GSR discussion paper

The impact of data on ICT business models

Work in progress, for discussion purposes

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The economic influence of data and their impact on business models

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Executive summary

An increasing number of devices that collect and transmit data have been improving access to data. New data transport, storage and analysis procedures have been enabling more and more businesses to utilise data in their business models. This indicates a trend towards data becoming a new driver of economic growth. In light of this development, this paper first traces the evolution of business models built around data and it finds evidence for a sustained structural change leading to a data-driven economy that policy-makers and regulators need to be alert to. Hence, a structural approach to analyse this economy and its development is devised: the data value circle. When applied to analyse the market size and prospects for each of its parts, three important characteristics of the data-driven economy emerge. First and foremost, this first analysis underlines data's economic influence stretching across almost all sectors. Second, it is found that the data-driven economy is shaped by two-sided markets that seem prone to create dominant positions in the market and thus should be monitored by policy-makers and regulators – especially since, third, the analysis indicates that it is still uncertain which players will win the most powerful position.

This last finding merits a closer investigation of business models, strategic options and emerging challenges in the data-driven economy. Thus, this paper analyses five key value propositions and surrounding business models: (1) Mobile device ecosystems; (2) Connectivity; (3) Cloud services and content delivery networks; (4) Targeted online advertising; (5) Video streaming. From these analyses, strategic options of market players and emerging challenges for all stakeholders were identified. Finally, the paper sketches potential avenues for policy-makers and regulators in response to these challenges. The following challenges and potential responses represent the main findings of this paper:

Independent from their position in the data value circle many actors aim to gain a foothold or even control in additional parts of the data-driven economy. If they are successful, they might be able to gain a dominant position and may be able to exert it to hamper competition. On the other hand, such a dominant position would grant them access to data that would allow full profiling and potentially may lead to concerns as privacy and data security. Policy-makers and regulators should be aware of this trend and closely monitor it.

Instead of entering other market segments themselves, the paper shows that partnerships can be a powerful way to build successful business models. Such partnerships may be an attractive avenue for OTTs and operators, for instance, as regards preferential treatment of specific OTT services that can increase the operator's value proposition. Such partnerships may lead to quasi managed services for some OTTs in some networks and they deserve the attention of regulators to ensure sustained fair competition.

Due to the value that data hold for successful business models today, there are strong incentives for all actors in the data-driven economy to collect as much data as possible. Consumers are often unaware about if and which data are collected about them and what happens with these data. More often than not, they cannot make informed decisions. Policy-makers should take steps to enable consumers to such informed decisions. First and foremost, it will be necessary to find out how consumers conceptualise personal data and what terminology they use. This will enable effective information and more transparency for consumers. Next to information and transparency, one may also consider steps to enable consumers to access the data that, for instance, OTTs and operators have about them.

Finally, it became obvious that the data-driven economy is very much a global economy. Thus, all the above interventions may have little effect if they are only applied on a national level. In essence, the structural change towards a data-driven economy calls for internationally agreed responses by policy-makers and regulators. Consensus needs to be reached regarding governance, the organization of the process, implementation, enforcement, and cooperation for all major policy actions that may be necessary to ensure an overall positive economic effect of this structural change.

1 Introduction

With the spreading of digitization and the Internet as well as the evolution of devices connected to it, the ability to collect, analyse and utilize data has made huge leaps recently. Numerous, often innovative business models ranging from data transport and data storage to sophisticated data analysis as well as insights creation are based on revenues essentially gained from data. This indicates a trend towards data becoming a new driver of economic growth and their significant impact on business models. The present paper will therefore start by tracing technical innovations that have enabled better access to as well as transport and utilization of data. Each of these innovations has triggered new business models that ultimately result in a sustainable ongoing structural change resulting in a data-driven economy that policy-makers and regulators need to be alert to.

Data have gained economic influence far beyond the 'traditional' ICT-actors. For instance, pharmaceutical, biological and chemical research and development has become very much data-driven. Cars feature Internet connectivity collecting and analysing data to provide safety and comfort functionalities. Home appliances become 'smart' by being aware of their environment and reacting accordingly based on data. On the other hand, these data have to be made accessible to the end user. They have to be transported and handled. Otherwise, no meaningful services based on data can be developed nor successfully applied. As policies and regulation have a significant impact on whether all these value propositions can work hand-in-hand and initiate positive economic effects, policy-makers and regulators need to understand the interrelations of different actors. To this end, this paper develops a structural framework of the data-driven economy by defining stakeholder relationships – the data value circle. It also highlights some of the key characteristics of the data-driven economy such as two-sided markets that already hold some policy implications. Building on this structure, it is important to recognise the economic importance and projection of each sub-market and the role it plays for the ongoing structural change. This paper will therefore briefly analyse each segment in the developed structure.

Besides cutting across numerous sectors, the data-driven economy shows some other rather uncommon features:

- Data unlike most other economic factors become more valuable with increasing availability.
- Consumers often pay with their data not their money, but seem to be largely unaware of this.

In light of these characteristics, the paper sets out to analyse specific value propositions within the data-driven economy as well as the business models that surround it. This part of the paper will emphasise the functioning of business models, their profitability and the strategic options they enable. Emerging challenges for actors within the data-driven economy as well as policy-makers and regulators will be identified.

In fact, various challenges may emerge from the business models in the data-driven economy and the strategic behaviour of its stakeholders:

- Strong incentives to gather more and more data about consumers have to be balanced out with consumers' interests and privacy.
- Increasing data traffic needs to be dealt with in an efficient and fair manner to all competitors.
- Consumers need transparency and empowerment as regards their own data.
- Effective solutions have to be brought forward to clarify and simplify jurisdiction across borders that can cope with the global nature of the data-driven economy.

These and other challenges identified throughout the paper will be summarised and potential avenues for policy-makers and regulators will be sketched at the end of this paper.

Section 2 traces the development of technical innovations and business models in general that have led to the data-driven economy as we see it today. Section 3 develops the data value circle as a structural

framework of the data-driven economy that allows a more in-depth understanding of the individual segments as well as their interrelations. It also provides a first analysis of the value of the data-driven economy exploring the market size and market development for each segment in the structure. Section 4 selects and analyses key value propositions and their surrounding business models from the data-driven economy for in-depth analyses. Within that the emphasis is put on the profitability and potential strategic options these business models enable as well as challenges that may emerge from these options for both actors in the data-driven economy, policy-makers and regulators. Finally, Section 5 pulls together the insights gained in the paper, summarises the challenges that may emerge and sketches avenues for future policies and regulation in light of anticipated strategic behaviour of stakeholders in the data-driven economy.

2 The evolution of the data-driven economy

This section aims to trace how technical innovations have made it possible to collect, analyse and utilize ever increasing volumes of data and how this has triggered a process of structural change building on data as the driver of economic growth. Starting with the first computers and early networks, the evolutionary paths to a data-driven economy can be split into four phases that revolve around the evolution of the World Wide Web:

- Phase 1: The commercialisation of the World Wide Web

Access to data has gone through significant changes during the late 20th and early 21st centuries mainly due to the invention of the computer. As soon as the 1960s, early forms of computer networks developed, which can be considered the predecessors of the Internet and World Wide Web as it is known today. The latter began to evolve in the early 1990s. At first, the few websites that existed usually provided information from public institutions or followed largely altruistic motives. The commercialisation of the Internet commenced with the Global Network Navigator (GNN), which was the first site that generated revenues through online advertising. The dominant trend at that time, however, was to transfer traditional brick-and-mortar business models into the online world. For instance, Amazon and Ebay started their online presences in 1995.

- Phase 2: The "seek and find" growth phase of the World Wide Web

With the amount of data available on the World Wide Web increasing dramatically over the next years – the number of websites increased from 10,000 in 1994 to 650,000 in 1997 – a need was created for a more convenient way to navigate the web as compared to the ever more crowded directories common at that time. This led to the first business that can be considered data-driven in the sense of the present paper, i.e. search engines. Their main purpose was to offer users a free, quick and reliable way of finding their way through the Internet. On the other hand, they were able to sell online advertising to businesses that soon was individualised by adapting to the keywords entering in the search field. Thus, it offered a much better targeting than other forms of advertising. To improve their service to businesses that pay for these advertisements, search engines providers have started to collect more and more data about their users. In essence, data have become the pivot of their business models today. They need to be able to analyse large volumes of data quickly to provide a satisfactory search service and match the online advertising accordingly. On the other hand, they have to collect, analyse and understand data about consumer behaviour to offer the most competitive service to their paying customers.

- Phase 3: The "always on" growth phase of the World Wide Web

The advent of broadband connections and flat rate charges in the 2000s increased the importance of data as it enabled consumers to be 'always on' and the use of data intensive services. As regards business models that profited from these developments, the most prominent examples include social networks (e.g. Facebook, MySpace), file sharing services (e.g. Napster) and messaging (e.g. ICQ) as well as video telephony (e.g. Skype). The first examples rely heavily on online advertising to monetise the services they offer for free to the public. Therefore, they are also keen to collect and analyse user data. For the latter,

digitised data have presented a way to enter markets that formerly were controlled by network operators.

- Phase 4: The "on everywhere" and "seamless integration" phase of the World Wide Web

The introduction of the IPhone in 2007, the first smartphone, and its revolutionary user interface building on so called apps available through the Apple iTunes AppStore, which was swiftly followed by others, added 'on everywhere' to the already existing 'always on' culture. Mobile devices in particular are always in standby, always physically close to the consumer and with the app-inspired user interface the threshold of using the device and going online has fallen dramatically. This has increased the volume and value of data that can be collected about consumers and their behaviour. In turn, these data enable new kinds of business models that are able to offer even complex services to consumers seemingly free of charge. Whilst some of these business models are very profitable (e.g. Google and Facebook), many competitors struggle to monetise their services sustainably (e.g. Twitter, Spotify, Pandora). Next to advertising-based business models, some subscription-based ones seem to be successful as they managed to adapt quickly to the multi-device environment (e.g. Netflix).

In sum, this evolutionary path reflects the growing influence that data have been having on the economy. In phase 3, messaging and telephony services based on data have started to substitute messaging and voice services offered by network operators. In phase 4, music and video streaming services begin to enter the business of traditional media companies. Apps realise mobile services from various sectors everywhere and consumer data have become a key resource in the fight for advertising investments. Recently, one observes that continuously, new types of devices connect to the Internet, collecting and transmitting data that supports or initiates new business models in many sectors. In essence, this indicates a structural change towards a data-driven economy that is likely to affect all economic sectors. Within that interrelations between the individual groups of actors have to be clarified and the prospects for individual parts of the market should be investigated to evaluate their relative weight within the data-driven economy. The following section therefore aims to develop a structural framework of the data-driven economy that enables an in-depth understanding of these issues.

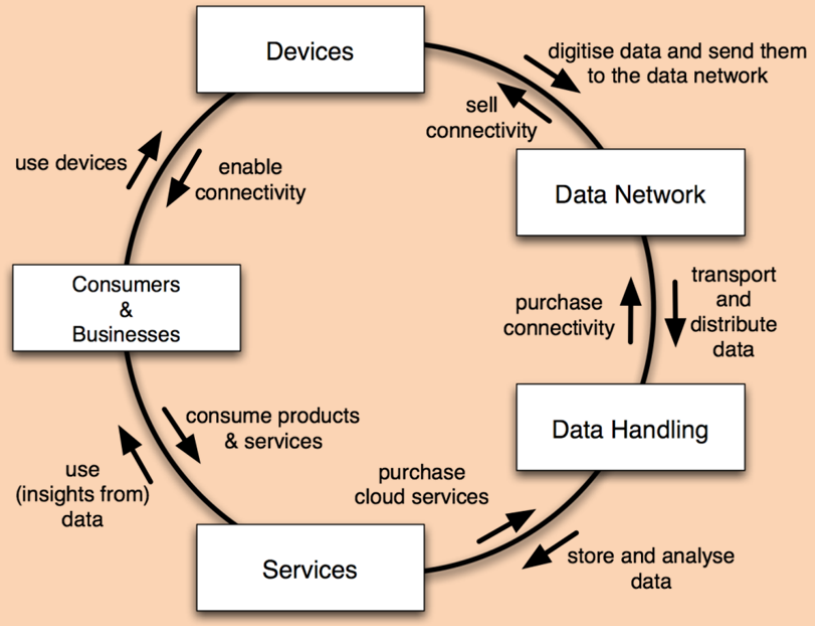
3 The structure of the data-driven economy – the data value circle

A structured approach to defining the individual groups of actors within the data-driven economy is missing thus far. The first section here develops such an approach – the data value circle. The following section investigates the size of the market and the prospects for each group of stakeholders. This will help policy-makers and regulators to recognise the importance of the shift that is going on. Furthermore, for each group of stakeholders, key insights will be derived that either characterize their role in the data value circle in more detail or highlight potential challenges that need to be addressed by complimentary policy or regulatory actions. Such measures will be sketched in Section 5 based on the identified challenges. The final Section 3.3 summarizes general characteristics of the data value circle that emerge from the preceding sections and that will aid to contextualise the challenges identified before as well as the following business model analysis.

