API
Approaches
to Paradigms
of a future Internet

The Different Perspectives of the Impact of Virtualization on the Internet

API 2010 White Paper, Third Think Tank Meeting

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Executive Summary

This report represents the outcome of the brainstorming session that took place on the "Third Think-Tank meeting" of the *Approaches to Paradigms of a future Internet* (API). The event took place in December 3rd, 2010 at Universidade de Aveiro (Aveiro, Portugal) and was dedicated to the discussion of the global theme of "The different perspectives on the impact of virtualization in the Internet".

The purpose of this document is informational and reflects opinions from different experts that have background on Internet services and technologies.

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Acronyms

Acronym	Meaning
IT	Information Technologies
MPLS	*Multi-Protocol Label Switching (MPLS)*
VLAN	Virtual Local Area Networks

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Extra information available at: http://siti.ulusofona.pt/ianlab/index.php/api-events/89-api-tt3

1. Introduction

In the past decade, virtualization has increased in popularity and is currently a fundamental technological advantage on many IT businesses. Several companies spent a significant amount of resources into developing novel software and hardware solutions, supporting different levels of server virtualization, and have produced several successful and widely used commercial solutions.

Network virtualization, on the other hand, is still in an early stage. Although some virtualization technologies, such as *Virtual Local Area networks (VLANs)* and *Multi-Protocol Label Switching (MPLS [8])*, have been developed and used on telecommunication networks, the full potential that can be achieved from a complete virtualized network environment is yet to be accomplished. A fully virtualized solution would be extremely flexible, by allowing multiple networks to run simultaneously, while supporting different technologies, protocols, topologies, and QoS requirements. Specifically focused in network virtualization, future Internet initiatives such as, AKARI [6], GENI [7], and 4WARD [9], have been looking into it as a viable, non-disruptive route, for implementing novel protocols and architectures, overcoming the known limitations of IP.

With the current trend on cloud computing, virtualization gains momentum in different operational networking aspects, ranging from resources and machines, data centers, as well as nework provisioning: virtualization becomes the **block** which will be used to provide cloud services to the users.

Some topics included in the discussion held during the 3rd API Think-Tank meeting which is summarized in this document are:

- Network Virtualization, virtual machines, virtual servers and virtual storage;
- Requirements, interest, advantages and challenges;
- Applications and services;
- Security issues;
- Mobile environment issues;
- Operator vs. user-centred approaches for virtualization;
- Experimentation of new platforms vs. commercial deployments;
- Trends on virtualization and the evolution of Future Internet.

For this purpose, the 3rd API think-Tank meeting had a brainstorming session where invited experts brought in expertise from different fields on virtualization, ranging from network virtualization to servers

virtualization, to the impact of virtualization on the current Internet architecture, and the advantages on the build up of new Internet architectures. This report corresponds to the outcome of such discussion.

This is therefore an informational deliverable which has the sole purpose of assisting in igniting a debate on novel ideas concerning Internet services and architectures. It is not a report intended to exhaustively debate on the different aspects of the impact of dot-socialism.

The report is organized as follows. The next sections are dedicated to a few aspects that were brainstormed. Therefore, section 2 provides an overview of several definitions of Network Virtualization and our thoughts on them, and section 3 debates around the requirement of network virtualization as one key component of Future Networks. We then conclude this document.

2. What do we mean by Virtualization?

The first topic addressed was the exact scope of virtualization in the thereafter discussion. Three types of virtualization were identified: Computing Virtualization; Storage Virtualization; Network Virtualization. Broadly, they encompass the virtualization of 3 major components of nowadays computing environments: processing power (CPU & memory), long-term, persistent storage capacity, and network connectivity.

Specifically concerning the brainstorming session, we focused on network virtualization which we have agreed to define as **a way to provide alternative networks (graphs of links), protocols an services on top of a networking infra-structure**, from a provisioning and resource management perspective.

3. What is Network Virtualization?

The first major question to be posed is the definition of network virtualization, since several possible definitions come to our mind. The following are 3 possible definitions that were discussed.

