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## Challenges to European Internet Business Models:

### Governing a fragmented internet

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#### 1. Introduction

In this paper we use modularity theory to show that legacy governance and the myth of a layered, uniform, global, neutral and democratic internet undermines European digital economy business models. At the core of the problem lie a series of misapprehensions about what can and should be measured and reported, and how such analytics are used for business strategy, policy making and civil society advocacy. We present the analysis of over 200 reports and studies of internet metrics of demand and use and illustrate how better analytics can explain business practices by showing how digital goods and services are valued, monetised, and measured for data quantity and transmission qualities. This is central to our understanding of the size and shape of the internet and provides the basis for explaining both how and why European (and per force other regions') internet differ and also what effect that has on the ability of Europe's internet business models to compete.

The idea of *multiple internets* is not novel and research over the past few years (Liebenau et al., 2011 and 2012) has shown how new analytics can be applied to reveal the context for European provision of digital services. Coupled with breaches of privacy, recent reports of widespread monitoring remind us that the internet is neither global nor flat, but contained in geographical jurisdictions and modular architectures (Yoo, 2012). This idea is worrying to advocates of a universal internet, as envisaged by the ITU, the Internet Society, the World Wide Web Foundation, as well as multinational digital content and services companies. The recent decision of the United States Circuit Court of Appeals for the District of Columbia in striking down the Federal Communication Commission's "net neutrality" rule in its 2010 "Open Internet" order in the context of the merger proposal between Charter Communications and Time Warner Cable is further evidence of rapid change in the governance of a fragmented internet.

The exploration of possible scenarios for the future of the internet has been the source of multiple debates, reports and studies (Rueda-Sabater & Derosby, 2011). Now there are demands for clarifications of what is stored, where the storage is physically located and who has access to it changes the idea of a free flow of data through exchanges. But can multiple internets exist stably? Can we conceive of multiple internets not as walled gardens, but as internets where certain requirements have to be fulfilled to save the privacy of individuals? Our analysis draws from Claffy & Clark (2013) and Gawer (2009) of an internet based on multi-platforms and providing digital services. At the core

of the question of the sustainability of the internet is the problem of which metrics are needed for governance and who can utilise the relevant data.

In the European context these questions have special significance with regard to how internet business is sustained and in which ways it can develop. Since 2007 data traffic patterns have changed dramatically, but not evenly, around the world. Massive video traffic, new smartphone functions, the convergence of voice services to VoIP, and the changing architecture of the networks have redrawn the shape of competition. Since 2010 we have been challenged to assess the economic significance of rapidly growing phenomena such as the so-called “over the top” services [OTTs] and the roles of content delivery networks [CDNs]. This analysis has hardly affected the longstanding practice of special pleading from incumbent telecom operators – particularly in Europe – to regulators to protect their revenue streams. In parallel there has been a shift in demand patterns and usage, which has shaken the internet business models of privacy, security, identity and changed the shape of the internet.

The new shape of competition, challenges to net neutrality concepts, and the NSA/GCHQ monitoring had the effect of making people wake up to the fact that the system does not have the governance controls that they had assumed. Many longstanding assumptions about the architecture are now demonstrably fallacious and based on a 1960s layered model, such as the character of seamless interconnection and implicit protection against diversion and inspection. However, most learned discussions and policy initiatives on the future of the internet still refer to those as the primary models.

What is measured and how it is measured will have direct influence on the regulatory practices to be implemented in Europe. Appropriate measures are necessary to provide evidence-based policy making with regard to sensitive data, including personal, governmental and financial data that will force many to reconsider their expectations from cloud services and access to big data and open data sources. Impending regulatory changes will affect the creation of new business models for international customers. In this context new internet metrics can serve commercial purposes, especially with regard to the ways in which these new business models will be priced and negotiated (Lehr, 2012).

## **2. Background**

### **2.1 Overview**

Most people are not aware of alternative ways of seeing the internet. The response to the U.S. National Security Agency’s [NSA] indiscriminate and systemic monitoring of internet activity has convince people all over the world that the internet is not governed as they assumed and that situations such as mass surveillance are not only technically feasible but seemingly acceptable to many who hold power. This prompts us to question more generally: how feasible is it to continue with the internet as we know it, and what significance does that hold for the overall growth of world wide web?

