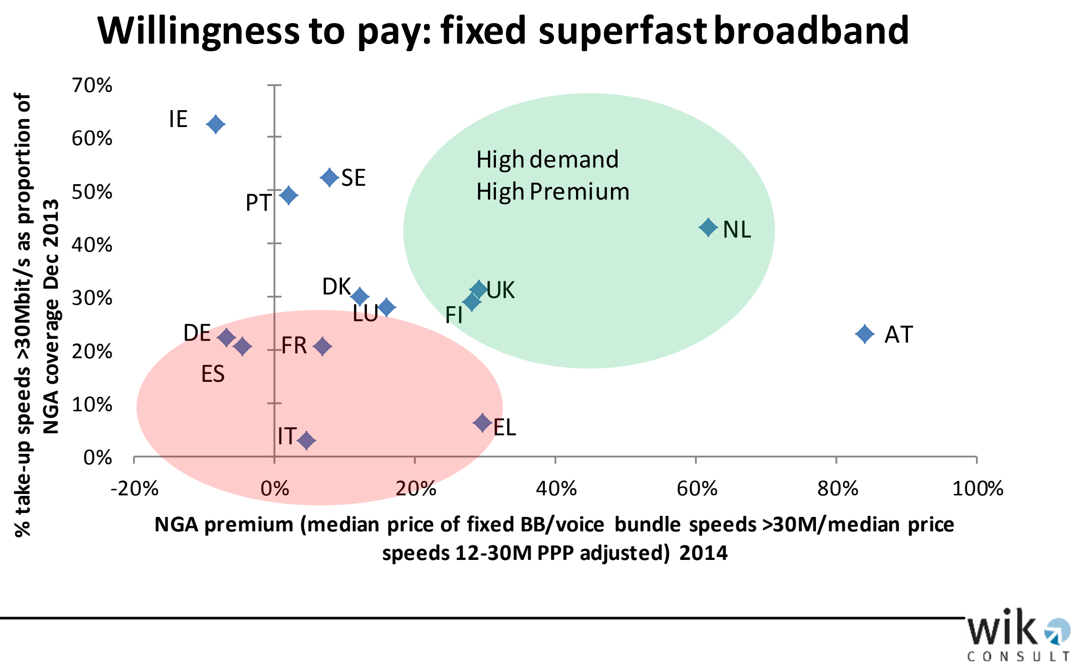
Figure 31: Business cloud use and mobile broadband



Source: WIK based on Eurostat (data downloaded December 2014).

In fixed residential access, it is notable that operators in some countries - including France, Germany, Spain and Italy, have struggled to achieve take-up of superfast broadband despite offering prices which are comparable with standard broadband, whilst take-up has been higher in certain countries including Denmark, Portugal, Sweden, Ireland and also in the UK and Finland, despite an apparent price premium in those countries of more than 20% (see Figure 32). Did the increased availability and use of high bandwidth content and applications in some countries support increased take-up (reducing unit costs) and in some cases increased willingness-to-pay?

Figure 32: NGA premiums and take-up – is there willingness to pay?



Source: WIK based on Digital Agenda Scoreboard data collated by the European Commission.

It is perhaps relevant that usage of online storage by individuals as recorded by Eurostat[102] was (in some cases considerably) above 30% in the UK, Sweden, Denmark, Netherlands and Luxembourg – countries which showed an above average conversion of customers to superfast broadband – in some cases despite high premiums. Meanwhile cloud storage by individuals in countries with low conversion to fast fixed broadband despite low prices - Germany, Spain, France, Italy - was below (in some cases considerably below) 25%.

Public data on the fixed broadband speeds purchased by enterprise uses in Europe and relative prices depending on speed is not readily available, and might be difficult to gather for those (often larger) businesses using bespoke communications packages. However, if consumer interest in using high bandwidth applications such as online storage in the cloud contributes to their uptake (and perhaps willingness-to-pay) for high bandwidth broadband, it is conceivable that the same logic would apply for business users.

102 Eurostat (2014): Internet usage by Individuals in 2014 http://ec.europa.eu/eurostat/documents/2995521/6343581/4-16122014-BP-EN.pdf/b4f07b2a-5aee-4b91-b017-65bcb6d95daa.

