A Summary Of Is SDN the De-constraining Constraint of the Future Internet

Cihan Seçinti
Department of Computer Engineering
Istanbul Technical University
Maslak, Istanbul, 34469
Email: secintic@itu.edu.tr

Murat Can Zahmakıran
Department of Computer Engineering
Istanbul Technical University
Maslak, Istanbul, 34469
Email: zahmakiran@itu.edu.tr

Yılmaz Dilek
Department of Computer Engineering
Istanbul Technical University
Maslak, Istanbul, 34469
Email: dileky@itu.edu.tr

Volkan İlbeyli
Department of Computer Engineering
Istanbul Technical University
Maslak, Istanbul, 34469
Email: ilbeyli@itu.edu.tr

***Abstract*—The tremendous increase in employment of computer interactions through the recent years triggered the evolution of software and hardware towards computer network services. Even computer network services is not able to suffice requirements of the people from internet so the network must be improved with some approaches such as SDN, virtualization.**

***Keywords*—SDN, virtualization, openflow, network, computer, testbed, prescriptive, clean-slate**

I. Introduction

The tremendous increase in employment of computer interactions through the recent years triggered the evolution of software and hardware towards computer network services. As the technological advancement continue improving computer placed our live with many aspects. Therefore, advanced network systems are become more significant issue that is dealt with computers. In order to improve network there are two different approaches; firstly clean slate approach that is meaning new fresh start to networking and forget whole defined constraint before. In our circumstances current network constraints will be forgotten. Secondly evolutionary approach, with this approach improvements are done by adding the current network so the current network can accommodate the changes is an assumption [1]. The other topic for creating future network is considering main challenges; firstly network design that have to obey architectural guidelines such as layered reference models(OSI) and end-to-end argument that provides communication between two end points and increases reliability because of the ignorance on the intermediate nodes in the network. The second challenge is virtualization that provides tremendous potential of flexibility and mobility. Virtualization is used many areas in network such as vpn, overlay networks etc. Besides, multiple infrastructure providers needs for division between the network operations and physical infrastructure so virtual networks must be changed their way of the management debugging and operating. This topic will be talked deeper in our presentation.Finally, The internet must be standardized by using process that relies on running code and real world verification. Also large scale testbed networks must be built by using virtualization and tested with SDN that simplifies managing network by administrator with the help of the abstracting lower level functionality. In this paper, future network properties are discussed that separated into three subtopics; in first chapter prescriptive network theory , in second chapter experimental researches with using testbeds, in third chapter SDN, virtualization and openflow subjects are investigated.

II. PRESCRIPTIVE NETWORK THEORY

The prescriptive network theory, as opposed to descriptive network theory, basically tries to clarify the vaguenesses in network design. Therefore, prescriptive network theory is asks what should be rather than asking what is. This is why prescriptive network theory is threaded as high-level guidelines for network design. While it is axiomatic, it may not be proven in itself[2]. The importance of prescriptive network theory is hair splitting behaviour. It should be concerned about more detailed area; which is, focusing on Internet rather than general networking concept, protocols rather than principles, backward compatibility and incremental deployment rather than more general theories such as teletraffic theory, graph theory etc. the difficulty of uncertainty is faced in prescriptive network theory. In the 3 day seminar in Dagstuhl, 1 day has been spent for prescriptive network theory for the knowledge of its difficulty. Discussion groups have been formed and the following results have been obtained presentations and group work.

A. Qualities

There may not be a single, all-containing network theory; while networking has a tight relationship with neighbour disciplines like Information and coding theory. This relation should be considered while designing network systems. On the other hand, prescriptive network theory is rooted on well-defined axioms, which are not certain rulings ; hence, prescriptive network theory has different qualities than descriptive network theory. In this way, In this way, prescriptive network theory could be accepted as less formal high-level guidelines, which do not go into detailed design patterns, for the design of networks (in an easy and panoramic looking way).

B. Multi Mechanisms

The locution multi-mechanism is used for defining sets of mechanisms that serve the same functional purpose and are interchangeable with each other. Luckily, the non-functional outputs like throughput, delay reliability etc. are still identical. Recent researches have showed that new mechanisms are rarely discovered . Unfortunately, the compositions of today explored mechanisms are not discussed enough , even they offer significant opportunities for the Future Internet. However, dynamic and requirement-based mechanism combinations may improve the structure of the Future Internet.

C. De-constraining constraints

The hourglass model is commonly used to visualise the protocol stack of Internet (this idea is copied from the DNA -how it leads to variety-). The narrow spine of the hourglass has an releasing (loosing effect) on the design space for the top and bottom layers evolving. The core of the hourglass is the IP, therefore alternatives may spread and be developed above as well as below (HTTP, CDN, etc.) .

D. Middleboxes

Recent researches show that there is a significant increase of middle boxes (NAT, firewalls, rate limiters, proxies). These increases result in a Internet with layers 4 + interconnection of IP networks. Therefore, bypassing, for instance, tunnelling over HTTP (TCP port 80), may be risky while middleboxes would block applications. On the other hand, middleboxes bring big potential for innovation and may be handled as de-constraining constraints (e.g. Delay tolerant networking, IPng network tracker).