Changes in the structure of the internet require periodic re-conceptualisation from the 1990s concept of the “network of networks” (Noam, 2003) to the idea of multiple

internets (Yoo, 2012; Claffy and Clark 2013). Such approaches help to structure our thinking about the inter-relationship of networks for policy and commercial purposes but are undermined by a number of factors. These include efforts to define policies that promote and shape internet markets by affecting regulatory boundaries and mechanisms. Independently, internet firms have moved quickly, especially in the seven years since 2007, to build strategic vertically integrated components. During this period of change incumbent telecommunication network operators have only tentatively engaged in efforts to emulate fast moving digital economy companies in establishing content delivery networks [CDNs], provide cloud services, engage in content production, etc. More recently, both public policy and commercial business models have been affected by the rise in mistrust of monitoring activities by both governments and other organizations<sup>1</sup>, by identify theft, privacy infringements, security breaches, spam and other maladies.

## **2.2 A governance and regulatory revision of internet strategy**

Many conceive of the internet as flat and global with only small anomalies to grow out of or repair. The confluence of interests calling for a new governance regime may have been accelerated by the NSA revelations, but there have been growing sources of unease about the attempts of countries such as China and Iran to create walls around “their” internet. While the dominance of Google in the search market may be seen as an outcome of market forces, the specific features of competition that come into play when, for example, concentration measures are used, are scarcely applied.

The speed of change to the internet model has accelerated since 2007 with the launch of the iPhone and the convergence of voice services to VoIP. Since 2010 the argument has been framed in terms of the roles of OTTs and CDNs. There has been special pleading from incumbent telecom operators, particularly in Europe, who expect regulators to act to protect their revenue streams (ATKearney, 2010 and 2013).

In parallel there has been a shift in demand patterns and usage, which has shaken the internet business models of privacy, security, identity and the architecture of the internet. This is well document by the forecasts of companies such as Cisco (2011 and 2012) and Sandvine (2013). The response from the internet companies has resulted in polarisation of business models and revenue streams: a very different model is emerging, contrasting the USA based internet companies and the rest of the world. This difference has been highlighted by the Snowden scandals, and in the words of Cisco’s CEO, “faith in US technology companies was being eroded by the NSA's activities”<sup>23</sup>.

The recognition from the US internet industry that the NSA actions have jeopardised the trust of current institutions overseeing the monitoring and development of the internet.

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<sup>1</sup> In June 2014 US internet tech companies have again stressed the difficult position they are due to the NSA actions and its impact in their business models <http://www.bbc.co.uk/news/technology-27712913>

<sup>2</sup> <http://www.bbc.co.uk/news/technology-27468794>

<sup>3</sup> <http://www.techtimes.com/articles/4659/20140323/obama-meets-facebook-and-google-ceos-to-discuss-nsa-zuckerberg-presses-for-answers.htm>

Users have come to regard the system to be inadequate with regard to governance mechanisms that they had previously assumed to be effective. These assumptions correspond with common understandings of the architecture, business models, and operation of the internet that are fallacious or out of date. However many policies and discussions on the future of the internet still rest on layered models<sup>4</sup>.

### **3. A new approach to describing the internet of today and tomorrow**

A new approach is needed that focuses on changes to functionality and architecture in relation to innovation, and also to assessing the risk and conflicts of power that are associated with those changes.

#### **3.1 Modularity and innovation**

Modularity theory is used in systems engineering and is widely understood by the technical community with regard to software design. It rests on principles that include clear specifications of functions and relationships within and among modules that determine boundaries where interfaces allow for interaction. Those design principles also can be applied to understand internet architecture, which has traditionally been conceptualized more simply in a layered model (Yoo, 2012). Earlier conceptualizations of internet activities, especially where technical contributions prevailed, tended to focus on activities delineated by their layered position. Infrastructure services remained within well-defined boundaries

Modular activities within the digital economy are characterised by functional relationships that knit together technical forms of interaction, as for example facilitated by application protocol interfaces [APIs] and social network linkages, and commercial functions such as online shops, advertisements and personal data useful for customer relationship management [CRM] uses. Increasingly, those engaged in transport, content delivery and connectivity have explored ways of integrating those increasingly commoditized functions with more value added activities in specialist software, content creation and services. This has opened new areas of competition and challenged longstanding notions of industry structures, strategies and policies. It has also forced regulators to reconsider their roles and the measures they have with regard to market forming.