6.4 To what extent do applications affect competition in telecommunication networks and services?

Another way in which it is alleged that applications may destroy value in communications networks and services is (i) by directly competing with some services provided by telecommunications operators and (ii) by introducing countervailing market power by virtue of the value customers ascribe to 'must-have' content and services.

The first argument is for example presented in the 2014 CERRE report via the following observations:

> *Observation 2: "The success of OTT apps for communication and messaging is making the traditional revenue model of telcos unsustainable*"…
>
> *Observation 4: "OTT entry may lead to an essentiality of the OTT app or may undermine the ISP's metering of consumer calls and messages. In both cases, the ISP's profits suffer and undermine the ISP's investment incentives." "*

There may be some truth in at least part of these observations. By introducing enhanced services (including email, video conferencing) etc which directly or indirectly substitute for legacy network-tied services, some applications have undoubtedly contributed to the erosion of traditional telecom service revenue. The potential for substitution and competition from voice applications (amongst other things) was reflected in the decision of the European Commission to remove markets for fixed telephone access and call origination from the list of Relevant Markets which may be susceptible to ex ante regulation[103]. This substitution from 'OTT' communication and messaging services and the consequent erosion in revenues for voice and SMS could indeed make 'traditional' revenue models based on these services unsustainable.

However, if our analysis is correct that new applications such as cloud (and also potentially video) increase customer demand for higher bandwidths (see Section 6.3), and especially if this increases willingness-to-pay over time, this could support an alternative revenue model in which data rather than metered voice services predominate. In this scenario, telecoms providers may be incentivised to invest in upgrading networks to meet customer demand and profit from the value associated with bandwidth. The high LTE coverage, high data usage and high ARPU outcomes witnessed in the US mobile market (see for example Figure 29) could point in this direction[104].

103 Commission to cut number of regulated markets in Europe http://europa.eu/rapid/press-release_IP-14-1112_en.htm.

104 It may be that US-based operators which lacked the legacy of high mobile termination rates and traditionally offered flat-rates for inclusive calls, may have been better placed to commercially manage the voice/SMS to data transition than European operators.

Although it could ultimately offer a ‘win win’ for all players in the value chain, the alternative data-centric scenario still presents a challenge for European telecoms operator to reflect the new ‘disaggregated’ value chain by rebalancing their pricing structures away from usage-based service (call and SMS) tariffs towards structures that are more relevant to a data-based environment. However, it is more of a commercial than a policy challenge.

The CERRE paper makes a further observation around the potential role that telecommunications providers might play as ‘honest brokers’ between users and OTTs in a two-sided market. The hypothesis is as follows:

> *Observation 5: ISPs can possibly manage the interaction between OTTs and users. The unregulated price structure chosen by the ISP may then resemble the socially optimal price structure, as the ISP internalises cross-group externalities. In particular, neither prices below cost nor very high prices are indications of anti-competitive behaviour.*

The idea is that an optimal pricing structure could be achieved by operators arbitrating between the two sides of the market (users and OTTs), even if the supply of broadband services is not competitive (ie OTTs are considered to provide a degree of constraint on the pricing behaviour of telecoms operators, due to the value users place on applications – and vice versa). Indeed, the CERRE paper observes that a ‘socially optimal’ pricing arrangement may not be not achieved under competition between ISPs, because ISPs are ‘too concerned about user participation’[105] and therefore may set suboptimally low prices to users.

The discussion however misses an analysis of what would be the profit-maximising strategy for a *vertically integrated* operator whose retail services (such as calls, SMS or TV) compete against those offered by OTTs, resulting in declining revenues and profitability. In a scenario of limited competition in broadband access a customer denied access to given content and applications by its ISP could not switch their broadband provider to avoid blocking, and likewise the ‘OTT’ provider would not have an alternative channel through which to offer its services to users. In this scenario, the broadband access provider might have an incentive to block or degrade certain content or services – or to levy excessive charges, if such discrimination allowed them to profit from leveraging market power from the access network into their own downstream services.

In this context, it is important to recognise the limitations in the ability of applications providers to exert competitive constraints in the telecommunications sector. Measures to support competitive broadband connectivity and legal clarity on net neutrality, protecting against potential abuses which foreclose markets for digital content and applications, are likely to remain necessary.