3.1 The data value circle

The first and most obvious difference of the data-driven economy as compared to traditional sectors is the form of its structure. It is not characterized by a simple linear value chain that has a defined start and endpoint. Rather, the data-driven economy has to be thought of as a value circle. The actors found in each segment can interact forwards and backwards with other actors in the circle. The data that is exchanged and monetised throughout the value circle originate from consumers and businesses. Consumers and businesses also constitute the end users of services based on these data. Figure 1 provides an overview of the data value circle.

Figure 1: Data value circle



Source: WIK-Consult (2014)

On the one hand, the consumers and businesses which comprise the data value circle produce digitised data by utilizing devices.

Data can be produced consciously by consumers and businesses (e.g. by typing a letter) or unconsciously (e.g. by moving around with a mobile phone in their pocket that tracks their movements). On the other hand, consumers and businesses consume services that are ultimately based on the data they have produced in one way or the other. Next to digitizing data, devices also transmit these data into the network. They therefore fulfil an important function in the data-driven economy. Data networks transport and distribute these data most commonly to providers of data handling such as cloud services or content delivery networks, who support both providers of data networks as well as providers of data based services. This final segment of the data value circle is the one most discussed in the public. Most OTTs offer services and products based on data or insights stemming from data to consumers and businesses. Such services include, for instance, audio and video streaming on the one hand, but also targeted online advertising that more often than not serve as the major source of revenue for these companies.

The following sections investigate the market size, revenues gained in the market, and the potential development of the market for each of these actors or market segments in turn.

3.2 Market analysis along the data value circle

3.2.1 Devices as part of the data-driven economy

Devices within the data-driven economy enable data gathering and data transmission into the network. They constitute a necessary precondition for any consumer or business to connect to the Internet and use services offered digitally. Such devices can be stationary as well as mobile. For instance, they include naturally PCs, laptops and mobile phones as well as tablets, but also stretch to other things like cars with built-in infotainment and security appliances, home automation systems or refrigerators. Next to the distinction between stationary and mobile, it is also important to look at how these devices produce data namely with or without human interaction. For instance, PCs, laptops and phones require human interaction to produce data at least once when you agree that certain data may be tracked and send from

e.g. your phone. Cars or home automation systems often have built-in data gathering and transmission functionalities to provide comfort or safety functions; in some cases the consumer may be unaware if, which and how much data are collected. Most often, he or she cannot opt out if comfort or safety functions are to be used. Independent from the awareness of the consumers, the data brought into the data value circle by mobile devices and in particular mobile phones appears to be especially valuable due to their physical and psychological proximity to their users.

The number of devices connected to the Internet ultimately defines the market size of this segment in the data value circle. This number is growing fast. This is true for both "traditional" ICT-devices such as PCs, laptops, mobile phones and tablets as well as more unconventional ones like cars, watches or home equipment. Turning to "traditional" ICT-devices first, one clearly recognises a strong and ongoing trend towards mobile used to access the World Wide Web. In fact, mobile devices are likely to become the most important access point to the Internet for the next few years. They are much more widespread than PCs or laptops with fixed access already today and their numbers are still increasing sharply. Furthermore, in most developing countries they are often the only way to connect to the Internet. Many other devices that collect and transmit data are also mobile, for instance, cars with infotainment or safety functionality, smart watches or wristbands. To discuss the whole breadth of products that can be subsumed under the flag of the data-driven economy would certainly go beyond the scope of this paper. However, the number of devices connected to the Internet as registered by Cisco's Connections Counter[1] is certainly indicative for the trend that more and more products rely critically on an Internet connection and offer enhanced functionality through data. In May 2014, there were substantially more than 12 billion connections counted by Cisco, who expect this number to rise to 50 billion by 2020.

Despite the multitude of types of devices and stakeholders, it is surprising that a key enabling part of devices – their operating system – is controlled by only a handful of players. The leaders in this market are Google (Android) and Apple (iOS). Both of them have made steps to extend their influence into e.g. cars by joining up with car manufacturers and suppliers, homes by set-top boxes or thermostat appliances or wearables like smart watches.

This first general investigation of devices as part of the data value circle generates the following insights:

- Devices play a key enabling role in the data driven economy.
- Consumers may often be unaware of whether, which and how much data are collected about them.
- Many stakeholders produce and sell devices; however, very few control key components of devices such as their operating system.
- The importance of devices within the data-driven economy is likely to grow as more and more devices connect to the Internet entering all areas of our lives.

3.2.2 Data networks in the data-driven economy

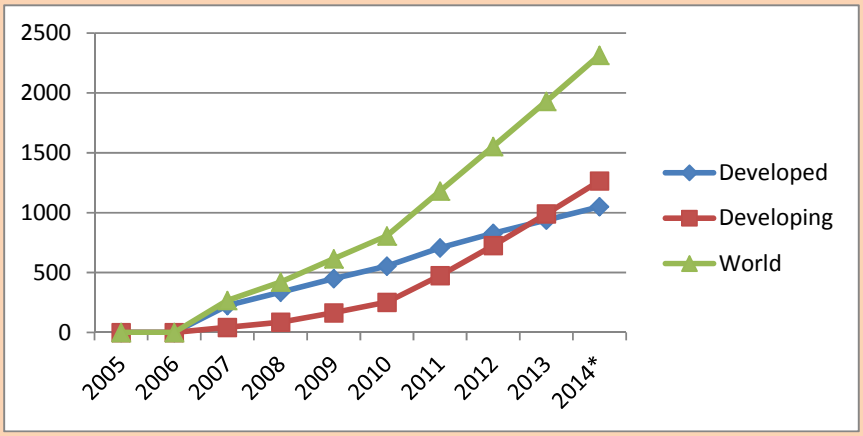
Data networks are at the heart of the data-driven economy. They transport the data that devices produce and distribute them. Connectivity can be provided either as fixed line access or mobile access to the end users and is commonly converged to a fixed access when transmitting data to those who have specialised in handling data.

[1] Cisco (2013): Connections Counter: The Internet of Everything in Motion, available at: http://newsroom.cisco.com/feature-content?type=webcontent&articleId=1208342

A strong indicator for the size of the relevant market is the number of broadband subscriptions that potentially can bring data into the data value circle using the numerous devices that can collect and transmit data. The following paragraphs will therefore analyse the development of mobile as well as fixed broadband subscriptions worldwide.

ITU numbers[2] for mobile broadband subscriptions show for 2014 an estimated continuation of the constant growth observed since the mid-2000s (see Figure 2). A continued path of subscriber growth is expected for both developing and developed countries, whereas subscriber numbers in developing countries have surpassed those in developed countries in 2013, plus the growth rate in developing countries is significantly higher than in developed countries. In 2014, more than 2.3 billion subscriptions worldwide will be reached. This reflects a penetration rate of close to 32 %. Ericsson's research looks further into the future and predicts 5.1 billion mobile broadband subscriptions by 2017[3].

Figure 2: Mobile broadband subscriptions in millions



Source: ITU World Telecommunication/ICT Indicators Database (2014)

The outlook for fixed broadband subscriptions (see Figure 3) looks similarly positive according to ITU figures (numbers for 2014 estimated). Although both the absolute amounts as well as growth rates of fixed subscriptions are lower than for mobile broadband, an outlook of further growth in the next years appears realistic. Year-over-year growth rates from 2013 to 2014 are at around 5.6 % worldwide (3.7 % in developed and 7.4 % in developing countries).

Despite increasing market size, it is often asserted that network operators have difficulties with decreasing ARPUs that fail to recover the costs inflicted by increasing volumes of data traffic on their networks. Obtaining revenue figures that capture the full market is not possible to the knowledge of the authors. Thus, the following paragraphs build on the mobile revenues of two prominent examples of network operators: AT&T and Bharti Airtel.

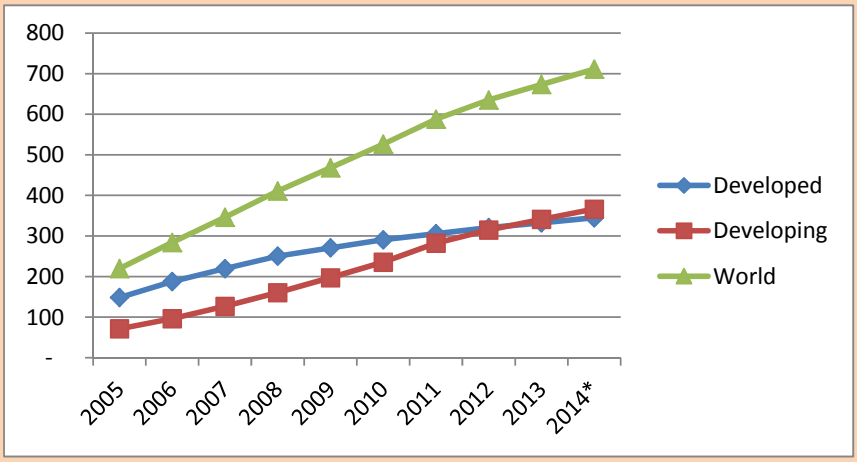
[2] ITU (2014): ITU World Telecommunication/ICT indicators database, available at: http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2014/ITU_Key_2005-2014_ICT_data.xls

[3] Ericsson (2012): Traffic and Market Report 2012.

AT&T was able to keep the overall ARPU almost stable from Q2/11 to Q2/13[4]. Within this period data ARPU increased, whilst voice ARPU decreased. Bharti Airtel was able to double its data ARPU from Q1/12 to Q1/14[5]. Voice APRU remained stable over this two year period. However, in the same period, data usage per customer increased also constantly – and significantly – in every quarter reported. The comparison of quarterly growth rates for data ARPU on one hand and data usage on the other hand reveals that data grew in most quarters faster than data ARPU (see Figure 4).

In essence, the two considered cases of AT&T and Bharti Airtel India show that overall ARPU does not necessarily decrease – it seems at least possible to keep it at comparable levels. Data ARPU was observed to increase nearly every quarter, which indicates that data business gains – and will probably continue to gain – even more relevance in the future. However, the faster growth of traffic volume than data ARPU may develop indeed into a significant challenge for sustainable profitability.

Figure 3: Fixed broadband subscriptions in millions



Source: ITU World Telecommunication/ICT Indicators Database (2014)

On the other hand, network operators may be able to compensate for a part of this trend by falling acquisition cost of IP transit traffic. TeleGeography research into monthly IP transit prices from Q2/08 to Q2/13 indicates that "10 GigE port prices have decreased at a compound annual rate of 28 and 30 percent"[6]. Price levels differ, however, significantly. Whilst prices in London have come down from 13 USD per Mbps on a 10 GigE port in 2008 to around 1.50 USD in 2013, prices in e.g. Sao Paolo are at around 20 USD still in 2013. Another means to compensate for fast growing traffic volumes for a network operator is to circumvent IP transit traffic by means of typically cost-free peering traffic whenever

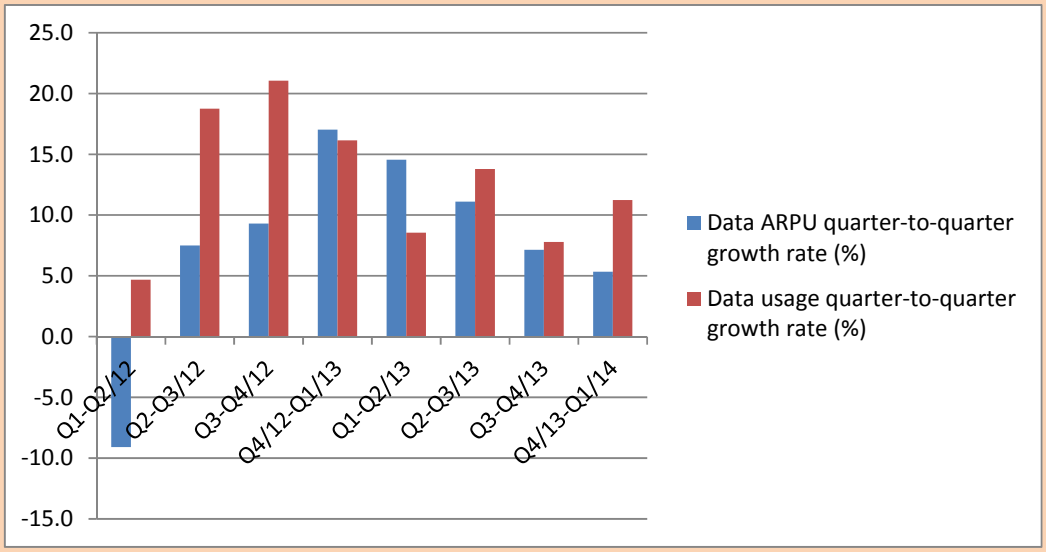
[4] Network Strategies: LTE vs ARPU – data takes over. Available at: http://www.strategies.nzl.com/wpapers/2013014.htm

[5] Bharti Airtel Quarterly Reports (2012-2014)

[6] TeleGeography (2013): IP Transit Port Upgrades Yield Steeper Price Declines for Buyers, available at: http://www.telegeography.com/press/press-releases/2013/10/08/ip-transit-port-upgrades-yield-steeper-price-declines-for-buyers/index.html

possible. The industry blog Dr. Peering forecasts[7] that most network operators will be able to extend their peering traffic to a level of about 25 % of their total traffic in 2015.