Increasingly, however, leading internet companies such as Amazon, Google and Apple have successfully been able to use the vertical integration of internet functionalities to create value in digital services. While first mover advantage (Fransman, 2010), larger home markets, and competitive superiority can explain some aspects of these companies' market positions, US regulatory practices have also been important in fostering modular-type business strategies. European competitors have felt more constraints to specialize and operate within a layer, furthering opportunities for US companies to dominate. These firms have mastered the use of digital platforms to deliver services in more than

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<sup>4</sup> The debate on net neutrality is behind in achieving a common view from all members of the community and many wish to keep the internet under this vision: <http://www.freedomonline.eu/node/131>

one layer of the internet. They are adept at devising new business models that encase lucrative proprietary goods and services that integrate across layers, while designing broadly flexible interfaces that allow them to reach mass markets<sup>5</sup>.

European technology companies and in particular the telecommunication industry sector have failed to follow this path and respond to the US dominance in the sector, even when they had the strategic advantages or were innovators in the field (e.g. Nokia in the mobile sector)<sup>6</sup>. Some of these failings are attributable to inefficiency, inadequate innovation and in some cases incompetence of European business decision makers versus their US counterparts. There are also structural and governance inhibitors, and regulators in Europe have ignored the modular aspects of the vertical integration in the use of the internet to focus their policies on ensuring access instead of traffic generation when developing regulatory policies.

Modularity does not necessarily presuppose fragmentation. However, it does offer design choices that allow simultaneously for integrative digital functions and scalability through easily accessed interfaces. Those same features have two kinds of tradeoffs. One concerns innovation choices and the imposed stability of technologies within modules. The other allows for choices of interfaces that might promote the antithesis of integration. The latter is at the core of some net-neutrality discussions because it describes how proprietary or favoured services can be structured. It is also relevant for choices of governance that nations might apply to control internet uses for political or commercial reasons.

### **3.2 Risks and power conflicts**

There is an imminent possibility that more governments will decide to apply the internet development model of China or Iran. Brazil has acted by embedding more “protection” for local content, vulnerable groups (including not only children but also politicians), favoured content providers and technical features, along with idiosyncratic interpretations of net-neutrality<sup>7</sup>. Meanwhile, the US position has become increasingly ambiguous<sup>8</sup>, prompting ICANN to adjust its procedures<sup>9</sup>. These actions form the background to the internet governance debates that dominated world forums such as the ITU Dubai meeting in 2012.

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<sup>5</sup> The constant merges of internet companies at the global level, e.g. Twitch and Google are seldom seen to happen in Europe without regulators' actions. <http://www.bbc.co.uk/news/technology-27468967>

<sup>6</sup> Others like Telefonica has attempted and failed (e.g. the now closed down Telefonica digital brand) to raise and create digital platforms. Other attempts to compete with Google are still under development <http://www.ft.com/cms/s/0/3e748944-c3fe-11e3-870b-00144feabdc0.html>

<sup>7</sup> <http://yro.slashdot.org/story/14/04/24/1646230/brazil-approves-internet-bill-of-rights>

<sup>8</sup> <http://www.bbc.co.uk/news/technology-27426937>

<sup>9</sup> <http://m.europe.wsj.com/articles/SB10001424052702303546204579439653103639452>

A more straightforward response to political pressures is that which Germany is proposing as part of the EU-USA negotiations for open trade<sup>10</sup>. Privacy is taking a role that is unexpected and there is open discussion as to whether it is privacy or security that is at the core of what needs to be protected<sup>11</sup>. Many of these issues go beyond the traditional perspective of the internet as a network that provides unrestricted communications, and some, especially in the US, regard European privacy protections to be tantamount to trade restriction tactics.