105 Page 33.

More generally – in focusing primarily on monetary values and the distribution/direction of payments along the value chain – discussions around two-sided markets may not take sufficient account of the wider economic benefits that could be gained from greater diffusion of ICT and its interaction with infrastructure investments.

7 Implications for the Digital Single Market

Key findings

- Policy-makers have historically aimed to support telecoms networks and cloud (and other applications) in parallel, while debates around the value chain have tended to be adversarial. *A joined up policy approach could provide a 'win win' for Europe.* For example, policies which support the use of ICT could also in turn support the business case for broadband, as well as conferring wider economic benefits.
- Another area of mutual benefit could be in defining a common EU-wide approach for digital services, which encompasses both new and traditional means of communication. A core aim in this context should be to provide consistency, ensure trust and minimise bureaucracy and administrative burdens as far as possible. Further research on this subject could be helpful.

In the past, policy-makers have pursued largely parallel policies concerning telecommunications investment[106] and support for applications such as cloud[107]. Recent policy debates combining the two, have on the other hand often involved corrosive exchanges with network operators and applications providers in opposing corners battling as to which confers greater value.

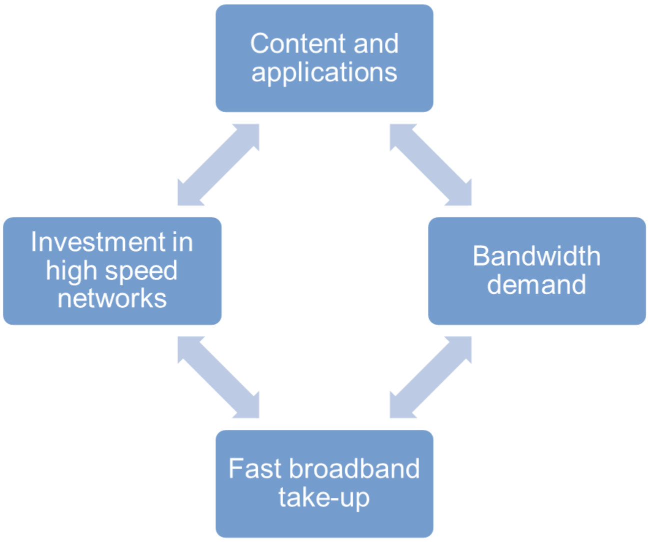
A subtext to debates around networks and applications is the idea that there is a clash of regions whereby telecommunications providers operating in Europe, which are (mostly) European, are losing ground to applications providers operating in Europe, which are (mostly) North American.

Our analysis suggests that both sides of the value chain offer value to each other, and that considering this value as purely 'monetary' may be overly simplistic. Telecoms operators provide a channel through which end-users receive services (a channel to market). Applications providers offer services that make connectivity desirable thereby boosting take-up of broadband access – and potentially facilitating demand for higher speeds. Considerable benefits, especially in the long run, could be gained from a more joined-up approach.

106 For example, the activities undertaken to support achievement of the 'Digital Agenda' broadband connectivity objectives.

107 See for example the European Cloud Computing Stratregy http://ec.europa.eu/digital-agenda/en/european-cloud-computing-strategy.

Figure 33: The virtous circle between networks and applications



Source: WIK-Consult.

Furthermore, an analysis of the EU US ICT productivity gap suggests that the geographic origins of players within the ICT value chain are less economically relevant than their ability to enable better diffusion of ICT across the wider economy. A US-based cloud provider could support the export business of a European manufacturer, as well as supporting other ICT applications developed by European manufacturers for example in relation to the Internet of Things.

Considerable benefits, especially also in the long run, could be gained from a more joined-up approach. The idea is to create a virtuous circle to foster growth and competitiveness of European companies. A refreshed policy should embrace the inter-linkages between broadband infrastructure and applications and content. It should acknowledge the investments made on both sides of the value chain and the important role that cloud and other applications play in driving demand for fixed and mobile broadband connectivity, as well as knock-on effects across the wider economy. In this context, a key focus for policy-makers should be to support ICT diffusion across other diverse industries to bridge the gap between European and US productivity.