Figure 4: Comparison of quarterly growth rates for data ARPU and data usage (2012 to 2014) for Bharti Airtel India



Source: WIK-Consult, Data: Bharti Airtel Quarterly Reports (2012-2014)

In essence, this first analysis of the field of data networks within the data-driven economy results in the following insights:

- Growth in mobile devices connected to the Internet is reflected by a growth in mobile subscriptions worldwide extending the market for actors in the data networks segment of the data value circle.
- Data traffic is growing within fixed and mobile networks around the world and is likely to drive revenue for actors in the data networks segment of the data value circle.
- Data is a driver of costs. Although there are ways to circumvent potentially shrinking profits, in the long term the growth of data traffic may still pose a risk to actors in the data networks segment of the data value circle.

3.2.3 Data handling within the data-driven economy

Data handling includes all services that facilitate data distribution, storage and analysis. Within the data-driven economy, this refers to content delivery networks, cloud computing including infrastructure as a service (IaaS), platform as a service (PaaS) and software as a service (SaaS) and Big Data analysis. With growing data volume produced by devices, data traffic on data networks and more and more services

[7] Dr. Peering (2013): 2014 Transit Prices and Peering Projections, available at: http://drpeering.net/AskDrPeering/blog/articles/Ask_DrPeering/Entries/2013/10/25_2014_Transit_Prices_and_Peering_Projections.html

seeking to use these data, it only seems natural that also the size of the market for all kinds of data handling increases.

It is, however, difficult to pin down a number to the actual size of market as it is constantly evolving. Thus, this section slightly diverges from the common structure and describes only the development of revenues in this segment of the data value circle. The analysis of revenues first considers providers of cloud technology and services and then looks at providers of Big Data analyses.

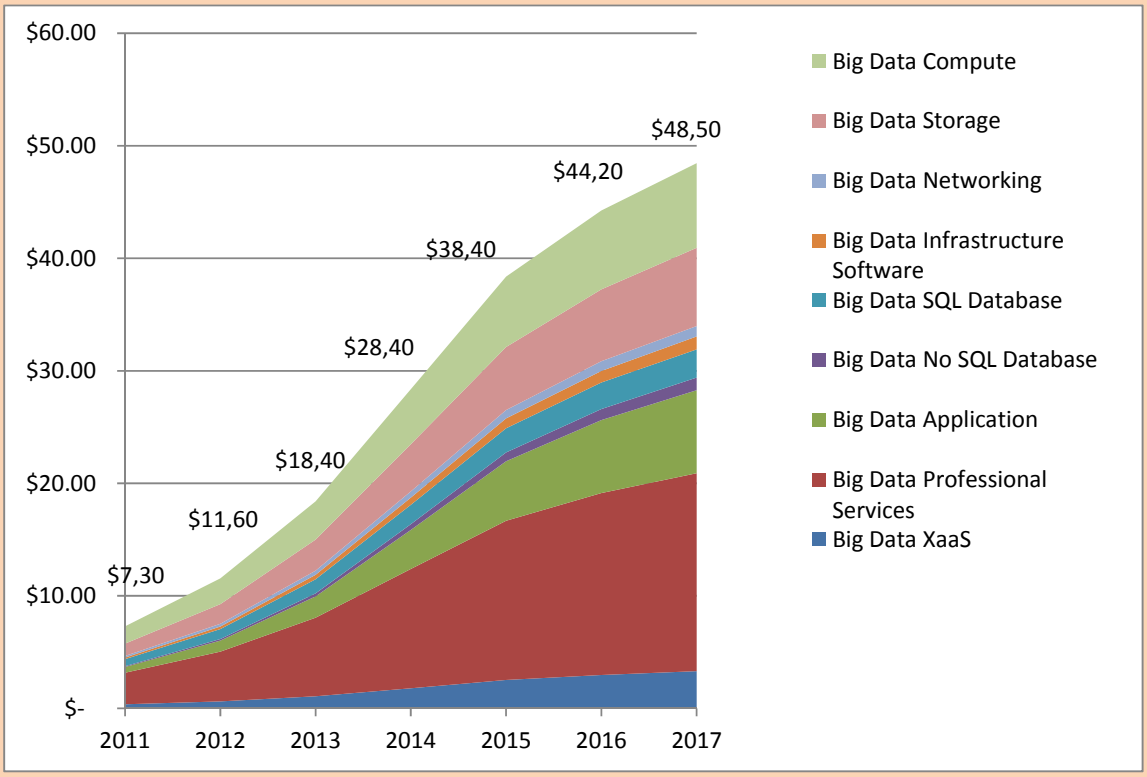
Publicly available insights into revenues for cloud technology and services are scarce. Synergy Research[8] estimate that the worldwide revenues for all cloud infrastructure services surpassed 12 billion USD in the fourth quarter 2012 growing 15 % from 2011. They predict that these revenues will grow more than six fold until 2017 accounting to more than 75 billion USD.

Within the market of cloud infrastructure services CDNs/ADNs contributed 11 % to revenues in 2013 (approx. 1.4 billion USD). The largest share was contributed by managed hosting (45 %) and collocation (29 %). The strongest growth, however, was identified for PaaS and IaaS (over 50 % YoY). Synergy Research Group expects these two cloud services to show a CAGR of more than 25 % until 2017. Next to infrastructure related services, SaaS is seen as the major driver of growth for cloud services. Forrester Research[9] report it at a revenue of 33 billion USD in 2012 and project that it will surpass 100 billion USD in 2017 reaching 134 billion USD in 2020.

[8] Synergy Research Group (2013): Cloud Infrastructure Services: Market Primer.

[9] Forrester Research (2011): Sizing the Cloud – A BT Futures Report. Understanding And Quantifying The Future Of Cloud Computing.

Figure 5: Big Data worldwide revenue 2011-2017 by types in billion USD



Source: Wikibon (2013)

Big Data services build on technology optimized for the handling of large quantities of data very quickly. For instance, such systems build on in-memory processing architecture like SAP's HANA or IBM BLU Acceleration. Big Data services are in high demand as businesses turn to Big Data more often to gain business intelligence and to make business decisions. Other applications can be found in the biological, chemical and pharmaceutical research. Estimating the market size of Big Data technology and services delineated from cloud infrastructure services is difficult as there is some natural overlap in the figures. IDC[10] estimates that worldwide revenues were just shy of 10 billion USD in 2013 and will grow to almost 17 billion USD in 2015. Particularly high growth rates are foreseen for storage (CAGR 61.4 %), networking (CAGR 42.4 %) and services (CAGR 39.5 %). Wikibon foresees even stronger growth in the field of Big Data (see Figure 5). They estimate the market size in 2014 at 28.4 billion USD and predict it to grow to 48.5 billion USD in 2017. Given the overlap with cloud infrastructure services in general, it can be assumed that in particular Big Data will be the major driver of growth in the field of data handling.

In sum, three insights can be drawn from the general analysis of data handling within the data-driven economy:

[10] IDC (2012): MARKET ANALYSIS: Worldwide Big Data Technology and Services Forecast 2012-2017

- Growing numbers of devices, resulting growth in data traffic load and increasing demand for services such as Big Data analyses from providers of data-based products and services (see next section) lead to increased demand for data handling.
- Data handling constitutes a critical supply function within the data-driven economy.
- Big Data is the major driver of growth in this field.

3.2.4 Services within the data-driven economy

Services in the data-driven economy can be understood as all services that build on digital data either in form of data gathered from consumers and businesses or digital content being distributed. Such services stretch to services aimed at consumers like social networks, IPTV, video and audio streaming or (mobile) applications as well as services aimed at businesses e.g. online advertising, business intelligence or market research. The following paragraphs will first shed light on different approaches to monetize services. Hence, the market size for each of these markets is analysed based on user and revenue figures.

Many services in the data-driven economy are offered for a marginal or even free of charge to the end user (usually consumers), but are monetized through offering services to other businesses like targeted online advertising or market research insights. On the other hand, there are also a substantial number of services that are offered on a subscription-based revenue model. Most commonly, these are video and audio streaming services showing premium content, dating services or news-related services. Additionally, one can identify hybrid revenue-models relying on a mix of fees and secondary monetization. Consequently, it is difficult to identify a single measure that would capture the development of the services market in the data-driven economy fully. Nonetheless, some indications as regards market size and development can be drawn from the figures presented in the following.

Indicators relating to usage of data-driven services are one way of understanding the market size for such services as well as their future development. All the examples of services mentioned in the above show increasing usage and analysts foresee further growth. Social networks have been adopted by users faster than any other innovation before. The most prominent examples, Facebook, Google+ and Twitter currently feature >1.2 billion, >500 million and >230 million users respectively. This is a trend that is certainly not limited to the developed world. For instance, Facebook has more than 50 million users in African countries[11]. Also the Chinese are very active on their own social networks Renren, Tencent Weibo and Qzone as well as Sina Weibo. E-marketer[12] foresees the worldwide number of users to climb to 2.33 billion in 2017 indicating declining growth rates over the next three years. Digital TV Research[13] shows at the end of 2013 already 88 million IPTV subscribers globally. They predict this number to almost double by 2018. User numbers for video and audio streaming are difficult to identify as most of these services offer a free and a subscribe option. For video streaming, Netflix is probably the most notable example. Its user base has increased from 34.2 million in Q1/13 to 47.8 million paying subscribers in Q2/14[14]. For music streaming, ABI Research[15] estimate the worldwide subscriptions to have reached 29 million at the

[11] SocialBakers (2014): Facebook statistics, available at: www.socialbakers.com

[12] eMarketer (2013): India Leads Worldwide Social Networking Growth, Country set to control largest Facebook population worldwide, available at: http://www.emarketer.com/Article/India-Leads-Worldwide-Social-Networking-Growth/1010396

[13] Digital TV Research (2013): Global IPTV Forecasts.

[14] Seeking Alpha (2014): Netflix: A Stock With Upside Potential. Available at: http://seekingalpha.com/article/2201453-netflix-a-stock-with-upside-potential

[15] ABIresearch (2013): Spotify to Hold 32% of 29-Mil. Music Streaming Subscribers Forecasted for End-2013, London, available at: https://www.abiresearch.com/press/spotify-to-hold-32-of-29-mil-music-streaming-subsc

end of 2013. The number of consumers using the free version of these services ranges between four- and six fold the number of subscribers depending on the service[16]. Mobile apps are even more difficult to grasp as only part of their services qualify as data-driven in the sense of the present paper. Mobile apps are most often only another channel for stakeholders from sectors outside the data-driven economy to offer their services such as travel services, e-commerce or infotainment. Some apps like the mobile versions of social networks, messengers and guiding/rating apps rely heavily on user data, whilst the online versions of video and audio streaming services draw a great load of traffic into mobile networks. A constantly increasing number of smart phones as well as available apps let this market grow over the next years.