Arguments for a less US controlled internet are based on political and economic competition arguments. Many countries that are recent fast adopters of the internet push for localized controls that seem to pose technical threats<sup>12</sup>. The European debate on the future of the internet is focused mainly on development of business models and the impact or lack of impact of cloud services (Mims, 2014), as well as on the social effects, privacy and regulation at regional, national and local government<sup>13</sup>. Additionally the discourses of power, how to achieve equilibrium between government and regional institutions, and citizen goals<sup>14</sup> couched as user benefits.<sup>15</sup>

How will the architecture of the internet need to change to cope with the demands for the new data and service requirements<sup>16</sup>? Segmenting the cloud, while technically feasible, goes against the business model that entails load-balancing worldwide and various arbitrage techniques and will be resisted as an underlying (as opposed to superficial) architectural element. New approaches to walled or controlled or protected internets need to be addressed. Some approaches such as Brazil's require major infrastructure alterations (new undersea cables, controls on internet exchanges, etc.) and significant investment for the build up<sup>17</sup>. The Chinese have geographic firewalls and huge armies of net monitors who systematically watch everything. The Germans<sup>18</sup> have hinted that their proposal will

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<sup>10</sup> Data proposals from Privacy in EU

<http://www.ft.com/intl/cms/s/0/92a14dd2-44b9-11e3-a751-00144feabdc0.html#axzz2k3etX3jf>

<http://www.ft.com/cms/s/0/e3df8030-4494-11e3-8926-00144feabdc0.html#axzz2k3etX3jf>

<sup>11</sup> Other examples related to the jurisdictional argument for data storage:

Study of the Tennessee/Alabama: about pornography, personal website. Family nudes on the beach.

Geography: Mosley pictures in France have to be removed just in France.

<http://slashdot.org/story/13/11/07/1623222/french-court-orders-google-to-block-pictures-of-ex-f1-chief-mosley>

<sup>12</sup> <http://www.bbc.co.uk/news/world-europe-24781417>

<sup>13</sup> The EU decision to support the right to be forgotten is an example of this social pressure: <http://www.bbc.co.uk/news/world-europe-27388289>

<sup>14</sup> <http://www.theguardian.com/world/2013/nov/01/nsa-surveillance-cause-internet-breakup-edward-snowden>

<sup>15</sup> <http://www.faz.net/aktuell/feuilleton/debatten/the-digital-debate/shoshanna-zuboff-dark-google-12916679.html>

<sup>16</sup> <http://www.wired.com/threatlevel/2013/10/global-net-infrastructure/>

<sup>17</sup> <http://www.wired.com/threatlevel/2013/10/global-net-infrastructure/>

<sup>18</sup> <http://www.businessinsider.com/now-germany-wants-its-own-internet-in-nsa-spying-wake-2013-10>

be a closer monitoring of routing tables plus dramatic restrictions on data centres to keep analytics and storage within the country (or within Schengen economic area, or somewhere with similar physical laws); this is already partly the case with Russia, Turkey and elsewhere where there are restrictions on financial data location<sup>19</sup>. All these problems lead us to believe that we require a new typology of differences.

#### **4. The internet business model revisited**

In order to assess economic changes in the internet we need to revise how we obtain the information that is used to discuss its expansion and development. Many of the emergent conflicts and paradoxes among traffic, economic models and business innovation stem from a two-sided market analysis. The internet is not a production line factory; at many stages in the delivery of digital services, multiple actors might compete to provide services. This has entailed a new form of business and technical integration.

For example, Facebook has attempted since its creation to be a unique platform for social media and communication. It has fine-tuned security and privacy settings to make its users feel comfortable integrating their different social media. When Facebook launched a communicator or chat that did not succeed because of competition from Whatsapp, Facebook bought Whatsapp. A similar story occurred with Instagram and now Facebook is trying to develop a new application that competes with Snapchat.

Similarly, Google tried to compete with Facebook on social media through Google Plus, and linking it with Gmail and YouTube, to the consternation of users<sup>20</sup>. Google also was ubiquitous in bringing Gmail to the core of the experience for Android in mobile devices, in particular with Samsung devices and is moving into online gaming distribution, through Twitch, to try to capture part of that market<sup>21</sup>.

The current cloud model will be one of the first victims of the changed perception of how to protect business core development. At this point the cloud is not sufficiently trusted to be geographically autonomous, secure, or ethically managed. US courts have asked Microsoft to hand over data hosted outside the physical boundaries of the United States, causing concern among many in the private and industry sector<sup>22</sup>. That vulnerability, taken along with the technical failure on October 31, 2013 that brought down Azure<sup>23</sup>, reveal a relationship between internet governance and technical design.