Measures which could support such an approach include:

- Highlighting the significance of demand-side measures in the digital economy and their inter-relationship with supply
- Promoting a consistent approach across Europe to foster supply and usage of applications within the single market
- Identifying targets for business ICT use

- Understanding the reasons for low usage of productivity-enhancing applications by European corporations, and finding the best means to address these, including standardisation strategies where appropriate
- Fostering an open and competitive market for applications, and not raising barriers to global competition in this space
- Minimising administrative and bureaucratic hurdles to providing and using digital applications of all kinds. In this context, perhaps a distinction could be made between connectivity, which is typically locally provided, and services and applications – which may form part of a wider, EU or even global market. A simplified, pan-European approach to services and applications could support enterprises as end-users of services, traditional suppliers[108] as well as 'new' players in the market.

In turn, creating a single European market in which digital applications can flourish could help to support not only European businesses which use these services, but also expand the market as a whole, creating further room for emerging European providers of cloud and other digital applications to find their niche. For example, more intensive use of cloud services could provide a stimulus for other important European initiatives e.g. in the field of industry, Internet of things, and mobility, as illustrated in the case studies in Section 4.

A rising tide lifts all boats.

108 Voice and SMS could in some respects be considered as applications going forwards.

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Annex I: end-user questionnaire

1. Please describe your main business activities, where the business is headquartered and where the main business activities take place

2. What is the total turnover for the business (i) globally and (ii) in the EU

3. How many staff do you employ in total (i) globally and (ii) in the EU

4. How do cloud-based productivity applications support your business activities? To what extent are your computing needs outsourced? Which applications do you use and for what purposes?

5. When did you start using cloud-based applications? What were you using previously? To what extent did cloud-based applications replace previous internal systems or add new functionality?

6. What were the main benefits you experienced from the use of cloud-based applications compared with previous internal systems? Please expand with reference to the effect on your business of:
    a. Cost reductions
    b. Enhanced capabilities for mobile/multi-device working
    c. Productivity
    d. New business opportunities
    e. Expansion into new geographic markets

7. How is your current and planned future usage of cloud-based services affecting your demand for connectivity?

    a. Has connectivity constrained your ability to effectively access cloud services in particular locations and/or countries?
    b. Do you anticipate a need for increased upstream and/or downstream connectivity across your organisation for fixed and/or mobile services?
    c. How has your usage of cloud-based services affected the value you ascribe to bandwidth? Have you upgraded connectivity in connection with your cloud requirements? Would you be willing to pay more for higher speed and more reliable fixed and/or mobile broadband connectivity in order to secure more effective access to cloud services?

8. What if any, were the disadvantages associated with the migration to cloud-based applications?

9. What are the main barriers, if any, to your increased usage of cloud-based applications?

Annex II: interview transcripts

TVH – Kalman Tiboldi

TVH is the largest distributor in the world of spare parts for industrial equipment. The company is building a similar business for agricultural equipment and this segment is growing fast.

A second activity for the company is the rental and servicing of new and second-hand industrial equipment. TVH has one of the largest rental fleets in Europe offering more than 15000 machines for renting.

TVH's has a global turnover of more than €1 bn of which the European component is around two thirds. 3,300 of TVH's 4,300 employees worldwide are based in Europe.

TVH was an early adopter of the cloud concept, and uses cloud solutions at every level – from Infrastructure as a Service through to Software as a Service – and for nearly every aspect of their IT support functions. Kalman Tiboldi, Chief Business Innovation Officer at TVH says "Every time we enter into a new functionality, we raise two major questions. Is there is a cloud-based solution and is the app already mobile enabled? If so, we go for the cloud."

They started by adopted an e-invoicing system in 2009/10. Then they opted for Google as their collaboration platform provider in 2012. Their marketing efforts are supported by the cloud, which means that they can push mobile content to all their salesforce enabling them to showcase their product portfolio. Their cloud usage has also encompassed the migration of their technical library – hundreds of thousands of technical books – into the cloud. "Many functions of IT can be seen as a commodity and cloud helps it to be a commodity," says Kalman. "Computing capacity is becoming like electricity or water."

A particularly interesting aspect of TVH's cloud usage is its use of the cloud to collect and process data from more than 5,000 connected vehicles and other equipment such as fork-lift trucks – leased through the rental business.

