

Internet Architecture, Software Defined Networking, and Network Virtualization

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Short Bio

Rudra Dutta has been a faculty member at NCSU since 2001. His current research interests focus on design and performance optimization of large networking systems, Internet architecture, wireless networks, and network analytics. His research is supported currently by grants from the National Science Foundation, the National Security Agency, and industry, including a recent GENI grant and a Future Internet Architecture grant from NSF. Most recently, he has served as Program Chair for the Optical Networking Symposium at IEEE Globecom 2008, General Chair of IEEE ANTS 2010, and as guest editor of a special issue on Green Networking and Communications of the Elsevier Journal of Optical Switching and Networking. He is the author of numerous premier journal and conference papers, editor of a contributed volume on traffic grooming, and author of two books on mesh wireless networks and SIP performance.

Tutorial Scope

In this tutorial, I will briefly cover the recent research from various groups in Future Internet Architecture, describe the emerging area of Software Defined Networking, and interpret the architectural change represented by the dominant SDN visions in the light of the future Internet research. I will also integrate a discussion of network virtualization, and describe how virtualization may be seen as either an outcome of or a vehicle for the architectural concepts described. This will be an expositional style tutorial, not hands-on.

Intended Audience

- The tutorial will be aimed at undergraduate and graduate students with technical knowledge of networking, whether they intend to go on to industry or further study and research.
- The tutorial will also be useful for networking practitioners or researchers with deep knowledge of networking but with little or no prior knowledge of the above areas, considering moving into this research area.
- This tutorial will not be suitable for students or researchers without a working knowledge of the Internet protocol suite.
- This tutorial is likely to be of limited use for researchers who are already active in the above areas.

Tutorial Modules

Networking Architecture

In this preliminary module, I will introduce the architectural view of internetworking (as opposed to protocol view or design view). We will examine network architecture as an exercise in identifying entities, interactions, and interfaces, and interpret current Internet protocols and technologies in these terms.

Future Internet Architecture Research

In recent times, there has been a resurgence of interest in Internet architecture in the academic research community. In the USA, this has been embodied in the Future Internet Design (FIND) and Future Internet Architecture (FIA) projects. In Europe, a parallel effort has taken place in the Future Internet Research and Experimentation (FIRE) testbed project, and similar efforts have started in other parts of the world. I will discuss the general motivation and nature of the research needs identified by these programs, and discuss the research results of a few projects from the FIND and FIA programs, including the following:

- Postcards from the Edge (FIND)
- Concurrent Architectures are Better than One (FIND)
- Mobility First (FIA)
- ChoiceNet (FIA)
- Named Data Networking (FIA)
- Extensible Networking Architecture (FIA)
- Nebula (FIA)

Software Defined Networking

In the last few years, the concept of SDN has gained popularity in both academic and industrial worlds. Various models for SDN has been proposed, and a particular model focused on traffic engineering called OpenFlow has become the standard bearer of SDN. OpenFlow has been adopted by both academic labs as well as significant industry users such as Google. I will discuss the basic concepts behind OpenFlow, and examine them from the architectural point of view introduced above. I will also describe the surrounding ecosystem, such as the OFConfig protocol, the newly emerging Open DayLight consortium, and some switch vendors and how they have accommodated OpenFlow.

Network Virtualization

Network virtualization is a term that has been used to indicate a diverse set of technologies in recent years. Most recently, the term has been used to indicate complete on-demand provisioning of user-defined topologies. I will discuss the various meanings of the term, with special attention to the latest or “slicing” paradigm, and describe the national scale testbed called GENI that has been designed and built funded by the US National Science Foundation, which employs sliced virtualization. We will again examine the design of GENI from an architectural perspective.

Take-aways

The above topics are inter-related, though they have risen from different contexts with different names. The conceptual space they occupy is a crucial one for networking students and engineers to know. At the same time, they are new enough that they have not yet broadly penetrated into standard networking curriculum. This tutorial will allow the attendee to take away an overall comprehensive if introductory view to this area of networking research and development.

References

1. <http://dutta.csc.ncsu.edu>
2. <http://www.nets-find.net>
3. <http://www.nets-fia.net>
4. <http://groups.geni.net/geni/wiki/IMF>
5. <http://www.geni.net>
6. [Network Virtualization: Technologies, Perspectives, and Frontiers](#), A Wang, M Iyer, R Dutta, GN Rouskas, I Baldine, *Journal of Lightwave Technology* 31 (4), 523-537