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<sup>19</sup> <http://www.cbr.ru/eng/>

<sup>20</sup> Google follows a company strategy of investment in hardware and software that has been noted by financial regulators <http://www.ft.com/cms/s/0/40d917bc-e0fb-11e3-875f-00144feabdc0.html?siteedition=uk#axzz32SPTDJ3J>

<sup>21</sup> <http://www.bbc.co.uk/news/technology-27468967> and <http://www.independent.co.uk/life-style/gadgets-and-tech/google-reportedly-in-talks-to-buy-videogame-streaming-service-twitch-for-1bn-9393743.html>

<sup>22</sup> <http://www.v3.co.uk/v3-uk/news/2341817/us-judge-rules-cloud-firms-including-microsoft-and-google-must-hand-over-data-stored-overseas>

<sup>23</sup> [http://www.theregister.co.uk/2013/10/30/windows\\_azure\\_global\\_fail/](http://www.theregister.co.uk/2013/10/30/windows_azure_global_fail/)



The reporting of the NSA monitoring<sup>24</sup> prompted a swift response by the dominant internet companies<sup>25</sup>. They have come up with interesting ideas. For example, Google is experimenting with solutions offshore for the provision of data centers<sup>26</sup>. Facebook has similarly hinted that they may further segment their services<sup>27</sup>. The Apple consumer base has also raised concerns about the usage of the recently enabled features in iOS for fingerprinting and the potential sharing of this database with the NSA<sup>28</sup>, as well as the fact that in the US it is legal for police to demand a fingerprint, but illegal to demand a password.

Aside from technical solutions on reinforcing the encryption processes at the network layer<sup>29</sup>, it is not clear how US internet companies will be able to deal with the current demand for a review into how the internet is being monitored and by whom, when and what for. Internet companies might have to explore routing based restrictions on data as in the actions of the online gaming community to bypass US regulation on gambling within its territory. It seems possible to think that corporate investors might see big opportunities in Balkanisation of the internet as "separate" internets based on loose geographical areas and perhaps demands for service. For example keeping data hosted in the country where the data is sourced might be a requirement for having a company in a country; there is plenty of room for experimentation in terms of technical solutions and policy enforcement.

## 5. Metrics

At the heart of any such discussion are the measures that are regarded as indicative of business behaviour. Here, we review how the internet is measured, correlated and analysed, and we discuss how regulators and policy makers can be use more evidence-based and better informed metrics.

### 5.1 Traffic: users, access and speed

The most commonly used traffic metrics are those from Cisco (2012), describing traffic in well described but nonetheless idiosyncratic categories, TeleGeography (<http://www.telegeography.com>) and Sandvine (<http://www.sandvine.com>), describing types of traffic with a focus on specific sectors, e.g. entertainment, and communication services. Such information is also available through the ITU and reused by the OECD

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<sup>24</sup> [http://www.washingtonpost.com/world/national-security/nsa-infiltrates-links-to-yahoo-google-data-centers-worldwide-snowden-documents-say/2013/10/30/e51d661e-4166-11e3-8b74-d89d714ca4dd\\_story.html](http://www.washingtonpost.com/world/national-security/nsa-infiltrates-links-to-yahoo-google-data-centers-worldwide-snowden-documents-say/2013/10/30/e51d661e-4166-11e3-8b74-d89d714ca4dd_story.html)

<sup>25</sup> <http://www.theguardian.com/technology/2013/oct/30/google-reports-nsa-secretly-intercepts-data-links>

<sup>26</sup> <http://mashable.com/2013/10/25/google-floating-data/>

<sup>27</sup> [http://news.cnet.com/8301-1023\\_3-57603561-93/zuckerberg-thanks-nsa-now-people-trust-facebook-even-less/](http://news.cnet.com/8301-1023_3-57603561-93/zuckerberg-thanks-nsa-now-people-trust-facebook-even-less/)

<sup>28</sup> <http://nationalreport.net/apple-iphone-5s-fingerprint-database/>

<sup>29</sup> <http://www.nytimes.com/2013/11/01/technology/angry-over-us-surveillance-tech-giants-bolster-defenses.html>

(2012), albeit with a significant lag and dependent on national reporting. Both the ITU and the OECD have made efforts in recent years to identify, which sorts of data might be more relevant to new usage models of the internet and to economic analyses, but neither has yet been able to shift their metrics and insist on member countries collecting new kinds of data.