Kalman explains: "Our equipment is able to produce a tremendous volume of data. We want to use that to achieve more efficient fleet management. One of the most exciting goals is moving from corrective maintenance to predictive maintenance, where we maintain our vehicles based on need, and can understand immediately if things go wrong. The equipment used for the Internet of Things does not itself have the capacity for storage and computing – so this is where the cloud comes in."

TVH sees the benefits of cloud not just from the perspective of cost. "Having the possibility to manage everything in a standardised way does help achieve cost savings, but that is not the first driver for cloud for us," says Kalman. "The main aspect was flexibility and availability to support a growing business." Cloud has also brought 'applications' to the fore and has enabled business-people to become more directly involved in choosing and introducing solutions, opening new opportunities to increase productivity."

Mobility is another business requirement that has been supported by the cloud. Kalman notes that: "Our technical library is being mirrored everywhere we need it – giving us availability across the world."

In general Kalman sees technology as providing tremendous value-add to its business, and cloud is extending this value and providing new opportunities for the business – for example in relation to the Internet of Things. "All businesses with a service activity will be impacted by this evolution," he says. "It is not just about outsourcing, but disrupting and changing our view of how we do our business."

As cloud takes an increasing role in TVH's business, so the importance of Internet capabilities increase. TVH has seen increasing demand for fixed and especially mobile capacity, the latter driven by IoT, which can generate as much as 200 Terrabytes per year. "The Internet is critical for our company. 85% of our daily commerce goes through Internet," says Kalman. "We have a good SLA for service availability from Google, but if my Internet provider is down, I don't have any cloud." In order to address these issues, TVH is investing in capacity – building up three different Internet paths and pursuing 'local Internet break-out' solutions so that each corporate centre has a direct connection. The change of focus towards public cloud services has to some degree allowed TVH to make savings on their corporate WAN. "Previously a main focus was connectivity between company sites. That has quite a high level of cost. As we are moving to the cloud, there is a shift from private secure networks to the public Internet, which is another price level. It also means however that having good capacity and availability for the Internet has become very important. Every single company would be ready to pay money to have those elements," says Kalman.

Although there are numerous benefits that TVH enjoys from the cloud, they nonetheless note some remaining concerns. One is compatability between different cloud providers. "Vendor lock-in can be a concern." Interoperability and how to integrate with cloud-based solutions can also be a challenge. Kalman would welcome further standardisation efforts within the industry.

Security is another key challenge. "You have the feeling that being surveyed is easier to do in cloud than in your own data centre. If you let security concerns govern your decisions, you cannot take full advantage of the cloud," says Kalman. Privacy and security are two areas which Kalman considers could benefit from the attention of policy-makers. Another area in which Kalman would like to see policy leadership is in enabling IoT to be able to communicate with cloud in a more efficient and cost-effective way. These are not traditional 'broadband' questions, but rather how to enable cost-effective mobile narrowband communication for billions of connected devices.

TomTom – Ronny Bovijn

TomTom is a global provider of navigation solutions headquartered in Amsterdam. In the last reported financial year its turnover was €950m of which more than 50% was in the EU. TomTom employs 4,200 staff with more than 2,500 in the EU. In 2014 they expanded their workforce by 600, included a significant increase in their workforce based in Poland.

TomTom's consumer division manufacturers navigation devices for vehicles as well as providing real-time traffic information. It also produces sports watches for running, cycling and multi-spoirts.

TomTom's business to business division operates Europe's largest fleet management system in Europe. TomTom's devices and multi-platform software allow companies to track and gather data on fleets of vehicles, enabling them to optimise their route to reach their destination faster and reduce fuel consumption.

In the past TomTom maintained an extensive internal IT system. However, in recent years it has increasingly been migrating to the cloud – transferring its customer relationship management to salesforce.com two years ago, and their SAP database four years ago.

Cloud allows TomTom to focus its efforts on its own core business

Ronny Bovijn, VP for Infrastructure Services at TomTom explains that a primary reason for moving to the cloud for support services was to focus on TomTom's core business.