III. EXPERIMENTAL RESEARCH

Future Internet research is depends on research and its mostly implemented as testbeds. Some of the implementations are overlays, virtual and software defined networks. These implementations work side by side with the production networks and reside on the same hardware. Although testbeds are very important and helpful for testing and implementing new software, its usefulness is hard to observe. At the seminar, the goal was gathering as much information and insights as possible. To achieve this goal, the answers of the questions about experimentation, testbed-based approach, use cases of testbeds, properties of testbeds and research overlays was sought. At the seminar following aspects are mainly discussed:

A. Insights from Testbeds

Two important questions about testbed-based research asked by Brad Karp in his speech. These questions are Is the act of building a testbed research? and Do testbeds yield fundamental research insights? The general opinion about the first question was it might not be research. This answer can be interpreted as that building a testbed must be decided according to the resources that we can use and the necessity of it. For the second question Brad Karp suggested asking what we cannot simulate when researching software-defined networks. The answer of this question is also shows the aspect that should be researched using testbeds.

B. The Engineering Loop

Jrg Liebeherr talked about the experimentation process and its consequences. In this session the general concern was lack of objectivity because generally the people who design are also do the experimentation.

C. Scalability of Testbeds

One of the most important aspects that was discussed continuously at the seminar was scalability. Brad Karp argued that testbeds are very useful for seeing resulting effects such as latency, which are real-world effects coming from users and machines. To simulate these effects in testbeds one has to access real user usage data. According to Klara Nahrstedt, this kind of data can also show the behaviors of small groups of people because according to social scientist group size affects user behavior, which is hard to see from digital domain and the example technologies generally dont support more than 10 people.

D. General Purpose Testbeds

There were two opposite realities about this aspect. One of them was about the powerful insights that are gained from overlay-based testbeds and the other was the risk of testbeds falling short.

E. Contact with Reality

Meeting the goal of reproduce real-world behavior comes with a couple of challenges. Its hard to maintain testbeds, to include real users, to obtain realistic data, to work with anonymized data. And adapting to the changes in programing

IV. SDN, VIRTUALIZATION, OPENFLOW

Advances in computer science lead to developing safer programs much more quickly due to advances in, operating systems, developing tools, virtualization and isolation. These advances may be used to improve the dependence of the Internet rather than incrementally patching it. In the past, the internal components of network switches, routers, etc. evolved in a separate software and hardware ecosystem from end-systems. Therefore entities like commodity price, performance, production of smartphones, desktops and servers have benefited from the advances in computer science while the infrastructure of the Internet became a set of specialized business generating specialized technologies. SDN is aiming to reverse this trend by moving some parts of data and control plane into computer science area, thus aiming to have a platform similar to Android, Windows and iPhone for applications. This way SDN would have millions of applications in the platform. The following are some of the use cases of SDN captured during the last day of seminar:

1) Multi-tenant data centers providing specialized services to tenants with different needs
2) Multi-user VR and MMORPG have large scale dynamic network requirements. SDN can be used to support the needs.
3) VM migration, e.g. during maintenance and for load balancing, causes high loads on networks. SDN can

provide accessibility to VM during the migration without disturbing the net by re-routing.

4) Introduction of IPv6 will lead to Internet of Things (IoT). IoT will require security.
5) Contend Distribution Networks (CDN) (P2P content sharing) causes heavy load on the internet. SDN may manage this with ease.
6) Middlebox management is a use case for SDN. Theres an inability to deploy transport layer protocols due to ad-hoc nature of middleboxes (firewalls, WAN optimizers etc.). SDN brings these in a coherent network.
7) Management of multiple SDNs is a challenge itself.
8) A hybrid cloud where applications and specialized support are for SDN applications are in the cloud.
9) Ability to deploy flexible networks for enterprise intranets by SDN
10) Cross-layer design of distributed applications requires open and reflective APIs in SDN.

The motivation behind the use cases are:

- **Overcommit:** Economics of multi-tenancy depend on invisible overcommit. Tenant should not realize anything else being scheduled in the gaps of their usage
- **Latency:**Latency: VR and online gaming requires low latency
- **Flow based I/O:**Middlebox management, VMs (which can be thought as network flow through TCP and SSL) and CDN (which is similar to VM migration) cause heavy load. Balancing required.
- **Global Identity:**Internet of Things require naming in addition to addressing.

V. CONCLUSION

This document is a summary of Dagstuhl Seminar on the Future Internet. At the seminar some of the essential questions about the design of networks are discussed and tried to be resolved. How we can benefit from prescriptive theory; the research methodologies we should follow with the main focus on testbeds; and the promising technological aspects such as SDN, virtualization and OpenFlow were the main discussions of the seminar. The main conclusions of the seminar are as follows:

- The lack of prescriptive theory and the importance of such a theory were generally accepted. To reach to a prescriptive theory should be the main goal in a long term. And finally, there should not be a general theory that includes all but rather variety of different theories should address individual aspects.
- The general opinion about testbed-based research was positive and it is found to be important for the development of Future Internet. But it should be also noted that this kind of research may not useful and the people must calculate the need and the resources very well before deciding to use testbed-based research technique. Finally, the need for support from industry was emphasized.
- The progress of SDN, virtualization and OpenFlow were discussed. Variety of use cases formulated and new innovations were suggested based on the current technologies. People at the seminar tried to picture the internet after ten years.

REFERENCES

[1] J. Crowcroft, M. Fidler, K. Nahrstedt, and R. Steinmetz, "Is sdn the de-constraining constraint of the future internet?" *SIGCOMM Comput. Commun. Rev.*, vol. 43, no. 5, pp. 13–18, Nov. 2013. [Online]. Available: http://doi.acm.org/10.1145/2541468.2541472

[2] D. Alderson and J. Doyle, "Contrasting views of complexity and their implications for network-centric infrastructures," *Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on*, vol. 40, no. 4, pp. 839–852, 2010.