Chapter 5
The Ubiquitous Internet:
Into Eternity?

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ABSTRACT

We all take the ubiquity of the Internet for granted: anyone, anywhere, anytime, any device, any connection, any app…but for how long? Is the future of the Internet really at stake? Discussions about control of the Internet, its architecture and of the applications running on it started more than a decade ago (Blumenthal & Clark, 2001). This topic is becoming more and more important for citizens, businesses, and governments across the world. In its original set-up, the architecture of the Internet did not favor one application over another and was based on the net neutrality principle (Wu, 2003). However, architectures should be understood an "alternative way of influencing economic systems" (Van Schewick, 2010), but they should not be a substitute for politics (Agre, 2003). The architecture is laid down in standards and therefore discussions about the future of the Internet should also address the role of standards. This is what this chapter aims to do.

INTRODUCTION

Van Schewick (2010) argues that the original design principles of the Internet that shaped its architecture are at risk. Network providers tend to deviate from these principles for technical and commercially motivated reasons. These deviations can negatively impact the design and development of innovations for future utilization of the Internet. This would make it much more difficult to change certain parts of the Internet's architecture, thereby hampering the quality of application innovation at significant costs to society. Apparently, we need to address the Internet's architecture.

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THE INTERNET AND ITS ARCHITECTURE

A system's architecture describes the components of the system, what they do, and how they interact. The Internet can be seen as a system which provides the opportunity to interconnect computers and to use an enormous variety of applications. The Internet's architecture consists of different layers which were originally designed to operate independently from each other. Higher layers make use of the functionality of lower layers. The original design principles include (1) modularity, (2) layering, and (3) 'end-to-end'. (1) Modularity allows for an independent and loosely coupled component design, but imposes restrictions on overall performance. Integrated designs, with tightly coupled components in several architecture layers, are sometimes favorable for specific solutions but impact and restrict future design choices. (2) Layering is a special form of modularity which restricts the allowable interactions between modules and organizes modules into a particular ordered hierarchy (Hofmeister, Nord & Soni, 2000). In principle a layer is allowed to use only the one just below it. Each layer provides services to the layer above and uses services from the layer below. (3) A key element of these original design principles are the 'end-to-end' arguments that provide a rationale for placing application-specific functionality as upward as possible in a layered system. Saltzer, Reed & Clark (1981) were the first to explicitly articulate these end-to-end arguments. Also Internet pioneers such as Leiner contributed to its early development, by their theoretical foundations and ideas of open-architecture networking (Leiner et al., 1997). The broad version of the end-to-end arguments (Van Schewick, 2010) affects the economic environment for innovation and is defined as: "A function or service should be carried out within a network layer only if it is needed by all clients of that layer, and it can be completely implemented in that layer". Van Schewick (2010) shows that in a network architecture based on the broad version of the end-to-end arguments, anyone who is able to program can develop new applications and be a potential innovator.

VIOLATION OF THE INTERNET'S ARCHITECTURE

Recently, deviations from this approach have been implemented to optimize the network for specific applications and to increase the controllability of the network to make more profits. This leads to constraints for start-up companies and users to initiate innovations. In addition, it gives extra power to network providers to introduce and implement such innovations, if any (Van Schewick, 2010).

Incentives and opportunities for economic actors to innovate partly depend on the possibilities the architecture offers. Economic theories generally see actors as making rational decisions with the aim to maximize their profits. However, actors do not always show rational behavior and the question is how these actors act and why, which is particularly the case for network providers. A distinction can be made between individuals and organizations, and at times individuals can make the difference. Initiatives of individuals have led to companies such as Amazon, Skype and Google. Abbate (2001) shows that the origins of the Internet are found in the U.S. Department of Defense 'Advanced Research Projects Agency' (DARPA). It was intended to provide a nationwide, redundant means of communication between military, government and scientific entities. It gradually shifted to commercial players and this