Definition 1: *Network abstraction - virtualization is the framework that supports cloud computing.*

Virtualization is often defined to be the same as cloud computing; Cisco and Juniper disagree and state that this is the framework that supports cloud computing. We also agreed that this definition is too restrictive (and potentially misleading and incomplete) because: it is also the basis to expand network availability and of network support; virtual routers have been around for a while: IETF 2917. Network virtualization enables the support of cloud computing. Core virtualization supports more than

cloud computing, virtualization is required for cloud computing BUT is not just the framework for cloud computing.

Definition 2: *Federations - running multiple network services simultaneously in a shared environment*.

Virtualization is seen as a way to simplify networking services running in parallel and being offered to the same user/community. This is a relevant semi-definition. From an OS/application perspective, the question is how to deal with the different services; who will in fact "control" (authentication), from an OS perspective. Even if different services are provided, applications only want to use a single entity.

Definition 3: *The Internet today is mostly "virtual".*

From an end-user (mostly residential) perspective, today most of the Internet is a "virtual" environment; only the last mile is truly controlled or visible. This contains the concepts of multiplexing, layer (stack) abstraction. Virtualization may also be the necessary evolutionary step for network migration (towards other technologies, other wholesale models).

The virtualization hype had two stages:

- Around 2000, there was a first attempt to make the network flexible – infrastructure changes, services provided changed. The major players at that time were Cisco, Juniper (which proposed new solutions for private VPNs), and Lucent (which was also a key player).
- Recently, the urge for network virtualization emerged again. It can provide the infrastructure migration to Ethernet (carrier-grade Ethernet), which enables new possibilities, lower cost, flexibility. It can enable the support for Cloud computing and the need for autonomic behaviour of networks and components.

4. Do we really need Network Virtualization?

For the access operator, virtualization assists in simplifying network operation, providing lower costs, energy savings, and reusing the same infrastructure simultaneously. Notice that it increases flexibility (network augmentation) by the reuse of the same hardware.

As major challenges we have considered:

- **Complexity issues.** Due to the new "abstraction" layer and due to the different services that have to be simultaneously running and which have different requisites, it may be complex to attaint the desired QoS for all virtualized networks. A possibility for implementing the abstraction layer is on top different "virtual networks" (infrastructures provided by one or more operators).

- **New business opportunities**. The introduction of new business opportunities (e.g. virtual operators) within network virtualization is not yet clear.
- **New networks.** How can we deal with virtualization across a set of embedded systems (for abstraction purpose, for instance)?
- **Legislation**. Should virtualization be considered as a new (telecommunications) service? If we reach that point, how will we deal with it?

5. What Can be Virtualized on the Network Layer?

Since virtualization consists in proving a virtual resource on top of some set of virtual resources, a relevant question regarding network virtualization is what kind of virtual resources can be provided by the network layer, which could then be used instead of the real ones.

For answering this question we considered two different perspectives (cf. Table 1): the perspective of the end-user, and of the access provider.

Tabela 1: Virtualization main challenges and benefits, access and user perspective.

	What Can Be Virtualized	Why is Virtualization Beneficial or Required	Main Challenges
End-users view	Network interfaces	Optimize transmission opportunities Optimize resource management Assist mobility	MAC Layer limitations (e.g. prevents use of 2 networks simultaneously)
	Network discovery mechanisms	Hide Network complexity	Multitude of available mechanism; incompatibility with social roaming behavior
	Flexibility	Can use different technologies anytime	Signalling complexity; processing cost (e.g. energy) on portable user devices
Access providers view	Resource management framework	Less complexity, support for multiple transport services and architectures with a single framework	Node architecture refurbishing (trade-off between cost and network efficiency)
	Active elements	Lower cost, energy savings,	Greener elements vs.

	What Can Be Virtualized	Why is Virtualization Beneficial or Required	Main Challenges
	(node architecture, i.e. routers & switches)	increased availability	storage and memory
	New services, virtual business models	Can reuse the infrastructure to build new types of networking services	

6. Conclusions

This document aims to provide an initial analysis about network virtualization, what it actually means and its relevant advantages with respect to build the Future Internet. In this think-tank meeting several aspects of network virtualization were debated, including the several definitions, its advantages, its applications, and the impact on the support for new paradigms in Future Internet. We finalized by trying to provide some hints concerning the question: do we really need network virtualization?

7. References

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