He says, "In the past we had our own CRM, but we asked whether it was a key business. We decided it was not, so we looked at what we could buy 'off the shelf'. We also spent time in the past maintaining and developing our SAP system, but keeping it up-to-date costed a fortune, and we lacked the staff to implement new aspects." Ronny notes that because IT is cloud-based providers' core business, and they receive requests for new functionality from many companies – they can gather ideas together and deliver faster and more cheaply. "Freeing up resources that were used for internal IT can allow headcount to be shifted to real production – the areas that give you money," says Ronny.

TomTom also uses the cloud to test their own software for new products and services and for automated testing. Ronny explains that testing requires high peak-loads and processing capabilities. In the past, they set up hundreds of servers for this, but were using them for as little as one hour per day. With the cloud, they can run the test for 1 hour and pay only for what they use, meaning substantial cost-reductions.

TomTom is in the process of moving their communication and collaboration applications to the cloud, and will be using Microsoft mail services, Sharepoint and LYNC. As TomTom has operations in 68 countries, migration will be an important challenge, but the move should ultimately streamline the operation and bring benefits.

The benefits that Ronny observes from cloud are not all cost-related. Speed and flexibility are strong drivers also. “If I have a great idea and I want to put it up today – the cloud is one-click away,” he says. “If you go to a new country, it is much easier to enable the infrastructure in the cloud. People can start working immediately,” he says. Ronny points out that it is also easy to switch off extra capacity if the business doesn’t work out. This extra flexibility makes the business case easier.

Cloud services are also good at supporting a multi-device model, allowing access from wherever you are. In this context, Ronny particularly cites the benefits of Google’s offerings, which aim to move data close to the user to ensure effective access around the globe.

Another benefit for TomTom has been the role of cloud in bringing together different platforms, which is especially important for them as a significant number of their workforce rely on Linux. The competitive pressure in the cloud environment has helped to deliver on this important requirement, he says.

One area in which TomTom is not yet relying on cloud services is for its Machine to Machine (M2M) activities. TomTom creates traffic profiles by gathering anonymised data from more than 70m mobile devices and analysing how fast devices are moving in order to estimate traffic patterns. “Each second we receive millions of entries, which allows us to process the data in real-time,” explains Ronny. “However, because this is a process that never stops, it makes more sense for us currently to use our own data centre. If we paid on a usage-basis, it would cost a lot more.” Ronny notes however that TomTom keeps their IT support constantly under review and that the decision could change if cloud prices keep falling. “We always consider cloud when we ask how we should manage our applications,” he says. “We ask ‘Do I need to manage it myself?’ If the only reason is because it is cheaper – then we watch prices.”

Security and ‘loss of control’ are concerns in some cases

Ronny notes that although there were many positive aspects, nonetheless there have been a few negative impacts from moving to the cloud. TomTom had a high degree of integration amongst its systems, and lost some functionality by losing the cloud – such as picking up voicemails via email.

Security is another concern that could mitigate against using cloud solutions. “If I have significant Intellectual Property invested in an application, then I might want to keep it in-house, because I know how well it is protected,” he says. A key recommendation Ronny makes to cloud providers is that “Providers should disclose the way cloud is protected to give confidence, so people know what kinds of risks they take.”

Another experience that is common to many cloud adopters is the loss of control, and issues with troubleshooting if problems occur within the cloud. This is another area where Ronny believes greater transparency could help improve the experience.

Cloud is unlikely to overload telecom networks

Interestingly, despite TomTom's 'cloud first' approach, Ronny believes it has had, and will continue have a neutral effect on their demand for bandwidth. "Operators' equipment becomes less and less expensive and capacity is increasing," he says. "A 1G switch is cheaper than a 100M switch of 10 years ago. In the past VoIP required >300Kbit/s, but new technology means it now requires fractions of that speed. Demand and new technology will balance out," he concludes. "So fears that cloud will 'overwhelm' telecommunications operators' networks may be overblown."

Use of public cloud may however allow TomTom to save on expensive MPLS connections, which currently offer high capacity and secure links between offices and data-centres. Although they will continue to need to ensure quality of service, TomTom will increasingly be able to move to a hybrid model, where some services such as mail are provided over the Internet.