These traffic data are commonly reused in reports such as those issued by GSMA and other industry associations, or re-packaged by consultancies such as AT Kearney for specific arguments for bodies such as the European Telecommunications Network Operators Association [ETNO] and also the mobile operators association, GSMA. In addition to commercial and lobbying purposes, the data are used for analyses of cyber threats and resilience.

However, the weakest element of this analysis is tracking of sources of traffic, which is mainly done through the use of Alexa data because it is difficult to track meaningful relationships among sites in ways that capture economically significant features of traffic. It is for this reason that RIPE data are especially important, as they track at the level of AS numbers.

However there are new needs to be addressed to make more clear the relationships between traffic type and volume, the economic value of those transaction and the impact the architecture (e.g. routing, control points, load balance, etc.) that contribute to the economic decisions and impact.

In previous work by the authors (Liebenau and Elaluf-Calderwood, 2013) our proposal has been that the analysis of the diverse metrics raise a series of question on how to do comparisons among comparable networks, and between different types of networks (e.g. telecom, Google, peering networks) and how we distinguish comprehensive, segmented, partial views. Furthermore the current metrics do not indicate what is not been counted and where the missing content might be.

## **5.2 Data approaches**

In this section we show the different approaches for collecting and comparing of metrics. We can group then in three main categories: qualitative, quantitative, and hybrids. Figure 1 introduces the general use of metrics, and indicates the extent to which they are of economic utility.

Report Type	Qualitative classification	Economic analysis
Collectors of traffic counters connected to routers (e.g. Cisco VNI data)	Information based on Cisco's own collection from software installed in their hardware. Considered industry benchmark. Lots of exceptions. No Quality of Service analysis. Traffic is analysed in categories that are not matched by other industry reports.	No correlation between traffic and pricing, but regular reports commenting on economic context
Reports from firms generating traffic	Google, YouTube, Facebook, <a href="http://www.google.com/transparencyreport/traffic/#expand=CN">http://www.google.com/transparencyreport/traffic/#expand=CN</a>	No indicators for comparison
Classification of traffic (e.g. Sandvine reports)	Focus on sectors e.g. entertainment, home roaming, comm, and comm services.	Some based primarily on billing, by type of traffic
Academic studies on the internet (e.g. Professor Economides reports, CAIDA reports)	Theoretical and practical academic analysis of current status of the internet	Yes. Some of the pricing is indirectly estimated
Consultancy reports commissioned by interested parties	E.g. incumbents, consumer groups, industry associations such as BGC, ATKearney. Reports on traffic and demand based on ETNO members' data.	Yes based on own commissioned calculations
Regional, national, state regulatory frameworks	<a href="http://www.gpo.gov/fdsys/pkg/FR-2011-09-23/html/2011-24259.htm">http://www.gpo.gov/fdsys/pkg/FR-2011-09-23/html/2011-24259.htm</a>	Yes. Based on specialized studies FCC commissioned

Figure 1: Analyzing internet reports<sup>30</sup>

In figure 2 we have a commercial example on how one company, Sandvine, defines the metrics to be used in their reports (Sandvine 2013). These categories are not easily matched with Cisco categories (Cisco 2012) or ITU (2011). Adding as explained complexity to any analysis. Note that there is not clear explanation of any type of

<sup>30</sup> Extracted from Liebenau and Elaluf-Calderwood (2013) the analysis can be classified as qualitative with strong emphasis in trying to identify variables and correlations between the many network parameters.

economic variable. Sandvine uses highly qualitative data analysis focus on speed and the better known internet metric variables.

