Perceptible advantages of OpenFlow
in a multi-domain VPN deployment

Research Proposal

Michiel Appelman

June 6, 2013

1 Introduction

The current state of large scale networks is defined by a stack of networking protocols which were extensively amended to over the course of years to get control over the increasing scales and fix issues with previous protocols. Examples of this are the limited capability of the network to listen to the needs of applications with QoS and the recent additions in Ethernet to finally provide OAM functionalities. This inertia has resulted in rigid network architectures which can not be innovated upon without drastic changes and high risks of breaking existing services [1, 2].

The solution to the ossification is generally regarded as two-fold. First, a certain degree of network virtualization will need to be implemented. This will separate the networks from each other, lets them share lower-level resources and make hardware more flexible in how and where it is deployed. On a higher level, this will enable the growth of the networks in scale but also in numbers, adding new separate networks to the existing physical topologies [3]. Second, networks and specifically networking devices will need to be become programmable. Using an open API operators can rapidly deploy new service features in their network, while also gaining control over behavior of the network with regards to resource sharing, flow routing and fail-over procedures. [4]

Network separation itself is not a new technology and is already being used in a multitude of networks [5]. One of the earliest examples is of course the use of Virtual LANs (VLANs) specified by 802.1Q [6]. And presently, one of the most used protocols for network separation within service provider networks is MPLS. It can provide VPNs on layers 2 and 3 [7, 8]. Other technologies in use today that can provide some sort of separation on different levels are for example SDH/SONET, PBT and VRF. All these protocols are provided by the router vendors and as such are not adaptable. Their functionalities can of course be adjusted by using SNMP or to a lesser extent using NetCONF, but real programmability of the control plane has up until now only been provided by OpenFlow [9] and the Software Defined Networking (SDN) architecture as a whole. OpenFlow has been presented as a solution to all the problems that exist in networking today and additionally provide operators with the flexibility to once again innovate on their networks.

Research Question

It is unclear however if a real-world OpenFlow implementation will actually provide any additional flexibility or features when compared to contemporary technologies [4]. Indeed, the technologies in use today have served operators very well up until this point and their practicality has been proven over the past years. Given the use-case of implementing a multi-domain VPN over various campuses similar to gTBN [10], this research will show the advantages and limitations of implementing an environment using both COTS technologies and an SDN solution.

Doing so will provide researchers and operators with insight into the real world practicality of OpenFlow and SDN. It will help answer the question: *"What are the potential advantages and limitations of using OpenFlow when implementing a multi-domain service?"* This research offers that – with regards to the given use case – OpenFlow can provide network operators with the same functionalities as contemporary technologies can. At the same time we hypothesize that OpenFlow will give additional advantages in application-control of the network, thereby reducing the amount of overhead in configuring the network.

Scope

Initially this research will focus on a single use-case, namely the implementation of multi-domain VPNs. A possible implementation of this would touch on a wide variety of SDN and network virtualization techniques and would thus give a broad fairly complete image of the possibilities of this architecture.

Should there be any time left, other use-cases will be composed together with the supervisor to fill in this void.

Approach

This research will focus on the use case of multi-domain VPNs in the Internet backbone. First we will focus on how these can be implemented using contemporary protocols, then how this can translated to a SDN specific environment and finally how much these two implementations differ form each other with regards to flexibility and manageability.

2 Planning

This project will be carried out over a period of four weeks at the SNE Research Group at the University of Amsterdam. A rough timeline of the research is given in the table below:

Week	Task
1	Write proposal;
	Formulate research questions;
	Get approval for proposal;
2 & 3	Start research;
	Find documentation of other research/experiences within community;
	Work out use-case, hypotheses and experiment;
	Produce proof of concept;
4	Write report;
	Prepare presentation;
	Filter report to a scientific paper;

Products

The research will result in the following products: *a*) a report written for the System and Network Engineering master education describing the research, the process and results; *b*) a 20 minute presentation about the research to be held on July 3rd at the University of Amsterdam. Also, if preliminary results and available time allow for it, a proof of concept will be produced to provide the community with a sample implementation to test and adapt.

References

[1] D. Taylor and J. Turner, "Towards a diversified internet," *White paper*, November 2004.

[2] T. Anderson, L. Peterson, S. Shenker, and J. Turner, "Overcoming the Internet impasse through virtualization," *Computer*, vol. 38, no. 4, pp. 34–41, 2005.

[3] J. S. Turner and D. E. Taylor, "Diversifying the internet," in *Global Telecommunications Conference, 2005. GLOBECOM'05. IEEE*, vol. 2, pp. 6–pp, IEEE, 2005.

[4] J. Van der Merwe and C. Kalmanek, "Network programmability is the answer," in *Workshop on Programmable Routers for the Extensible Services of Tomorrow (PRESTO 2007), Princeton, NJ*, 2007.

[5] N. Chowdhury and R. Boutaba, "A survey of network virtualization," *Computer Networks*, vol. 54, no. 5, pp. 862–876, 2010.

[6] "IEEE 802.1Q - Virtual LANs." `http://www.ieee802.org/1/pages/802.1Q.html`.

[7] "Framework for Layer 2 Virtual Private Networks (L2VPNs)." `http://tools.ietf.org/html/rfc4664`.

[8] "BGP/MPLS IP Virtual Private Networks (VPNs)." `http://tools.ietf.org/html/rfc4364`.

[9] N. McKeown, T. Anderson, H. Balakrishnan, G. Parulkar, L. Peterson, J. Rexford, S. Shenker, and J. Turner, "OpenFlow: enabling innovation in campus networks," *ACM SIGCOMM Computer Communication Review*, vol. 38, no. 2, pp. 69–74, 2008.

[10] M. L. Cristea, R. J. Strijkers, D. Marchal, L. Gommans, C. de Laat, and R. J. Meijer, "Supporting communities in programmable grid networks: gTBN," in *Integrated Network Management, 2009. IM'09. IFIP/IEEE International Symposium on*, pp. 406–413, IEEE, 2009.