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Research In Brief

Convergence in action: A case study of the Norwegian Internet

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ABSTRACT

The conceptual framework for understanding the logical Internet is based on the construction of a horizontal, layered architecture, which differentiates between physical-, data link-, network-, transport-, and application layers (Woodard and Baldwin, 2008). This is different from the telecommunication networks model where a new service traditionally used to require new network architecture to be established (Yoo, 2012). However, the digitalization of services and products offered over the telecom infrastructure allows us to observe an emergent phenomenon of increased vertical integration on the Internet as well as the creation of further service specialization opportunities for telecom operators and users (Liebenau et al., 2011). We propose in this paper that this development and change in the way services are provided, leads to a new type of Internet – an addition to the current best effort Internet.

We illustrate our proposition by presenting the case study of the Internet in Norway, analysing 166 of the approximately 40.000 independent AS numbers registered worldwide as catering for end-to-end services. The paper categorizes the Norwegian AS numbers according to size and type of services. Through our analyses two major groups of actors can be identified, each of them seeking to gain strategic advantage from the current Internet traffic growth:

(1) Content providers and hosts seek to have a highly reliable network access with a minimal set of traffic or transmission costs. One action is to acquire AS numbers and use settlement-free peering agreements for distribution of their traffic, which is possible in traffic exchange regimes rooted in symmetry, slowly becoming asymmetric;

(2) Internet access providers (IAPs) seek to take control over incoming traffic growth by hosting content within their own network and thereby to rebalance traffic and create new revenue streams with content hosting and premium end-to-end connection on-net. Our findings support the hypothesis that Internet is becoming both more vertically integrated and converged, and more specialized or modularized (Clark et al., 2004).

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1. Introduction

The motivation of this research is to provide further insight on the changes happening to the overall Internet and the local Internet through the study of the changes on the autonomous system (AS) number distribution in Norway. An AS is a connected group of one or more IP prefixes run by one or more network operators, which has a single and clearly defined routing policy (Hawkinson and Bates, 1996). In recent years a number of people and organizations involved in the monitoring of the Internet (Bauer et al., 2010; Claffy, 2011a; Shakkottai et al., 2009) have reflected on the changes leading to the emergence of Internet walled gardens (Zittrain, 2008), modular Internet (Voss and Hsuan, 2009; Clark et al., 2004), new stakeholders such as over the top services (OTT) etc. A number of socio-technical characteristics (e.g. new service provisioning, new business models and consumer demands, etc.) signal for a clear change to the established logical Internet topology known as "best effort" or the layered model (Labovitz et al., 2010; Woodard and Baldwin, 2008).

The many Internet bystanders observe the trends that the traffic increases, the mobility of the users' access to Internet services increases (as opposite to the fixed access to the Internet from the early stages of development), as well as consciousness of the quality of service provision and measurement required to satisfy such demand (Meeker, 2012; Sandvine, 2011). The pressure on the Internet telecom providers is coming from the digitalization of products and subsequent opportunities for convergence in the whole value chain. In the first instance the emergence of an OTT service like Skype's Voice over IP (VOIP) have put telecom operators in direct strain due to their competition effect on the traditional telecom revenue streams (Herzhoff, 2011). Later the OTT phenomenon brought many new players such as Netflix and other Internet TV services suppliers, and together with the experience of YouTube they have created even more demand for bandwidth from the Internet core (Breznick, 2011).

These changes are producing conditions and strategies for commercial and network convergence enabling business integration of many Internet stakeholders (e.g. Cable providers as ISPs and media transport and content creators). The aspect that users are exposed to digital services enabling "live" experiences which are bandwidth hungry (e.g. multimodal digital integration and distribution of services in real time) and the rise of software platforms exclusively for digital services (e.g. Apple, Google, advertisement), promote new innovation and pricing structures. Software providers – whether they are Microsoft, SAP or Oracle or local SW providers – are slowly starting to distribute digitalized services over the Internet relying on cloud or network hubs. However we have not yet seen how large the cloud computing industry will grow (Yoo, 2012, 2011), and if they will be able to provide the capacity, quality performance and security that users require. As a result of these trends and changes, new business models for the Internet and the Telco industry may imply that digital services are provided with predictable performance in more than one layer as composed services based on their functionality (Liebenau et al., 2011).

How do we transfer these trends to understand, at a more local level, what is happening to the Internet and develop the case for discussing a new type of Internet? In the first instance we show the existence of a Norwegian Internet that is localized, providing services that generate demand and supply dynamics. The Norwegian Internet case study does matter to understand what is happening to the overall Internet. Norway, due to its advanced status from a technological and societal point of view, has the data resources to provide a full comprehensive map of its Internet – which is not the case with many other countries in the world.

On the other hand we have been able to identify the formation of hubs of companies using AS numbers as a way to improve their opportunities to offer digital services within the Norwegian community. Hence the analysis presented in this document using the AS numbers identifying enterprise strategies is not only relevant but also novel in its approach to the study of the Internet.

2. Related research

The measuring of the Internet growth and expansion has been undertaken since the start of the Internet and the monitoring tools and protocols are not standardized (Claffy et al., 2009). Since its creation and due to the original purpose of the Internet – primarily designed as a military command communication tool for a dystopian post-nuclear future – the monitoring (e.g. systems, protocols) has always existed. The principles of load balancing and equilibrium peering and the close attention from Regional Internet Registries (RIR), are the foundations of such monitoring (Jasinska, 2006; Sowell, 2012). Additionally technical reports on traffic from major vendors such as Cisco, or backbone providers such as Akamai provide interesting insightful ideas on the total volume of traffic in the Internet (e.g. Cisco, 2011, 2012).

The commercial Internet, which has been accelerated by the increased convergence of digital services with the use of the physical infrastructure, requires intelligent tools to monitor what is actually happening as trends. Many of the tools used either focus on the traffic monitoring only, or rely on one or two main sources of information (e.g. broadband connections vs. mobile connections (Cisco, 2011; Luzi, 2009)), while others only focus on the quality of service (e.g. the majority of the IPTV reports (Breznick, 2011; Steen, 2012)). Complex issues on the role competition and regulation tussles with the study of demands are novel aspects to be revised in the near future by researchers (Krauss, 2009).

However the data already available report permanent increases of traffic and analyses indicate a trend for further growth. The literature review for this paper revealed many traffic studies done by institutions such as MIT, CAIDA, etc. or sourced from specialized conferences in the field such as SIGCOMM on related issues (Ager et al., 2012), which give a partial view on the emergence of the issues described in the introduction of this paper. The different studies revised are partly