Traffic Category	Description	Examples
Storage	Large data transfers using the File Transfer Protocol or its derivatives. Services that provide file-hosting, network back-up and one-click downloads	FTP, Rapidshare, Mozy, zShare, Carbonite, Dropbox
Gaming	Console and PC gaming, console download traffic, game updates	Nintendo Wii, Xbox Live, Playstation 2, Playstation 3, PC games
Marketplaces	Marketplaces where subscribers can purchase and download media including applications, music, movies, books and software updates	Google Android marketplace, Apple iTunes, Windows Update
Administration	Application and services used to administer the network	DNS, ICMP, NTP, SNMP
Filesharing	Filesharing applications that use a peer-to-peer or Newsgroup as distributed models	BitTorrent, eDonkey, Gnutella, Ares, Newsgroups
Communications	Applications, services and protocols that allow email, chat, voice and video communications; information sharing (photos, status, etc) between users	Skype, WhatsApp, iMessage, FaceTime
Real-Time Entertainment	Applications and protocols that allow “on-demand” entertainment and is consumer (viewed or heard) as it arrives	Streamed or buffered audio and video, peercasting, specific streaming sites and services (Netflix, Hulu, YouTube, Spotify)
Social Networking	Websites and services focused on enabling interaction (chat, communication) and information sharing (photos, status, etc) between users	Facebook, Twitter, LinkedIn, Instagram
Tunnelling	Protocols and services that allow remote access to network resources or mask application identity	Remote Desktop, VNC, PC Anywhere, SSL, SSH

Web Browsing	Web protocols and specific websites	HTTP, WAP browsing
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Figure 2: Sandvine explanation of traffic categories (Sandvine, 2013)

In figures 3, 4 and 5 we illustrate how the Berkman Center (Faris and Heacock, 2013) have used hybrid methods to understand internet metrics. Note the similarities and differences between figures 2 and 3.

Metric	Data Sources
Penetration	<ul style="list-style-type: none"> <li>• Business surveys: total number of subscriptions.</li> <li>• Household and consumer surveys: proportion of households connected to internet broadband.</li> </ul>
Speed	<ul style="list-style-type: none"> <li>• Business survey and market research: advisory speeds (e.g. OECD, FCC, etc).</li> <li>• Content delivery networks and web services: download speeds (e.g. Akamai, Netflix).</li> <li>• Distributed client-based hardware: download and upload speeds (e.g. government partnership with SamKnows).</li> <li>• Crowdsourcing: download and uploads speeds (e.g. Oakla's speed test, M-Lab, etc).</li> </ul>
Price	<ul style="list-style-type: none"> <li>• Market research: comparison of offers across different ISPs and countries (e.g. OECD, FCC, etc).</li> <li>• Crowdsourcing: user submitted information on prices (e.g. Oakla's Net Index).</li> </ul>
Infrastructure: location, size and routing	<ul style="list-style-type: none"> <li>• IP address distribution.</li> <li>• Allocation of domains</li> <li>• Number of internet hosts</li> <li>• Number, size and relationships of autonomous systems (AS)</li> <li>• Network bandwidth estimates</li> <li>• Internet exchange (IX) location and traffic</li> <li>• Route identification and analysis</li> <li>• National networks status (e.g. Renesys, Arbor networks)</li> <li>• International pipe location, traffic and dependencies</li> </ul>

Figure 3. Definition of metrics and measures for internet infrastructure and access by the Berkman center (Faris and Heacock, 2013)

Metric	Data Source (s)
Take downs	<ul style="list-style-type: none"> <li>• Business self-reporting (e.g. Chilling effects, company transparency reports)</li> <li>• Content tracking (e.g. studies on the removal of Weibo posts)</li> </ul>
Filtering	<ul style="list-style-type: none"> <li>• Business self-reporting (e.g. company transparency reports)</li> <li>• Distributed data collection and analysis (e.g. OpenNET initiative, OONI)</li> <li>• Crowdsourced reports (e.g. Alkasir, Herdict)</li> <li>• Automated tools: website, keywords (e.g. Great Fire, It is Down Right Now)</li> <li>• Social/media reports</li> <li>• Leaked block lists</li> </ul>
DDOS	<ul style="list-style-type: none"> <li>• Distributed network data gathering (e.g. Arbor Networks, Akamai, Google)</li> <li>• Surveys of websites and services</li> <li>• Social/media reports</li> </ul>
Malware and other attacks	<ul style="list-style-type: none"> <li>• Malware analysis and signatures (anti-virus)</li> <li>• Malware hosting (e.g. StopBadWare, Google)</li> <li>• Response coordination (e.g. CERT)</li> </ul>
Legal restrictions	<ul style="list-style-type: none"> <li>• Legal analysis</li> <li>• Social/media reports</li> </ul>
Non-technical control	<ul style="list-style-type: none"> <li>• Watchdog group reports</li> <li>• Social/media reports</li> </ul>
Self-censorship	<ul style="list-style-type: none"> <li>• Surveys of internet users and online organizations</li> </ul>

Figure 4. Metrics for internet control. Source Berkman Center (Faris and Heacock, 2013).