Fragmentations in data policy are main public policy factors holding back cloud

As far as public policy is concerned, a core concern are diverse rules preventing free movement of data. "In some situations we are not allowed to export map data to be processed elsewhere," says Ronny. "In some countries there are also laws which prevent you from exporting data about individuals outside the country," he adds. A key action for policy-makers should therefore be to align policies so that all personal-related and other information can be held anywhere in the EU.

Coca Cola Europe – Laurent Bonherbe

Laurent Bonherbe, a French national living in Hungary, is Technology Platform Director at Coca Cola. He is responsible for Coca-Cola's infrastructure projects in Europe, and certain global projects, in co-operation with his US Atlanta-based colleagues. His recent IT challenges have included the redesign of the global wide area network (WAN), the start of a Lync Enterprise Voice initiative and office moves in Paris and London.

"Cloud is pivotal to what we do," says Laurent. "We have a far-ranging strategy, based on public cloud first."

Coca Cola in Europe is part of the $47 bn global Coca-Cola group business. Coca-Cola's 2013 annual shareholder report shows that it had 2,900 employees in Europe out of a worldwide workforce of 14,500, focusing mainly on brand management, marketing, product innovation, promotion and planning. Coca Cola group acts as a consulting organisation offering knowledge management, finance and collaboration for an extensive network of producers and franchisees employing further staff across the EU. For example, Coca-Cola Group's activities support Coca-Cola Hellenic, which is the second-largest independent Coca-Cola bottler, operating in 27 countries in Europe and Nigeria with a turnover of €6.9 bn, a workforce of 38,000 and serving a population of around 580m people. As such, Coca-Cola Group's activities can have a multiplier effect across the European economy.

Coca Cola Europe has pursued a pro-active approach towards migrating to Cloud, with usage increasing from zero around 5 years ago to well over 70% of applications within the company. "We have 800 applications," says Laurent. "For each application we ask – where can we host it? The first answer has to be public cloud. We start as much as possible with software as a service. We are not in the business of designing software or managing infrastructure. We want to focus on what we do best, which is to put our service in front of internal and external users. So we ask - is there a software as a service offering that can fulfil needs, with minimum customisation? If doesn't exist then we go to Platform as a service. Only if public cloud is not possible do we go for private cloud or hosting in our data centre."

"There are several benefits," says Laurent. "One is flexibility - you pay for what you use, and clearly that reduces costs. Another is that it allows the company to retire old applications more easily and keep pace with technological change. The applications landscape is moving all the time. Cloud helps to reduce engineering cycles – making life faster. For consumer websites the fact that we use public cloud infrastructure reduces the lifecycle for those developments, helping us to get content in front of consumers faster and with the right security considerations."

Coca-Cola EU's first experience was with Office 365. "One of the bottlers was one the first large-scale clients", explains Laurent. We followed them in 2010/11. Previously we used Lotus Notes. It involved lots of servers in different places and was not running as smoothly as desired from an operational perspective. As a communication-oriented organisation, email outage was one of the biggest problems that could happen in this company, and it was frequent – around once every 2 months.

The change to Office 365 was radical involving a change of the email client and back-end, and it was our first experience with the cloud model, but it was a huge success. We didn't have outages any more, and another advantage was the possibility to use a multitude of different mobile devices with inbuilt security, something that was not supported by Lotus at that time. Subsequently we moved from Lotus Notes to Sharepoint for knowledge management and achieved the same kind of benefit. Now we are trying to do the same for every corporate application that we have. During the migration to cloud we have seen a steady increase in our annual measurement of 'user satisfaction' relating to their perception of the operational effectiveness of IT from 3 to 4 out of 5."

The change was not without challenges. "Losing control and the ability to tailor to our exact needs was difficult at first," says Laurent. "We had become complacent about customisation, and used to love to change stuff. However, the consequence was that – pre-cloud – our systems had become complex and costly to maintain. We were spending a fortune on legacy applications. It was 'customisation to death' We discovered that despite short term difficulties the benefit of cloud-based services was that it simplified and standardised applications and forced us to adapt to a simpler more consistent mode of operation."

Laurent believes the way the whole industry is going now is "off the shelf" towards applications that can evolve quickly and are simple to maintain.

