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The Importance of Internet Measurements for Internet Policy

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Introduction

The Internet is more and more perceived as a critical infrastructure by many national and international governments. Many governments are formulating policy on the "Information Society" in general and on the Internet in particular. For example, the European Commission states that developing a successful European Information Society is at the very heart of the EUs "Lisbon Goal" of becoming the world's most dynamic and competitive economy by 2010 [1]. It also states that it is now widely acknowledged that e-government is a key tool for public sector reform [2]. Many of the member states also have active e-government programs and ranging from 72% to 15% of services are fully available online [3].

In contrast with the growing interest for *e*Anything, we see that our understanding of how the underlying Internet infrastructure really functions is lagging. The transition of the Internet into a competitive industry has resulted in the global infrastructure of the Internet now consisting of a complex array of telecommunication carriers and providers with an ever growing number of hosts, networks, network types and network peering points. Apart from this enormous complexity in the infrastructure, these developments have also led to the situation where there is not the cross-ISP (Internet Service Provider) communication and co-ordination required for engineering or debugging of network performance problems and security incidents [4]. In addition, the organisational structure of the Internet is highly complex and international of nature, making it difficult to gain insight in the value chain of IP (Internet Protocol) services.

From the above, it follows that our society is becoming dependent of something that is not fully understood, let alone controlled. The "government" lacks both *detectors* and *effectors* where Internet policy is concerned. Detectors are all the instruments that government uses for taking in information and effectors are all the instruments that government can use to try to make an impact on the world outside [5]. This paper focusses on the detectors for Internet infrastructure policy. Although many detectors exist today, we will show that for specific areas of concern the proper detectors are lacking. We explicitly do not argue for or against any form of Internet policy, but we do argue that it is important to develop the proper detectors. Only then is it possible to determine whether policy measures are justified and, once implemented, effective for certain Internet policy issues.

In this paper we show the importance of using Internet topology measurements to detect certain developments and trends in the evolution of the Internet infrastructure. In addition, we show some preliminary results to indicate that increased insight in the areas of free competition, free expression, reliability and performance can indeed be gained.

Internet Policy Issues

Spinello [6] identifies five areas of social concern: fair competition, free expression, intellectual property, privacy rights and security. In addition, the European Commission wants a faster, more secure Internet for all [2].

Much work is being done in all of these areas, but mainly focusses on the higher levels of the Internet architecture. In contrast, we focus on the areas on which the Internet infrastructure has a clear impact. Intellectual property, privacy rights, and most aspects of security are issues that should probably mainly be solved at the end points, but fair competition, free expression, reliability (a remaining aspect of security) and performance are directly related to the Internet infrastructure. We will demonstrate that for all four of these areas solid knowledge of actual Internet topology is important.

The need for topology knowledge

Regarding fair competition in the Internet infrastructure it is important that there be no ISPs with too much market power. Contrary to common beliefs, market power in the Internet can not be measured by only looking at economic market share or the number of routers owned by an ISP. A much more powerful indicator of market power in the infrastructure is the concept of routing power. There exists a clear distinction between ISPs that depend on other ISPs for their connectivity to the rest of the Internet and ISPs that can reach the entire Internet without having to rely on other ISPs[1]. The latter are called TIER-1 providers and the fact that there is only a small number (around 10) of global TIER-1 ISPs raises concerns about the potential abuse of market power [7,8]. Market power relations in the Internet

1 This description is not entirely accurate, refer to the full paper for a more accurate description.

infrastructure are reflected in so called peering and transit contracts [9]. Insight in these contracts is difficult to obtain, due to the sheer number of ISPs (30,000) and the non-public nature of these contracts. An indirect way to gain this insight is through knowledge of the actual routing and topology [10]. (In the full paper we will explain this in more detail, and we will discuss the other three policy areas as well).

Internet Measurement and Modelling

From the above it follows that not only insight in the current Internet topology is desired, but also in its development over time. Then it would be possible, for example, to identify trends such as the potential transformation of the ISP market to an oligopoly.

To date, realistic Internet topology data is not available to the research community, because ISPs regard their router-level topologies as confidential [11]. The resulting challenge is to infer the real Internet topology based on specific types of Internet measurements. Much research is already being conducted in this area [10,11], but most of these efforts are directed at detecting network problems of operational nature.

Our research focusses on using existing network measurements [12] to infer models of the Internet topology that can be used as detectors for above policy issues. We have already developed some interesting concepts, techniques and tools [4,13], but much work remains to be done.

As an example of the potential of our research, preliminary results indicate that TIER-1 ISPs tend to grow in terms of routing power, while the smaller ISPs tend to become increasingly dependent on these TIER-1 ISPs, which increases potential abuse of market power. (In the full paper we will discuss the three other areas as well)

Conclusions

We have shown that it is important to develop techniques and methods to infer network topology from Internet measurements and to derive models from these topologies that can serve as detectors for Internet policy. We have shown some preliminary results that indicate that increased insight in the areas of free competition, free expression, reliability and performance can indeed be gained.

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