Analysing corresponding revenue figures as it has been done in the sections for the other segments in the data value circle makes relatively little sense due to the two-sided nature of many data-driven services described in the above. The other side of the services market in the data-driven economy, which mainly consists of offering targeted online advertising to other businesses, however, highlights the financial impact of the growing adoption of such services. The following paragraphs will therefore focus on this aspect.

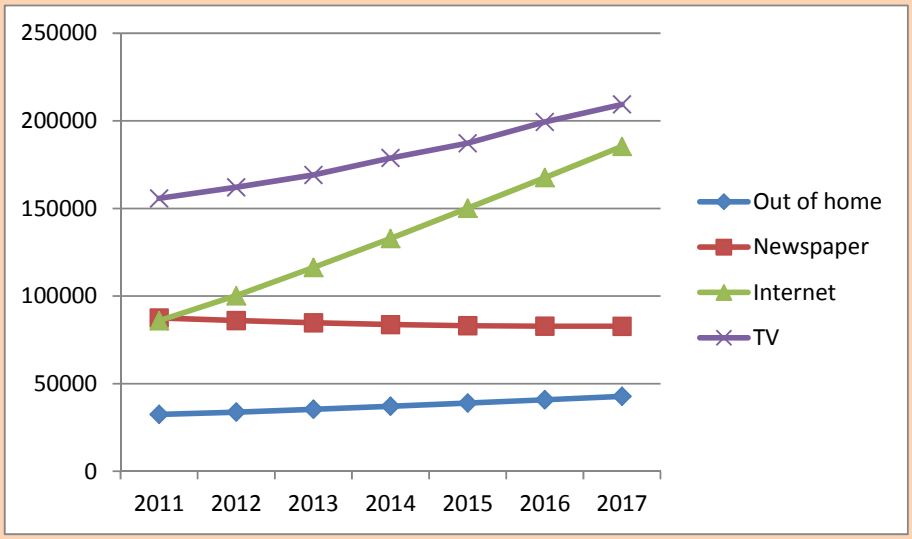
A PwC report on behalf of the interactive advertising bureau[17] illustrates the financial impact of online advertising in the United States – probably the most important advertising markets worldwide (see Figure 6). Here Internet advertising totals at 42.8 billion USD of revenue in 2013 (+17 % YoY) with further growth to be expected. On the other hand, broadcast and cable TV, which represent similar revenues (40.1 billion USD and 34.4 billion USD respectively) have shown stagnation over recent years and are expected to continue like that. According to PwC's Global media outlook[18], the worldwide situation shows a similar trend. Online advertising totalled at 116.4 billion USD in 2013. TV advertising had a total revenue of 169.2 billion USD in the same year. The forecast until 2017 shows significantly higher growth rates for online advertising than for all other forms of advertising. PwC expect it to reach 185.4 billion USD in revenue by that time reaching almost 90 % of the revenue generated by TV advertising.

[16] Inc.: Music Streaming Wars: Top 8 Contenders, available at: http://www.inc.com/ss/jill-krasny/whos-who-music-streaming-wars#3

[17] IAB (2014): IAB Internet advertising revenue report.

[18] PwC: Internet advertising, available at: http://www.pwc.com/gx/en/global-entertainment-media-outlook/segment-insights/internet-advertising.jhtml

Figure 6: Global advertising market (USD million) 2011-2017



Source: PwC

In sum, services offered to the end user show a great breadth and are difficult to illustrate fully. Nonetheless, some key insights can be taken away from this first overarching analysis:

- The wealth of services offered to end users based on data and the variety of revenue models they rely on indicates a great number of potentially innovative business models.
- Current numbers of users and revenues as well as their projections indicate an overall highly positive outlook for services offered to end users based on data.

3.3 General characteristics of the data value circle

In the above, this paper has analysed the market sizes, developments and revenues for all fields of actors in the data value circle that structures the data-driven economy along the production, transport, handling and utilization of data. Three general characteristics can be drawn from this first analysis:

- Data are a significant economic factor, whose significance is likely to grow and drive structural change in all sectors.

The analysis in the above underlines the results from Section 2. Data have become a major resource for businesses worldwide triggering new business models and structural change for all sectors. The analysis in the above has clearly shown that the number of devices connected to the Internet will grow dramatically within the next years reaching far beyond PCs, laptops, mobile phones and tablets. This will further increase the amount of data available and to be transported on networks. It should be noted that unlike most other economic factors data become more valuable with increasing availability. The more data are available for analyses the more accurate the results can be. Also, the more data e.g. in form of video or music files a content provider has to offer the more valuable its service becomes. Also, more data will likely lead to more services offered to the end user. This development will also spur revenues in the fields of data handling and data networks. In sum, the data-driven economy appears to be at the brink of a virtuous circle. Thus, policy-makers need to consider what changes this might bring to industries that are strong contributors to the economy of their respective countries. They should investigate how exactly the structural change driven by data will affect them and devise effective strategies that can support businesses in adapting and profiting from this change.

- The data-driven economy is characterized by two-sided markets.

Already the structure developed in Section 3.1 indicates that actors in all fields of the data value circle are likely to have business relationships with actors situated before and behind them in the circle. The above analysis supports this assertion. For all four analysed fields two distinct customer segments can be identified:

- Device operating systems: (1) end user and (2) app developers
- Data networks: (1) end users and (2) actors from data handling and data based service
- Data handling: actors from (1) data networks and (2) data based services
- Data based services: (1) consumers (often serve for free) and (2) businesses paying for targeted advertising

Policy-makers should be aware of this fact and take it into account when devising policies that target specific fields within the data value circle. They have to keep in mind that the two-sided nature can be prone to dominant positions of specific market actors as it can be witnessed in operating systems for mobile devices. From the two-sided nature of many data based services, a strong incentive emerges to collect more and more data to make the actual value proposition of their business models i.e. targeted online advertising more competitive. This holds strong implications as regards privacy and consumer's ability to make (actual) informed choices about which data he or she is willing to give away in exchange for a free service. Both aspects will be further elaborated in Sections 4 and 5.

- It is unclear which players in the data-driven economy hold the most powerful position

As it transpired from the previous point, the data-driven economy has numerous points were market dominance can be achieved. Operating systems for devices, for instance, enable a significant influence on how end users interact with devices and which services may be offered on these devices. Also, it enables the providers of these operating systems to direct access to most data produced by the device itself. Data network providers have significant influence on connectivity, which is the essential precondition for any data-driven business, whilst providers of data handling may hold significant power about what can actually happen with data in terms of using them for services or analysis. Their performance is also critical for the end users' Quality of Experience (QoE). Finally, services appear to be the real driver of the data-driven economy making attractive offers to end users be it consumers or businesses on numerous levels.

The growing economic relevance combined with the yet unclear shape of market power and its two-sided market characteristic make shifts in relative market power likely and places great emphasis on how individual groups of actors in the data-driven economy are positioned today and likely to behave strategically in the near future. Consequently, a more detailed analysis of business models and potential strategic options is needed. The following section addresses this task. It contributes a detailed analysis of business models and accompanying strategic options for key value propositions within the data-driven economy highlighting emerging challenges for market actors, policy-makers and regulators.

4 Selected value propositions and business models in the data-driven economy

The selected value propositions present a representative picture of the data-driven economy as they have been selected from all market segments within the data value circle. For each segment, the value propositions that, based on the analysis in Section 3, appear most influential were chosen. Each of these value propositions is likely to have sustained strong impact within the expected structural change and to pose specific challenges for other actors in the market as well as for policy-makers and regulators:

- Mobile device ecosystems
- Connectivity
- Cloud services and content delivery networks (CDNs)
- Targeted online advertising

- Video streaming

The following sections will discuss and analyse these value propositions and surrounding business models in detail to derive potential strategic options for each group of actors in the data-driven economy and potential challenges for market actors as well as for policy-makers and regulators.

4.1 Mobile device ecosystems

Section 3.2.1 has shown that more and more devices connect to the Internet and gather and transmit data. Discussing all of them would certainly go beyond the scope of this paper. Thus, this section focuses on the value proposition of mobile device ecosystems common in mobile phones and tablets, which have been identified as one of the major components of the data-driven economy in Section 3.2.1. Interestingly, it was shown that despite a growing number of types of devices and stakeholders, this area of the data value circle still appears to be controlled only by very few actors via operating systems and accompanying mobile ecosystems. These companies have gained a potentially powerful position and thus merit a more detailed analysis of business models and strategic options. This section will therefore analyse their business models highlighting key differences and culminating in the identification of strategic options as well as potential challenges for both other actors in the market as well as policy-makers and regulators.

In the case of mobile devices in the sense of this paper, there is a de-facto duopoly of android-based mobile devices on the one hand and iOS-based mobile devices on the other hand. This is manifested, for example, in the shipment figures published by IDC for the third quarter of 2013[19] (see Figure 7), where the two firms hold 94 % of the market between them. Other competitors such as the Windows Phone or BlackBerry (Research in Motion) phones have only marginal influence in the market. Thus, the following analysis of business models and strategic options will focus on these two major competitors.

Interestingly, the business models of Google and Apple in the field of devices share some major characteristics:

- They both address a two-sided market consisting of two distinct customer segments: (1) consumers and businesses and (2) app developers relying on similar value propositions.

Consequently, their value propositions are also similar. For the customer segment of consumers and businesses, each competitor offers an operating system that enables a mobile ecosystem, to which the end user gains access through purchasing a device that is running the operating system. Both competitors offer their operating system free of charge to keep all users as up to date as possible and thus establish a common standard. This common and widespread standard environment is the value proposition offered to the second customer group i.e. app developers. The larger the number of users of any of these operating systems is, the more attractive it is for them to develop apps for this operating system. Taken together, this results in a so-called mobile ecosystem that offers almost infinite functionality and individuality of devices to end users and that, on the other hand, opens up a market for many developers. In Europe alone, it is estimated that around 800,000 jobs have been created in the so-called app-economy[20].

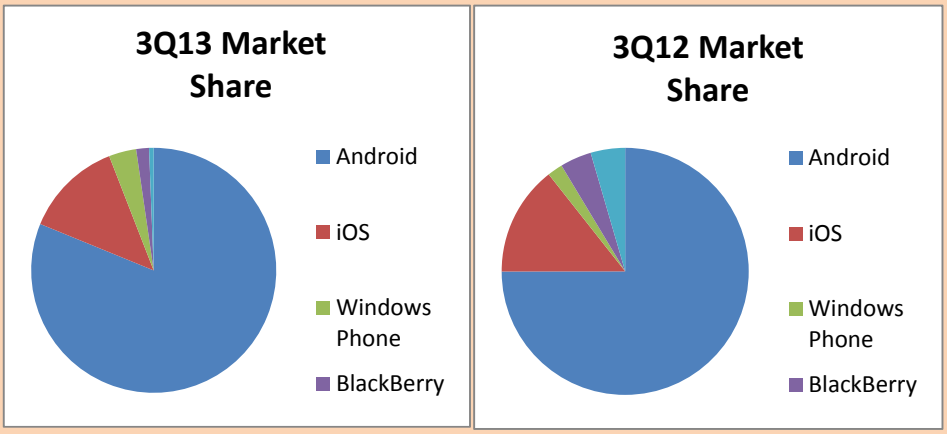
- For both, the major revenue stream stems from apps sold on their respective channels.

[19] IDC (2013): Android Pushes Past 80% Market Share While Windows Phone Shipments Leap 156.0% Year Over Year in the Third Quarter, According to IDC, available at: http://www.idc.com/getdoc.jsp?containerId=prUS24442013

[20] ACT (2013): The European app economy. Creating jobs and driving growth.

Figure 7: Worldwide mobile device shipments and market shares for the top-4 mobile operating systems in 3Q/13 in comparison to 3Q/12

Operating System	3Q13 Shipment Volumes	3Q13 Market Share	3Q12 Shipment Volumes	3Q12 Market Share	Year-Over-Year Change
Android	211,6	81%	139,9	74,90%	51,30%
iOS	33,8	12,90%	26,9	14,40%	26,60%
Windows Phone	9,5	3,60%	3,7	2%	156%
BlackBerry	4,5	1,70%	7,7	4,10%	-41,60%
Others	1,7	0,60%	8,4	4,50%	-80,10%
Total	**261,1**	**100,00%**	**186,7**	**100,00%**	**39,90%**



Source: IDC Worldwide Mobile Phone Tracker (2013)

Both Google and Apple gain revenue from each app sale on their channels (Google Play and Apple iTunes App Store). Apple reported more than 10 billion USD of revenue through their App Store in 2013[21]. Google Play registered roughly half that revenue according to App Annie[22]. With the growing number of devices as well as apps, this figure is likely to grow further.

