Chapter 13
Clean-Slate Information–Centric Publish Subscribe Networks

Laura Carrea
University of Essex, UK

Raul Almeida
University of Essex, UK

ABSTRACT
The Internet architecture of today does not seem suited to the current Internet usage, as the application layer is more and more content-centric, while the network layer is ossified around the IP concept. In this chapter, the authors explore a redefinition of the whole Internet architecture where nothing is taken for granted, especially IP addresses. The review focuses on the forwarding and topology components of the EU FP7 PSIRP architecture and on a few of the problematic issues and the ongoing discussions around a pioneering clean-slate design of the way to organize networks.

INTRODUCTION
The Internet architecture of today is a packet-based internetworking architecture that was created as an efficient multiplexed utilization of heterogeneous interconnected networks. The introduction of the Internet Protocol suite (TCP/IP) opened up the growth of the Internet and slowly the backbone was privatized and became distributed. Because a central coordinating element is missing, it has been difficult to apply major architectural changes to the Internet and the Internet architecture (i.e. hierarchical routing, TCP/IP, Domain Name System (DNS)) has remained the same since the 1980s when it was created (Jacobson, 2006a). Since then, only incremental improvements have been introduced to supply new services reducing the management costs of the network: the Classless Inter-Domain Routing (CIDR) (Fuller et al., 1993) was proposed to slow the growth of routing tables on routers across the Internet, and to slow the rapid exhaustion of IPv4 addresses; the Border Gateway Protocol (BGP) (Rekhter, 1995) was introduced to mirror the business relationship between providers and later extended for large scale deployments; the Multi-Protocol Label Switching (MPLS) (Rosen et al., 2001) was introduced to improve the performances of
IP routers. Later, *Virtual Private Networks (VPN)* and, recently Carrier Ethernet have appeared as new data services. Moreover, other solutions have been deployed for issues of Internet design in an open commercial environment such as *Network Address Translation (NAT)* boxes, which offer limited protection for unwanted traffic fracturing network connectivity and which have extended address spaces (Touch, 2002), (Handley, 2006) and Mobile IP (Perkins, 2002), which offers mobility to the host, using network indirection points.

However, despite all those efforts, Internet is considered as *ossified* (for example (Handley, 2006), (Anderson et al., 2005)), as all the solutions are considered as patching approaches based on ad-hoc extensions and overlays.

The original design of the Internet is centered on best-effort delivery between network-attached devices, forming the base of the concept of the *Internet Protocol (IP)* address. Every host has a unique IP address which acts as a location (where) utilized for routing purposes and at the same time as an identifier (who) of the host. The fact that the IP address has these two different functions is considered the root of many of the limitations of today’s Internet architecture (Meyer et al., 2007) and a split is considered necessary.

In the past and still today, efforts for the future Internet have been based on revisiting single concepts, such as the IP locator/identifier, to improve end-host reachability, end-to-end security, mobility and routing issues without questioning the host centrality of the communication. Still, the Internet moves a datagram in a best effort manner independently of the semantics and the purpose of the data transport.

The first person who envisioned the necessity of a true network revolution was Van Jacobson with a talk at Stanford (Jacobson, 2006a). He mentioned the evolution of networking from telephony which was about connecting wires to other wires, to TCP/IP which is about machines connected to the wires, to the next generation which should be about interconnecting information. This new idea implies the necessity of rethinking the fundamentals of the communication and it is based on the observation that the large-scale usage of the Internet is not an end-to-end communication but for data dissemination. This shift towards a networking which is based on information has started to happen already but as an overlay (Rothenberg et al., 2008). In fact, *Service Oriented Architectures (SOA)*, XML routers, *Deep Packet Inspection (DPI)*, *Content Delivery Networks (CDN)* and peer-to-peer overlay technologies are a clear effort from the 'top' to move towards a networking which is focused on information rather than the host. In these types of technologies a big issue is to be able to move large amounts of labeled data having, at the network level, to reach a particular host. A mismatch is clearly observable: user/applications are related to what they want to access while networks work with who wants to access data. The mapping between the models requires a lot of conventions and configurations (middleware). In fact, acquiring data is not a conversation but it is, in fact, a dissemination (Jacobson, 2006feb). In this case, only the data matters but not necessarily the source of the data, as long as the integrity and the authenticity of the data (and not necessarily the source) are guaranteed (Koponen et al., 2007). Dissemination can be obtained with a conversation but this creates a lot of the problems and results in the limitations which are present in the Internet today (Jacobson, 2006b). As Van Jacobson pointed out, the problem is not that the Internet does not work. It works in fact really well but the usage of the Internet has changed. The Internet has created a lot of content that it was not designed for.

After Van Jacobson’s talk, a few research activities started to focus on the investigation of this new way to do networking based purely on a content/information/data (throughout this chapter content, information or data are considered synonyms) centric paradigm, completely redesigning the Internet architecture from scratch. Pioneering work has been carried out in the projects EU FP7 PSIRP (PSIRP) and PARC CCN (Jacobson et al., 2009).