Figure 5 is another example of alternative methods to approach the collection of data through internet activity. It is not a surprise then that policy makers find it increasingly complex to relate measurement of the internet and explain their relevance for regulatory problems. A high level of fragmentation and multiple layers of the internet architecture are double counted with this type of approach.

General Data Type(s) and Origin (s)	Specific Source(s)
Reporting on individual behavior	<ul style="list-style-type: none"> <li>• Client-side behavioral monitoring software (e.g. ComScore, Alexa)</li> <li>• Cookies and browsing history</li> <li>• Consumer surveys</li> </ul>
Network monitoring: location, type and quantity of traffic	<ul style="list-style-type: none"> <li>• Monitoring by ISPs</li> <li>• Monitoring by network services (e.g. content distribution networks, internet security companies)</li> </ul>
Data collection by website and services: visitors, contributors, content, links, comments, languages and locations.	<ul style="list-style-type: none"> <li>• Websites including social media platforms (e.g. user-generated content websites, social network sites, blogging and micro-blogging sites)</li> <li>• Search data</li> </ul>
Social media mapping: link and/or content based	<ul style="list-style-type: none"> <li>• Landscape mapping: platform/service-based mapping (e.g. Twitter, Facebook, blogsphere)</li> <li>• Topical or issue-based mapping</li> </ul>
Qualitative assessments	<ul style="list-style-type: none"> <li>• Expert opinion surveys</li> </ul>

Figure 5: Data sources for measuring online activity. Source Berkman Center (Faris and Heacock, 2013).

In summary the key criteria required seem to be:

- a) *What the disaggregated characteristics of traffic are by type of traffic.* This would include differences between kinds of data, not only by routing through mobile systems, voice services, etc. but also by kinds of video services, differentiating, for example, streaming videos from surveillance cameras, etc.
- b) *How interconnections occur and what their business functions are.* This will need to take into account application protocol interfaces [APIs] as well as other methods to transfer data.
- c) *A relationship between descriptions of routing and the trajectory of disaggregated traffic* such that we can understand the extent of double counting. This would

- take into account the traffic that remains within specific networks as well as those that move between networks through peering and transit arrangements.
- d) *A direct link between pricing for traffic carriage and the cost of generating and maintaining networks.*
  - e) *We also require an open debate on metrics collection and repositories of data, which includes both open and walled internet data.*

## **6. Discussion and conclusion**

Practices that are common among leading internet companies are rare among European network operators, such as i) detailed data mining, ii) detailed network monitoring, iii) rapid shifting of routing using optimal and suboptimal routers, and iv) use of outsourced services. There is some level of incompatible international differentiation for business terminology that makes it difficult to match requirement and metrics. For regulators it is important that the data they use to elaborate new working frames reflect what is happening in the networks, however an approach to collect all data that is out there as proposed by the French state in the case of France Telecom vs. Cogent (Liebenau and Elaluf-Calderwood, 2013a) is counter-productive for innovation and trust.

It is clear for many that the governance and regulatory practices of the internet will have to change in the near future. The actions of the NSA as well as the new business models and emergent internet players are making possible a new layer of segmentation based on privacy and data requirements on internet service provision. What is certain is that the internet of 1969 is now mature and entering middle age. European regulators cannot remain focused on earlier network forms and models.

However, the drive for regulation to satisfy new demands for privacy are emerging, and are threatening US-based companies in their effort to provide data assurances for cloud services. New regulatory practices will be put in place to protect data that is geographically sensitive. New business models may emerge for international customers, perhaps to offer some customers contracts that specify their data is NSA-monitored and some non-monitored.

Such trends, and the demand that we understand better the underlying economic indicators, require new internet metrics that can discern the ways in which new business practices will be priced and negotiated.

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