- Both business models support lock-in effects.

A third aspect that the two competitors share is their ecosystems' proneness to lock-in effects that characterize the customer relationship of their business model. This is true for both customer segments addressed. Whilst end users are likely to be unwilling to lose their investments in apps that they usually cannot take with them when they opt out of one system, app developers often cannot afford to lose their established customer segments as their business model more often than not depends on continuous in-

[21] Apple (2014): App Store Sales Top $10 Billion in 2013, available at: http://www.apple.com/pr/library/2014/01/07App-Store-Sales-Top-10-Billion-in-2013.html?sr=hotnews.rss

[22] App Annie (2014): App Annie Index - Market Q1 2014: Revenue soars in the United States and China, available at: http://blog.appannie.com/app-annie-index-market-q1-2014/

app purchases or advertising rather than the initial fee for downloading the app. This appears to lend some long-term stability to the business models of the two main competitors in this area.

However, there is one important difference in their business models. Whilst Google provides the Android operating system and therefore access to its ecosystem of applications to anyone who wants to use it[23], Apple, on the other hand, complies with its long-established policy already known from its PCs and laptops of selling a bundle of a device together with a dedicated operating system. With the iPhone and the iPad, they follow their usual premium brand strategy. For Apple, this strategy pays off as they are one of the few firms which actually earn profits from their device-related revenue stream. Figure 8 documents Apple's profitability by Canaccord Genuity numbers[24] collected for major mobile device manufacturers from 2007 to Q3/13. These numbers show that Apple is the only manufacturer that can claim stable and substantial profits from 2007 to 2013 for its mobile devices business. It is noteworthy that the market has changed dramatically over the same period. Nokia had roughly the same operating margins in 2007 as Samsung had in 2013. Equally, BlackBerry had in 2008 about the same operating margins as Apple had in 2013. Both Nokia and BlackBerry are currently suffering.

The fast-changing nature of the market of mobile devices that these numbers imply may continue as the current market leaders do not go unchallenged. For instance, there are quite serious contenders for a potential third strong ecosystem. Microsoft's Windows Phone is certainly a valid candidate. Amazon is reportedly planning to launch its own mobile phone extending its already established ecosystem around the Kindle device[25]. Others have managed to bring key partners on board that may help them to a significant position in the market. For instance, Mozilla's Firefox OS initiative has found support by key international telecommunications providers such as America Movil, Telefonica, China Unicom, Sprint, Deutsche Telekom, and KDDI[26]. Also mobile device manufacturers like ZTE, Huawei, and LG act as key partners for Firefox OS. In a market environment with shrinking unit prices and where the highest growth can be expected from mobile device sales in developing countries[27], Firefox OS may be particularly well positioned as it provides a lean solution than can run on very simple phones or other devices.

Thus, it is not surprising that the two main competitors have devised strategies to extend their strong position in the field of devices. These strategies build on their key resources the existing customer base combined with the extensive knowledge these two firms have about consumer behaviour and their key activity in this area i.e. building mobile ecosystems that enable a seamless customer experience and offer added value to app developers. The main strategic direction appears to be entering additional types of devices. Google offers Google Glass currently only in a trial phase, but normal sales are expected to commence this year. This device is strategically interesting for Google as it will enable them to expand their revenues from selling devices themselves, but more importantly this device is likely to be physically

[23] It should be noted that some fees usually apply to get a third-party certificate that allows a device manufacturer to run Google Mobile Services (GMS). See http://www.theguardian.com/technology/2014/jan/23/how-google-controls-androids-open-source

[24] Shared by Canaccord Genuity analyst T. Michael Walkley with the industry blog AppleInsider on the occasion of a research note; see http://appleinsider.com/articles/13/11/14/apple-samsung-take-massive-109-of-mobile-industry-profits-while-competitors-lose-money

[25] TechRadar (2014): Amazon phone release date, news and rumors, available at: http://www.techradar.com/news/phone-and-communications/mobile-phones/amazon-phone-release-date-news-and-rumors-1085821

[26] Mozilla (2014): Unleash the future, available at: http://www.mozilla.org/en-US/firefox/partners/

[27] The Guardian (2014): Smartphone explosion in 2014 will see ownership in India pass US, China and India will add more than 400m new smartphone users amid growth for FirefoxOS and Android, forecasts Mediacells, available at: http://www.theguardian.com/technology/2014/jan/13/smartphone-explosion-2014-india-us-china-firefoxos-android

even closer more often to its user than the mobile phone and thus will give Google access to more valuable data that can be used for their main value proposition targeted online advertising (see Section 4.4). The second area, which appears to serve the same purpose for Google is Google Nest, a home-automation system that Google plans to launch. Apple's plans appear to be somewhat vague; nonetheless, it seems obvious that also they will attempt to capture additional device in their mobile ecosystem. The acquisition of Beats can be considered an example. Both competitors have entered associations that seek to bring their ecosystems into cars.

Figure 8: Operating profitability for mobile device manufacturers from 2007 to Q3/13

	2007	2008	2009	2010	2011	2012	Q113	Q213	Q313
Apple operating income	600	2421	5249	10482	26723	35903	8034	5991	6,487
Apple mobile device operating margin	28%	28%	33%	35%	44%	41%	35%	33%	33%
Apple value share	4%	14%	35%	44%	65%	69%	58%	53%	56%
Nokia operating income	117	9586	4905	4418	2347	-905	5	-42	-63
Nokia mobile device operating margin	20%	18%	13%	11%	7%	-4%	0%	-1%	-2%
Nokia value share	67%	57%	33%	19%	6%	-2%	0%	0%	-1%
Samsung operating income	1561	1754	2246	3465	7078	17458	6019	5632	6,125
Samsung mobile device operating mar	10%	9%	9%	10%	15%	21%	22%	19%	20%
Samsung value share	10%	10%	15%	15%	17%	34%	43%	49%	53%
BlackBerry operating income	809	2554	3219	4408	2996	-230	17	-143	-426
BlackBerry mobile device operating ma	21%	33%	27%	30%	20%	-3%	1%	-7%	-55%
BlackBerry value share	5%	15%	21%	19%	7%	0%	0%	-1%	-4%
Motorola operating income (loss)	-688	-1458	-925	-198	-126	-604	-236	-218	-292
Motorola mobile device operating mar	-4%	-12%	-13%	-3%	-1%	-8%	-23%	-22%	-26%
Motorola value share	-5%	-9%	-6%	-1%	0%	-1%	-2%	-2%	-3%
Sony (Sony Ericsson) operating incom	2110	32	-1430	214	-287	-602	-23	72	0
Sony mobile device operating margin	12%	0%	-15%	3%	-4%	-8%	-1%	3%	0%
Sony value share	14%	0%	-10%	1%	-1%	-1%	0%	1%	0%
LG operating income (loss)	658	1188	1017	-575	-254	48	123	55	-73
LG mobile device operating margin	8%	11%	7%	-5%	-2%	1%	4%	2%	-3%
LG value share	4%	7%	7%	-2%	-1%	0%	1%	0%	-1%
HTC operating income	0	908	725	1452	2329	640	1	35	-118
HTC mobile device operating margin		20%	16%	17%	15%	6%	0%	1%	-7%
HTC value share	0%	5%	5%	6%	6%	1%	0%	0%	-1%

Source: Canaccord Genuity (2013)

The current position and the strategic avenue of the two major competitors in the field of devices as part of the data-driven economy holds some challenges for actors in the market as well as policy-makers and regulators. Actors in the market within and without the data-driven economy may see themselves faced with increasing entry-barriers due to the strong customer relationships that the existing competitors have established. With the increasing number of types of devices the two major competitors in this field can draw into their systems these barriers grow further. Also, every new app has to be certified for the respective platform and can be removed from these platforms by its owner, giving the two major competitors in this field a powerful position. For all competitors in the field of devices, connectivity to the Internet will be a key bottleneck to extending their markets. This is particularly true in developing countries, where some competitors (e.g. Google, Microsoft, and Apple) have started experimenting with their own access solutions. Given the growing number of devices and the growth of mobile traffic, spectrum may become a limiting factor to the types of services that can be transmitted to mobile devices. These last two challenges are certainly also relevant to policy-makers and regulators. Moreover, issues of privacy protection may become an even more pressing issue as more and more devices run within the same ecosystems and potentially allow combining data across numerous devices and situations. Such combinations may, for instance, enable the transformation of anonymous data into personalized data.

4.2 Connectivity

The value proposition of connectivity is really at the heart of the data-driven economy. Without it, no one would be able to access electronic communications based service and no data could be transported or distributed within the data value circle. Subsumed under this value proposition in this section are access to electronic communication and transport of data and connectivity amongst data networks. It is important to note that within this value proposition, one of the unique characteristics of the data-driven economy is that two communication partners are very likely to obtain access from different network operators. Network operators, thus, need agreements and common standards for interconnection and the hand-over of traffic which either originates from a source, or which is intended to be transported to a destination outside their own network.

In essence, the connectivity value proposition relates to two rather different customer segments:

- The access business represents the customer-provider relationship involving a network operator and either an end user or a service/content provider.
- The inter-carrier business typically represents either a customer-provider relationship among two network operators of different traffic volumes and geographical reach (called transit), or else a typically free-of-charge agreement among network operators of comparable traffic volumes (called peering).

The value propositions in those two business segments shape the business model of a network operator both on the revenue and on the cost side. For the latter, it is essential to comprehend the effect of growing traffic volumes:

- Traffic growth implies the risk for a network operator to be forced to implement its value proposition at higher costs, without being able to scale revenues accordingly.

There are a number of factors that influence this risk. Especially in the access business, network infrastructure may become a bottleneck resource meaning that access networks run at their capacity in peak hours. Network planning has always been driven by peak (not by average) traffic volumes as there are huge traffic volume fluctuations over the course of a day. Different approaches exist to give incentive to end users to shift their usage to off-peak hours, but with the rise of flat rate-based charging in both the fixed and mobile access business, many of these incentives are essentially obsolete. Network operators are in consequence exposed to a pressure to continuously and drastically increase network capacity – which means significant capital expenses.

In this light, considerations on data ARPU as outlined in Section 3.2.2 need to be reflected. Data ARPU would have to raise quite substantially, as it would have to compensate not just one trend (increasing data traffic), but also decreasing voice ARPU (the traditional voice-oriented telecommunications business) as well as a potential increase in costly IP transit traffic. IP transit traffic is likely to increase as more end users have access, as more devices become connected, and as additional types of devices become connected (and create additional – novel – traffic). This is due to the fact that in the data-driven economy traffic is often transported across multiple networks as described in the inter-carrier business above. In case of a communications path involving transit, the smaller network operator typically needs to pay the larger one.

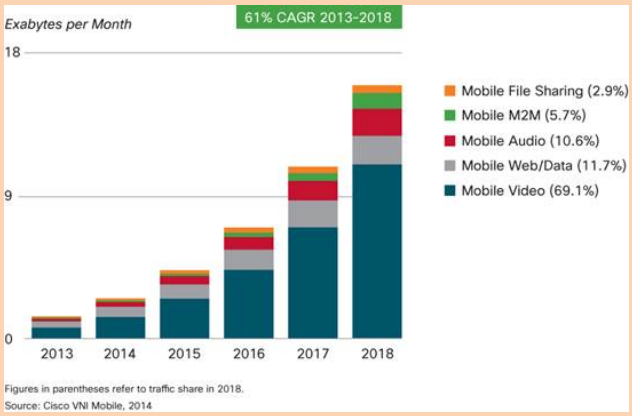
It needs to be emphasized that the above factors contribute to a risk only. The examples given in Section 3.2.2 for AT&T and Bharti Airtel show that it is possible to keep overall ARPU levels relatively stable – in other words, decreasing ARPU is not a given for all network operators. Higher traffic volumes do not automatically lead to higher traffic acquisition costs as unit costs are decreasing. Moreover, even in times of flat rates, there may be other instruments that give incentive to (heavy) users to limit their data usage (e.g. data caps).

Since data exchange is bi-directional, the increase of data volumes from one side of electronic communications implies a multiplication of data by the respective other side responding. This multiplication may take extreme forms when considering products and services in the data-driven economy that are characterized by asymmetric bandwidths needed for request and response. For

instance, when an end user requests a video stream, the request in itself means relatively little data to be transported and routed in and across interconnected networks. The response, however, is an ongoing flow of data of much larger size.