One of the biggest side-effect of the adoption of cloud has been increased demand for bandwidth. Coca-Cola Europe used to operate with a network based entirely on MPLS with "not that much bandwidth capacity". Laurent explains that it was principally focussed on supporting the user to gain access to a local or regional data centre. With the move to cloud, they realised that the Internet access link in Brussels was not sized to handle such a large proportion of applications.

Coca-Cola responded by significantly increasing its Internet connectivity bandwidth by up to 5 times, but it was not only a case of increasing bandwidth, explains Laurent, but also radically changing the architecture of the WAN towards a hybrid WAN. Laurent explains that they still use MPLS for some corporate applications and internal collaboration tools such as video conferencing and legacy applications. However, they combine this now with a high bandwidth lower cost VPN network – often supported by broadband connections. A core challenge for Coca-Cola is to keep increasing bandwidth whilst keeping the budget flat. Fortunately, in Europe, they find that Internet bandwidth is both available and relatively cheap, which is not true of all countries in the world.

Coca-Cola has already transferred a large portion of its application to a cloud-based platform. However, cost (the combined cost of the cloud service and network connection) remains a barrier to transferring the remainder. Laurent observes that they conducted an analysis of the costs of transferring the Brussels data centre to an IaaS solution, but found that it was cheaper to continue to run it internally. However, since then, Laurent notes, the price has decreased. A second barrier is maintaining security. “This issue can be solved but is costly,” says Laurent. Lastly, he notes that they need to make priorities when migrating applications and tend not to prioritise legacy applications which are planned to be shut down. “Overall, we want to reduce the number of applications,” says Laurent. “The smartest solution may be not to run them at all. We should standardise on the best.”

Although many of the cloud and applications providers to Coca-Cola and Coca-Cola itself are North American, Laurent emphasises that cloud has a significant positive impact on Coca-Cola’s European workforce and the producers which depend on it. “We don’t care about the nationality of the provider of our services,” says Laurent. “We want to concentrate on what we do well, offering simple tools to our users to help them achieve what they want to achieve. For example, our tools might support a brand manager in Spain to making sure he or she is promoting brands in the best possible way and is maximising sales to local consumers. In turn, that brand manager will work in close collaboration with our bottling partner in Spain.

Laurent’s message to policy-makers is that they should try to keep things simple and not erect barriers where there shouldn’t be. “The intentions are good,” says Laurent, “but not always the results”. Data protection is one key topic. It would be better to have a harmonised approach, and simpler to have common institutions,” he concluded.

Syntra – Emmanuel Cambron

Syntra is a Belgian regional government agency, which organises training of contractors and craftsmen in areas where job shortages remain in order to support the local economy. Syntra provides early school-leavers with a means to 'learn on the job' by taking apprenticeships where they can combine learning with other day-jobs.

Syntra has a budget €140m, and employs 140 people in 5 locations within Flanders and Brussels.

Syntra is interested in finding out how cloud could support their activities. As an organisation they do not use it officially, but know that people within the organisation are using it every day through their individual initiative – for example to share documents online.

Syntra's main motivation for exploring cloud use is cost reduction to meet challenging budget reduction targets. Initially they are considering it not for core business applications, but only for supporting tasks such as email. In Belgium, they benefit from abundant and cost-effective Internet connectivity, so this is not a barrier to cloud use. However, they face other obstacles, which have thus far inhibited their decision to move services to the cloud.

The main barrier for them are security and privacy concerns, as they hold sensitive information, which must be kept secure and within the EU. They find it difficult to obtain contractual guarantees that data will remain in Europe and are concerned at the possibility that foreign authorities might oblige suppliers to reveal the data.

They are currently trying to weigh up the risks associated with security, with the potentially significant cost-reductions of up to 50% that they believe could be achieved.

Syntra would like to see support from policy-makers on privacy and security issues, with guidance for example on where data is stored and the jurisdiction over that data. They would also appreciate actions from service providers to offer ring-fenced European services and make greater commitments around security.

Another internal challenge they face in their journey towards cloud is the need to train their staff and communicate changes in software. These learning hurdles apply not only when starting with a cloud-based service, but also when the cloud provider updates applications.

Syntra is keen for all parties to find solutions so that they can feel confident in embracing cloud. "We must go fast, because we have no time to lose," they conclude.

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