To stay with this example, the network operator that connects the respective video streaming provider to its data network will most probably be able to monetize the traffic pushed into its network. Both sides of the access business normally pay for connectivity – end users as well as service/content providers. A problem may arise though for the network operator that has to transport the substantially larger response to the requesting party (its customer) without being able to earn from the relevant source generating most of the traffic (not its customer). This situation is further intensified when considering that it is exactly those services with asymmetric bandwidth requirements that are about to cause the most traffic in data networks in the future. Cisco's forecast illustrates the expected growing importance of video in mobile traffic (see Figure 9).

Figure 9: The importance of video and audio in mobile data forecasted for the period from 2013 to 2018



Source: Cisco Visual Networking Index (2014)

All these factors combined explain the fundamental change that the industry is undergoing. This leads to a second part of discussion in this section, namely the analysis of strategic options that may lay down paths towards viable and sustainable business in the future. The set of strategic options may be subdivided into four areas:

- To further optimize the cost of data traffic.
- To obtain access to revenues (or at least a relevant share of it) from those who create masses of traffic.
- To offer entertainment-oriented value propositions in addition to connectivity.
- To start monetizing end user data.

The optimization of costs related to data traffic may mean a set of different measures. In relation to the access business, the fostering of offloading traffic to e.g. unlicensed spectrum and infrastructure such as WiFi hotspots may certainly constitute an option which will be available already in the nearer future. For the inter-carrier business, a near-term response towards lower costs may be negotiating and concluding more peering agreements. On a more long term perspective, larger network operators may intensify their regional or international presence with an extended backbone network. As prices for IP transit fell quite drastically in recent years, however, some network operators may decide differently and invest less in (or even crowd out from) this business segment in anticipation of being able to source transit traffic at anyway falling prices from third parties. On an even longer time horizon, exploring efficiency gains (and the resulting cost optimizations) by ongoing research activities may become highly relevant. Examples include the utilization of end-user infrastructure in the access business and different ways to route traffic in networks. The latter relates primarily to routing mechanisms that qualify best for content (thus, traffic-

intense) delivery. Information-centric networking approaches may be investigated in this context. Also, the use of multicast-based techniques in existing networks may constitute an interesting future opportunity to reduce transported traffic in large parts of a network.

The option for sourcing from third parties may become a valid option to optimize costs even further. The so-called Minute Factory business model (introduced by Bharti Airtel in the early 2000s and successfully applied ever since) could be a template for such cost-optimized business structure in the data-driven economy. It aims to minimize the production costs of a voice minute or a data packet. All activities which are not considered a key activity are outsourced to partner businesses. Outsourced – thus, non-key – activities include IT, network management, and call centre management. The underlying assumption is that the respective outsourcing partners are able to provide the activity in question more efficiently, resulting in lower total expenses for the outsourcing network operator, which in turn can optimize its (smaller set of) key activities and key resources. The remaining key activities are then to monitor resource usage very closely, to design and manage products and the respective pricing according to observed and anticipated service usage patterns, and to gradually extend the infrastructure of the network where usage goes beyond a certain threshold value.

Obtaining access to revenues from those who create masses of traffic has been identified as the second major strategic option. This may mean for a network operator to build CDN and data centre infrastructure in order to offer the respective cloud infrastructure and services to content and service providers. As data centres are by their very nature sources or destinations of larger traffic volumes, providing access, transport and connectivity to/from a data centre would enable a network operator to participate in the respective revenue streams. Especially when being able to optimize the storage of data in data centres and, at the same time, its delivery in a CDN, network operators would be in a unique position to combine the connectivity value proposition by means of the cloud and content delivery value propositions. However, this strategy appears to be difficult to achieve for network operators as the market for CDNs and cloud services can already be considered a relatively mature market (see next section) that has entered the phase of strong price competition.

On a similar line of thoughts, a network operator may go into all sorts of different partnership agreements with content/service providers. This could be an arrangement among a player like Spotify and a mobile network operator in which the technical part of the agreement would mean that Spotify's servers are replicated within the operator's network. Spotify traffic would ideally be limited to in-network traffic (except for the transit/peering traffic for regularly updating replica servers). In return, the network operator could offer a rebated monthly Spotify subscription. Not to forget that Spotify could promise its users a better quality of experience due to expectedly low response times as well as the fact that traffic stays within the operational domain of a single operator. In addition, Spotify could profit from much lower traffic acquisition costs – leading to a win-win situation for both the (network and service) provider as well as the user side.

Similar scenarios may cover agreements that include traffic prioritization for which the service/content provider would be willing to pay in order to ensure that its customers benefit from a satisfactory experience. The example of Netflix shows that there may be room for such agreements even though service/content providers will certainly try to avoid cost-sharing approaches and/or traffic prioritization payments. In light of strong net neutrality movements, it is, however, questionable whether such cost-sharing solutions are really viable in the long-term and will be accepted by all market players. Furthermore, traffic prioritization payments may become a regulatory concern in some markets.

The third major strategy option identified in the above means for a network operator to extend its traditionally connectivity-focused value proposition by offering entertainment-oriented value propositions in addition. This relates for instance to offer bundles combining the connectivity product (and possibly a telephony product) with IPTV, video-on-demand, music streaming, and similar managed products. In addition to developing additional fields for revenue, such bundle products may have the advantage to facilitate a high level of customer loyalty, and this would give the operator access to new insights on user behaviour which it may be able to monetize.

Monetizing end user data is the fourth major strategic option available to network operators. This is not a field where operators have been active traditionally. The reasons may be regulatory or simply less pressure to work based on these data as network operators had a viable and sustainable revenue model at hand. Nonetheless, there are first moves by larger network operators in recent years which show that the economic value of end user data did not stay unnoticed in this transforming industry. Examples for companies with activities in this field are AT&T, Verizon, and Telefónica. The latter has founded a business unit that aims to market footfall[28] data to local businesses. This example represents still a rather unsuspicious case for monetizing user data – first of all, footfall data is aggregated data (not data on an individual level) and second it just touches a very limited set of knowledge that a network operator potentially has access to about an end user. Naturally, such a strategic move of operators in the field of services within the data value circle has to be accompanied by a debate and the establishment of clear guidelines needed with respect to what is acceptable use of end user data for a network operator.

However, extending one's field of operation within the data value circle is an opportunity that also OTTs are keen to pursue. They may extend their already existing or announced activities towards becoming network operators of their own. The Google Fiber initiative is a very prominent example for such development. Albeit being limited to a number of geographically bounded US markets, Google's activities appear to prompt response by established network operators. AT&T has very recently announced[29] to deploy gigabit fibre in 100 US cities – which is supposedly a direct reaction to Google announcing[30] two months earlier to expand its fibre activities to 34 additional cities. Google Fiber is just one example of OTTs considering becoming network operators. Facebook's Connectivity Lab is an example for a research activity that investigates drones, satellites, and laser technology to provide Internet access especially in developing countries. Other activities may – in the long-term – threaten the exclusive reach of operators to end users: Technology is becoming available, or is under development, that has the potential to break up the termination monopoly in mobile communications. This includes a wide range of different approaches ranging from "downloading" a SIM card on the fly (e.g. Cell-Buddy[31]) to auction-based mobile termination (e.g. AbaCUS[32]).

4.3 Cloud services and content delivery networks

Just as connectivity in the preceding section, the value propositions of cloud services and content delivery networks (CDNs) as part of the data handling in the data value circle represent key enabling infrastructures/services for a functioning data-driven economy. Both data networks and providers of data-based services depend on data handling. In Section 3.2.3, this paper has already illustrated the market size and projected increases for cloud computing infrastructure services including CDNs. This section sets out to analyse the business models of the leading providers of cloud infrastructure and

[28] Footfall relates to the number of people stepping into a geographic area, such as a street segment. Businesses with stores in that area may profit from footfall data. Footfall gives insight into when and how many people pass by in front of a store location, whether people stop at, e.g., a café nearby etc. By combining footfall data with other user profile attributes, a network operator can offer enriched information (beyond pure footfall data) that, for instance, allows a business to assess whether people passing by might fall into a targeted market segment.

[29] http://about.att.com/story/att_eyes_100_u_s_cities_and_municipalities_for_its_ultra_fast_fiber_network.html

[30] http://googleblog.blogspot.de/2014/02/exploring-new-cities-for-google-fiber.html

[31] http://web.cell-buddy.com/

[32] http://www.csg.uzh.ch/research/abacus.html

software services to arrive at strategic options and derive potential challenges for market players as well as policy-makers and regulators.

According to Synergy Research[33], Amazon is currently the company that holds the largest share of the cloud infrastructure services market. They hold 5.2 % of the market. With Verizon, who hold 3 % of this market interestingly one of the main contenders is a network operator. This illustrates that this is the point within the data value circle where most providers of data based services and operators of data networks may become successful due to their existing data management infrastructure and capabilities to handle data.

In fact, Amazon's business model as regards data handling for third parties is a perfect example of how infrastructure and know-how originally aimed at providing a specific service function were turned into a business model of their own. To run their extensive e-commerce service, Amazon had to install substantial IT-infrastructure early on and learn how to effectively handle and analyse large data volumes. Amazon turned these resources into a business model of its own with the launch of Amazon Web Services in 2002. The fact that this service could be offered at a per-use basis made it attractive for both Amazon and their customers[34]. Over time, Amazon has added various services all revolving around their ever growing IT-infrastructure[35]. Amazon Web Services experienced another boost as apps and all kinds of other OTT services required affordable and scalable services supporting their own offerings in the background[36]. Such services include elastic cloud storage, content delivery networks as well as authentication. The most important of those services are Amazon Elastic Compute Cloud and Amazon S3 (Simple Storage Service)[37]. Most notably, Amazon handles most Netflix data (see Section 4.2.5).

In principle, Verizon have followed a similar strategy to enter the area of data handling. As a provider for fixed-line and mobile internet access Verizon owns an extensive telecommunications network. The provided bandwidth and its competence in network management can be regarded as key enablers for the cloud based services[38]. As some Verizon subsidiaries such as Wireless have reached market saturation[39] the requirement to identify new streams of revenue and new groups of customers became evident. Having acquired Terremark (a company specialized on datacentre management), Verizon became a main contender with Verizon Cloud Compute and Verizon Cloud storage services[40]. Verizon also initiated partnerships with computer software companies like Oracle in order to enhance the flexibility and the

[33] Synergy Research Group (2013): Cloud Infrastructure Services: Market Primer.

[34] Isckia T., Lescop D (2009): Open Innovation within Business Ecosystems: A Tale from Amazon.com, Communications & Strategies, vol. 74(2), available at: http://repec.idate.fr/RePEc/idt/journl/CS7402/CS74_ISCKIA_LESCOP.pdf

[35] Amazon (2013): History & Timeline, available at: http://phx.corporate-ir.net/phoenix.zhtml?c=176060&p=irol-corporateTimeline

[36] The Register (2012): Amazon to all data centers: Keep up, if you can, available at: http://www.theregister.co.uk/2012/04/19/amazon_vogels_aws_summit/

[37] ZDNet (2012): How Amazon exposed its guts: The History of AWS's EC2, available at: http://www.zdnet.com/how-amazon-exposed-its-guts-the-history-of-awss-ec2-3040155310/

[38] Lens 360 (2013): Verizon's Cloudy Services Horizon, available at: http://blog.saugatucktechnology.com/verizon-cloud-services-horizon/

[39] Verizon: Industry Overview, available at: http://www.verizon.com/investor/industryoverview.htm

[40] Datamation (2013):Verizon Unveils New Cloud Strategy , available at: http://www.datamation.com/cloud-computing/verizon-unveils-new-cloud-strategy.html

options for customers deploying Oracle software in the cloud[41]. Recently, Verizon offered supplementary services to address security and operational issues, e.g. the Secure Cloud Interconnect service for business customers.

Akamai's core market has been CDNs. The company estimates that 15-30 % of the worldwide data traffic is transmitted via their network[42]. Notable customers are e.g. Facebook, Netflix, Apple, Yahoo!, Bing and Twitter. In contrast to Amazon and Verizon that started their business in other segments of the telecommunication market, Akamai focused on data handling since the beginning of its operation. Due to increasing demand and traffic volume in video streams, social media, shopping, online games and software downloads, Akamai reported increased revenues and operating margins in the last quarters (as documented in Akamai's quarterly reports). Shopping Content and Media Content Delivery are considered the most valuable segments of its operation[43]. Akamai's pricing strategy appears to remain competitive, also in times of challenges by former customers[44]. In order to respond to security concerns and extend their business, Akamai offers the solution like the Kone Site Defender for their customers. Moreover, Akamai include more value added services to their portfolio like other cloud applications and the delivery of targeted advertising[45]. The company also prepares to resume operations for mobile traffic.

These three examples of business models around the value proposition of cloud infrastructure services illustrate that this part of the data value circle has become very competitive as actors from both surrounding segments i.e. data based services and data networks have entered the business. With Google, a fourth very serious contender for the future lead in this market has already entered the scene. Similar to Amazon, they also have accumulated a significant IT-infrastructure and knowledge of data handling including their own CDN. Despite these significant resources, they feature not yet amongst the Top 3 players in the IaaS/PaaS market (based on revenues according to Synergy Research numbers[46]). However, due to their aggressive pricing strategy, this is likely to change soon. In 2014 alone, they cut the price for the IaaS service Google Compute Engine by 32 % across all regions and sizes[47]. Moreover, the price for the storage services Google Cloud Storage was even decreased by 68 %.

CDNs represent a specific value proposition within the field of cloud infrastructure services. They are an overlay to the existing internet infrastructure. By means of globally distributed and strategically located

[41] Ovum (2014): Verizon partners with Oracle to offer database services by the hour, available at: http://ovum.com/2014/01/25/verizon-partners-with-oracle-to-offer-database-services-by-the-hour/

[42] Akamai (2014): Visualizing Global Internet Performance with Akamai, available at: http://www.akamai.com/html/technology/visualizing_akamai.html

[43] Wall Street Journal (2014): Akamai Profit Rises 1.8%, available at: http://online.wsj.com/article/BT-CO-20140501-716049.html#

[44] Wall Street Journal (2014): Akamai Hints It Can Weather Competition From Customers, available at: http://blogs.wsj.com/digits/2014/02/05/akamai-hints-it-can-weather-apples-diy-effort/

[45] Forbes (2013): Akamai Earnings: Watching For The iOS7 Impact With An Eye On Margins, available at: http://www.forbes.com/sites/greatspeculations/2013/10/21/akamai-earnings-watching-for-the-ios7-impact-with-an-eye-on-margins/

[46] Synergy Research (2014): Amazon Continues to Dominate IaaS/PaaS Despite Strong Push from Microsoft & IBM, available at: https://www.srgresearch.com/articles/amazon-continues-to-dominate-iaaspaas-despite-strong-push-from-microsoft-ibm

[47] Google (2014): Google Cloud Platform Live - Blending IaaS and PaaS, Moore's Law for the cloud, available at: http://googlecloudplatform.blogspot.de/2014/03/google-cloud-platform-live-blending-iaas-and-paas-moores-law-for-the-cloud.html

servers, CDNs aim to optimize the transmission of content via the internet. Starting over a decade ago, a wide variety of models regarding the configuration of the architecture can be differentiated. The primary customers of CDN providers are content providers that transmit the large data volumes that are often needed for data-based services.

In a dynamic market environment with an increasing amount of data traffic, the market players have chosen very different business models and strategies. However, several stereotypical business models can be distinguished: CDN specialists like Akamai, Edgecast and Limelight concentrate their entrepreneurial activities solely on the provision of CDN services and have shaped the CDN market since its beginning. Akamai represents the dominant company in this segment of the CDN market. Players entering the market to a later point of time have not focused their business models solely on CDN services. Instead, the CDN services were added to their product portfolio. Those providers can be divided into two groups: integrated CDN Providers owning an internet access infrastructure on the one hand and CDN resellers on the other hand[48]. Similar to cloud services in the above, the market for CDN is very competitive. It may also happen that providers of data based services with an own CDN decide to open this resource to third parties just like Amazon did with their IT-infrastructure. Such a move would certainly further increase competition in this field. This very competitive market poses serious challenges to market players. They will either have to significantly reduce costs to remain competitive or find other revenue streams like Akamai have done.

Since, due to energy costs, data centres are often situated in areas where there is naturally cold weather and services based on data usually address an international or global market, companies have to manage data handling across borders, which could become more difficult in light of the concerns that have emerged from the NSA debate triggered by the whistle-blower Snowden. Policy-makers should address this issue with great care in order not to impede specific actors. However, they have to strike a balance as regards valid security concerns of the businesses in their country that want to store data reliably and safely.

Finally, as cloud infrastructure services also address more and more consumers directly or indirectly through data based services, a debate has to be started as regards what consumers do understand about this issue, how important contractual parts can be presented to them in a manner that they are likely to comprehend and if these steps would help them to make informed decisions. Furthermore, as data are circulated around the globe and consumers as well as businesses cannot always be sure which jurisdiction currently applies, clear guidelines ought to be drawn up in order to support comprehension of this issue for end users of services as well as to clarify the legal frameworks for providers of services.

4.4 Targeted online advertising

As it has been shown in Section 3.2.4 many services offered to consumers free of charge rely for their revenues on the second customer segment of businesses, which seek access to these consumers through targeted online advertising. Consequently, these services can be considered to serve a two-sided market with targeted online advertising being the most important value proposition as regards the revenue stream within the business model. This basic structure of this business model is quite similar across the numerous services that apply it. Prominent examples include Google, Facebook, Bing (Microsoft's search engine), Yahoo and Twitter. Many smaller and less prominent actors in the area of services apply this business model, too.

[48] Gries / Philbeck (2013): Marktentwicklungen im Bereich Content Delivery Networks.

The key competitive advantage that online advertising holds over other media outlets is based on data collected about the consumer who is intended the target of the advertising. These data enable a much more individualised approach that results in a significantly higher Return on Investment for businesses buying advertising[49]. Thus, it is not surprising that the large competitors in this field have strategically constructed their business models around generating data about consumers. Google is probably the most all-embracing example offering free services for search, navigation, mailing, calendar, office applications, image viewing and editing, social networking and so forth. Recently, they have also entered the field of devices selling their own mobile phones, tablets, laptops, glass and home automation amongst other things. Thus, Google can gather more user data than any other company.

Facebook seems similarly well-equipped, although they follow a different strategy. Their business model is constructed closely around their major public value proposition i.e. their social network service. This site alone gives them access to extensive data about approximately 1.2 billion active users. A significant part of Facebook's success may be attributed to their smart strategy as regards the involvement of third parties and lowering the barrier to enter the network. Involvement of third parties was achieved early on through the launch of the Facebook Platform in 2007. This service enables third parties to access Facebook's "Social graph" and place advertisements, but also to connect their content to Facebook via a so called "like button". By this, Facebook is also able to collect some (rudimentary) data about their users' behaviour outside the network. Beacon, a technology introduced not much later had the objective to learn even more about users' behaviour outside of Facebook. This technology was, however, discontinued due to legal reasons and widespread public concerns. Instead, Facebook offers instant personalization for selected external sites since 2010, which allows Facebook users on third party sites to receive individualized content e.g. only reviews of a particular movie written by their Facebook friends. Besides tracking users outside of their site, Facebook have also found ways to lower the technological barrier for those who are still outside of the network due to insufficient connectivity in particular in developing countries. In 2010, they launched Facebook Zero, which is a text-only version also accessible on simpler phones. To make themselves more attractive to consumers, some carriers have decided to offer this service even at no charge. Facebook for SIM followed in 2011. It provides access to the network even without a data contract.

In sum, it is not surprising that these two companies control the digital advertising market. Google holds around one third of the total digital advertising worldwide. Facebook follows in second place with a market share of 5 %. For mobile ads, Google even controls almost 56 % of the market, whilst Facebook holds close to 13 %[50] (see Figure 10). Thus, it also not surprising that both companies are able to earn substantial profits from their respective advertising businesses.

Pandora on the other hand, even though it is a significant player in the mobile advertising market, cannot make a profit. One reason for this is likely a significantly smaller user group resulting in less data. The data themselves are also less valuable e.g. the likes as regards music only as compared to a holistic view on consumer behaviour. Furthermore, Pandora is less profitable due to their cost structure. Google and Facebook, for instance, do not have to pay royalties for their services. For the music streaming service, instead, royalties and legal costs pose a serious threat to a profitable business in the long run.

[49] Arnold and Schiffer (2011) found that the ROI for Google AdWords is on average almost 12 times the ROI to expected from other advertising format (Arnold, R. & Schiffer, M. (2011): Faktor Google – Wie deutsche Unternehmen Google einsetzen. IW Consult: Köln.)

[50] eMarketer (2013): Google Takes Home Half of Worldwide Mobile Internet Ad Revenues. - available at: http://www.emarketer.com/Article/Google-Takes-Home-Half-of-Worldwide-Mobile-Internet-Ad-Revenues/1009966#sthash.MjU6yas0.dpuf

The fundamental success factor for this business model is the number of users and the value of data that can be collected, analysed and used to target them. This implies that services that seek funding by offering targeted online advertising are likely to need an international distribution. Technically, this is easily achieved, however, legal and regulatory barriers are likely to hamper some services. This underlines the need for a more international approach to legislation and regulation that has transpired at various places in the above. This will be pivotal to future innovative services funded by advertising.

Foreseeable strategic options of actors base on these circumstances and depend on the market position of the specific actor. The main competitors in the market are likely to try and manifest and extend their market position. One avenue to achieve this is to gain access to data that originally was unattainable. Google has made steps into this direction offering more and more devices that can collect and transmit data, extending its business to data networks even up to the individual household (Google Fiber) and to data handling e.g. cloud services. Facebook, on the other hand, seems to follow a different strategy, targeting developing countries strongly with simplified versions of their service that will also run on simple phones as well as experimenting with their own connectivity solutions. As it transpired from the market shares in online advertising detailed earlier in this section, smaller actors in the market tend to have problems gaining a critical mass of users and monetising their services. Therefore, their strategic option lies more with either attracting a very valuable user group or very valuable data. To achieve this, they have to be innovative.

Figure 10: Market Shares online advertising and mobile advertising worldwide

	Online Advertising worldwide			Mobile Advertising worldwide		
	2011	2012	2013	2011	2012	2013
Google	32.08 %	31.46 %	33.24 %	38.11 %	52.36 %	55.97 %
Facebook	3.65 %	4.11 %	5.04 %	-	5.35 %	12.90 %
Yahoo!	3.95 %	3.37 %	3.10 %	-	-	-
Microsoft	1.27 %	1.63 %	1.78 %	-	-	-
IAC	1.15 %	1.39 %	1.47 %	-	-	-
AOL	1.17 %	1.02 %	0.95 %	-	-	-
Amazon	0.48 %	0.59 %	0.71 %	-	-	-
Pandora	0.28 %	0.36 %	0.50 %	2.99 %	2.71 %	2.50 %
Twitter	0.16 %	0.28 %	0.50 %	-	1.57 %	1.95 %
LinkedIn	0.18 %	0.25 %	0.32 %	-	-	-
Millenial Media	0.05 %	0.07 %	0.10 %	1.00 %	0.82 %	0.76 %
YP	-	-	-	2.32 %	2.86 %	2.39 %
Other	55.59 %	55.48 %	52.28 %	55.58 %	34.33 %	23.53 %
Market size (billIon US$)	86.43	104.04	116.82	04. Feb	Aug 80	15.82

Source: eMarketer (2013)

Next to existing actors the profitability of this business model is likely to attract new stakeholders. Providers of electronic communications, for instance, potentially have access to a wealth of data about their customers. Equally, it appears sensible to transfer the principles of this business model to other industries that handle potentially valuable data such as health, car manufacturers, manufacturers of navigation systems and so forth. Most likely the value proposition here would not be advertising, but rather consulting and market insights. This development might steer towards data becoming a key resource for business models across numerous sectors giving data more and more value. Eventually, this may create a market for data, where individual companies may acquire data that they themselves may not be able to collect, but which are relevant for the service they offer to other companies. Policy-makers should consider this possibility seriously and discuss if and how they want to react to it.

Such a development would emphasise the need for consumer education that is apparent already today. Consumers should be enabled to make informed actual decisions about which data are collected about them and what may happen with these data. Consumers should be made aware of the fact that their behaviour is not simply traced, but analysed and inferences are made and used by others to make a profit. Today consumers have little opportunity to learn about this nor do they have a real choice when it comes to using devices like mobile phones, tablets or even cars with connected features. Next to enabling consumers in that way e.g. through a standardised and intuitive terminology for contracts agreements, policy-makers also have to keep in mind general issues revolving around privacy. As more and more data are collected and potentially combined, anonymous data can with relatively little effort be honed down to either a small group of individuals or even the individual person him- or herself. This is even more important as such data may result in discrimination if, for instance, such data are used to decide who is the right candidate for a specific job opening.

Finally, it may be relevant to consider if one is willing to trade the more and more important objective of connecting everyone especially in developing countries for increased control of few competitors in the market, who may block innovation when they become a gatekeeper of the access as well as important services and their monetisation through online advertising.

4.5 Video streaming

Video streaming is one of the services offered to end users within the data value circle. It comprises IPTV as well as video on demand (VoD) services including offers by telecommunication companies (e.g. Deutsche Telekom), cable companies (e.g. Verizon) and OTTs (e.g. Netflix, Hulu, YouTube, Vevo).

This value proposition is interesting to analyse here as this service is clearly the most important source of data traffic on the Internet and therefore future developments in this area are likely to have significant impact on the business of other stakeholders in the data value circle i.e. data networks and data handling, but also policy-makers and regulators. From a business perspective, it is interesting to note that there has not yet emerged a dominant player in this market. Accordingly, there is a wide variety of business models especially as regards how revenue streams are generated. Although many of these services are not profitable so far, they have specific competitive advantages as compared to broadcast and cable TV and may alter the media landscape significantly. Consequently, the following paragraphs first discuss and analyse the variety of revenue models and corresponding profitability of business models as well as other critical success factors. Hence, this section sheds light on specific advantages of video streaming services and how they may further impact the media landscape. Finally, strategic options of actors in the market and potential challenges for them as well as policy-makers and regulators are highlighted.

Video streaming is supported by a wide variety of revenue stream concepts. Revenue concepts stretch from fully advertising-based ones (e.g. YouTube, Vevo) to subscription only services (e.g. Netflix). The following paragraphs illustrate two examples of video streaming services that earn a profit and exemplify the two ends of revenue models: YouTube and Netflix. IPTV services offered by telecommunication providers are also discussed below.

YouTube profits from Google's proficiency and market share in targeted online advertising (see Section 4.4) and can operate at a significant profit selling targeted online advertising. Other major success factors within YouTube's business model are the key ability to deliver a high quality of experience for the consumer based on Google's own network infrastructure and the wide variety of largely user generated content. YouTube shares its advertising revenues with users who have uploaded content and allowed the advertisement placements.

Netflix, on the other hand, does not show any advertising. Its revenue model is completely subscription-based. Since they could not rely on an already established infrastructure like YouTube, the major success factor for their business model has been key partnerships. On the one hand, this refers to device manufacturers and their respective ecosystems. Netflix established partnerships with video game console manufacturers (Microsoft in 2008; Sony in 2009; Nintendo in 2010), television manufacturers (Samsung, LG and Sony in 2009; Panasonic and Google TV in 2010) and manufacturers of mobile devices (Apple in

2010; Microsoft in 2010; Android (Google) in 2011; Nook in 2011) to facilitate seamless access for the end user or even have the Netflix preinstalled as it happened with Nook tablets. On the other hand, Netflix had to establish key partnerships with content producers. Most notably they recently formed a partnership with DreamWorks that will enable them to bring first rate Hollywood content to the Internet first. Just like for YouTube QoE plays a pivotal for Netflix' success. Thus, they also have established partnerships with firms that offer data handling (Amazon) and Comcast as well as Verizon to give priority to Netflix's traffic on their networks. Beyond that, they produce high-quality original content only accessible through their service.

Next to OTTs, it is important to note that also many providers of telecommunication push into the media market offering their own IPTV solutions. As regards revenue models they usually come in a bundle with telephony and Internet access. Providers which own an electronic communication network have the natural advantage that they can offer their IPTV service as managed service i.e. monitoring and adapting the flow of data to ensure a constant high-quality consumer experience. However, since their offers are usually confined to their own network, the number of users is naturally limited and tends to be much smaller than that of OTTs. In turn, this renders them a less attractive distribution channel for producers of content.

Independent from the platform, video on demand and to some extent also traditional IPTV have distinct competitive advantages as compared to traditional TV broadcast and cable services. This has to do with their revenue models. If they support their service by advertising, they can offer a much more targeted service to businesses that takes into account the actual viewing habits of the individual and is able to make further predictions about their (dis-)likes based on a large volume of other user data. Traditional media can do this only based on samples of users and cannot individualize advertising messages. Furthermore, broadcast and cable TV's advertising revenues grow much slower than those for online advertising worldwide. In some countries they even decline due to a shift towards online advertising. Still, they have to fill their broadcast every day, which makes it difficult not to compromise the quality of content. Video on demand platforms can produce or purchase content that fits their customer segments. There is no obligation to provide a constant stream of content. It only has to be made accessible to the user. He or she watches it whenever or wherever he or she wants. This renders the cost structure in the VoD business model more manageable. In sum, it makes VoD providers well-equipped to prosper in the long-term and change the media landscape.

Especially video streaming services that seek to provide premium content face challenges acquiring premium content. On the one hand, this content is expensive, but also many content providers may be reluctant to sell premium content at all as it is their major source of income. Furthermore, there are often issues about international licensing of premium content. International distribution is, however, a key success factor for VoD services as they rely on a sufficient number of users to make their service viable. Thus, it is likely that VoD platforms more and more will rely on original content they produce themselves. Netflix and Amazon illustrate this starting trend. However, IPTV services by network operators may often not have the necessary critical mass of users nor the capabilities to produce attractive original content. Thus, if policy-makers intend to open up the media landscape to competition and foster structural change, they should make steps to facilitate international licensing of premium content and also support network operators in their move towards IPTV and VoD services.

Next to a trend towards original content, there is a trend towards differentiating digital video streaming in terms of quality of experience from broadcast and cable TV. It is already visible in Netflix' recent agreement with Sony to stream 4K video to selected high-end Sony TV sets. This will add even more data traffic to existing networks. Moving to 3D television, virtual reality entertainment and other immersive media that we are likely to see in the future will aggravate this issue further. Policy-makers and regulators will have to debate issues around cost sharing and data network infrastructure (see Section 4.2.2).

Finally, policy-makers should consider the long term evolution of consumer behaviour as regards video consumption. In total viewing hours, the trend towards VoD may still be small compared to broadcast and cable TV. However, when one turns one's attention to the video consumption behaviour of youth, it becomes obvious that this trend is all but negligible. The TV set is becoming less and less important to them as they watch an increasing volume of content on platforms such as YouTube. Often such content is

produced by small or even amateur producers. In the long run, this trend may harm the business case for established studios and producers of premium content.

5 Potential policy and regulatory implications

The present paper set out to investigate the economic influence of data and their impact on business models. The investigation of the evolutionary path of technical innovations allowing better access, distribution and analysis of data and concurring innovative business models demonstrates that a structural change towards a data-driven economy has been happening since the late 1990s. Section 3 supported this finding by developing the data value circle – a structural framework that helps to understand the specific characteristics of the data-driven economy. It proceeded by analysing the market size and prospects for each segment within the data value circle. The positive results for all segments underlined the importance of the data-driven economy and highlighted the value that data have today and are likely to have in the future. Section 4 analysed the potentially most influential value propositions within each segment of the data value circle and surrounding business models. In this analysis, but also throughout the paper potential challenges for market players, policy-makers and regulators were identified. This section summarizes challenges and strategic options for market players that have emerged from the investigations of the present paper. Hence, potentially appropriate responses by policy-makers and regulators will be sketched.

Through the course of this paper, it has become obvious that many actors within the data value circle seek to extend their businesses to other market segments in the circle. Data handling appeared to be a segment that is under a great deal of pressure. Both providers of data driven services as well as network operators have the relevant infrastructure and know-how that can be put to use relatively cheaply to also offer cloud and/or CDN services. Google is currently undercutting prices in this area and is likely to gain market share quickly. In fact, they are currently the only firm that operates in all four relevant market segments of the data value circle, albeit with relatively small operations in data networks and data handling. Amazon is possibly the second candidate to enter all four market segments. If this happens, it might at least nationally or regionally have some effect on competition, such that small innovative service providers might have to find new ways of entering the market. This situation might be aggravated if the dominance of operating (eco-)systems is furthered through the trend towards mobile devices, which might possibly result in a de facto duopoly in the online advertising market. This would make it potentially even more difficult for small firms to monetise their services through advertising.

Instead of entering other market segments themselves, the example of Netflix has shown that it can be profitable to work with partnerships. Such partnerships may also be attractive to other OTTs and to network operators. By means of such partnerships, OTT services may de facto turn into managed services. For a network operator, cost reductions are not the only opportunity to benefit from such partnerships: network operators might attract more customers by offering highly popular services such as Spotify or Netflix in their network at attractive terms and with a high quality of experience. Bundling such services with a network operator's own IPTV, access, and telephony products may positively influence customer loyalty – suggesting that IPTV and Netflix are possibly not competing, but instead are potentially complementary offerings. Depending on the terms and conditions as well as regional legislation, such partnerships may, however, be subject to regulation.

The issue of payments (e.g. for better-than-best-efforts transmission) between OTT content providers and network operators has been contentious, and is likely to continue to be a point of contention for some time. The linkage between these issues and network neutrality concerns makes them particularly difficult to resolve. It should be noted that many of the commercial parties in both camps (but not all) consider commercial (QoS-aware) agreements between willing parties to be unobjectionable. An amicable solution along those lines might perhaps be possible, but it is not likely to be easy or quick. Again, this thorny issue will not be easy to resolve.

Whether partnerships can resolve the open questions around net neutrality and the associated discussion about cost sharing of infrastructure investments between operators and OTTs is thus questionable.

However, the two issues elaborated in the above have highlighted that non-discriminatory access may not be limited to the Internet itself in the future, but rather the question of non-discriminatory access may extend into the field of market access in vertically related markets as well. Policy-makers and regulators may (depending on the specific situation in their country) see some need for intervention here. A second potentially important area of intervention emerges, when one considers this issue from a consumer perspective. One major building block of these ecosystems is lock-in effects. Policy-makers and regulators may encourage competition amongst ecosystems by supporting migration from one system to another by common standards or similar agreements (i.e. to achieve lower switching costs). If consumers can switch easily, new entrants at various levels of the value chain may find it easier to gain traction in the market.

Another incentive to enter more and more segments of the data value circle is to gain more complete insights about consumers and thus to acquire more valuable data. For network operators, an interesting strategic avenue would thus be to assess which data they can gather about consumers, and whether their behaviour might constitute a competitive advantage over the data that OTTs can gather. From a regulatory perspective, however, it is questionable whether network operators are likely to be allowed to act just as freely as OTTs do. If this is not the case, it becomes necessary to consider whether it is not time to open this competitive avenue for them. Generally, however, the collection and utilisation of more and more consumer data should be an area of concern for consumers, policy-makers and regulators alike as full personal profiles and predictive analytics may have adverse effects when put to the wrong purposes. As consumers are often unaware that data have been collected at all, which data are collected about them, and what is done with these data, transparency and information appear to be the key means of intervention here. However, to be effective information must address the consumer using terminology that is easily understood. Thus, a first step for policy-makers and regulators who wish to empower consumers and enable them to make meaningful and informed decisions about what happens to their data will be to explore how consumers conceptualise and understand the topic.

Beyond information and transparency, one might also consider steps to enable consumers to access the data that, for instance, OTTs and operators have about them. For instance, a standardised procedure could be devised to facilitate such requests for both sides. In light of a recent verdict of the European Court of Justice (giving consumers the right to demand deletion of personal data from search indices; based on the argument that search engines allow the compilation of a rather fine-grained personal profile with relatively little effort),[51] one might also ask whether consumers in countries outside of Europe should receive the right to ask for their data to be deleted, and not to be used for targeted advertising.

It is clear that the data-driven economy is very much a global economy. Data are often stored in regions with cold climate, because doing so is cheaper due to energy savings. Also, data may be routed through numerous networks until it arrives at its destination. This naturally raises questions about data security and jurisdiction.

Many of the policy interventions that could potentially be introduced to address these emerging issues are unlikely to have much effect if they are applied only on a national level. In essence, the structural change towards a data-driven economy calls for internationally agreed responses by policy-makers and regulators. Thus, consensus needs to be reached regarding governance, the organization of the process, implementation, enforcement, and cooperation for a wide range of policy interventions in order to ensure an overall positive economic effect of this structural change in the marketplace.

[51] http://curia.europa.eu/jcms/upload/docs/application/pdf/2014-05/cp140070en.pdf