Munich Internet Research Retreat 2016

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ABSTRACT

This article summarises a 2 day long Munich Internet Research Retreat held in November 2016. The goal of the retreat was to provide a forum for both academic and industrial researchers to exchange ideas and get feedback on their current work. It was organized in a spirit that is similar to an highly interactive Dagstuhl seminars, with a very limited number of full-length talks, while dedicating most of the time to poster sessions, panels and group discussions. The entire set of presentations delivered during the seminar is made publicly available at [2].

Keywords

SDN, NFV, Security, IoT, Internet measurements

1. INTRODUCTION

2. INVITED PRESENTATIONS

The invited presentations were intended as a basis for triggering discussions and identifying areas for group work.

2.1 Edge Computing considered harmful

2.2 Towards A Clean Slate – Digital Sovereignty in the Post Snowden Era

2.3 On software network management

2.4 FlexNets: Quantifying Flexibility in Communication Networks

2.5 An Accidental Internet Architecture

2.6 Measuring IPv6 Performance

2.7 Path tracing and validation of IPv4 and IPv6 siblings

With the growing deployment of IPv6, the question arises whether and to what extent this new protocol is co-deployed with IPv4 on existing hardware or whether new hardware or proxy solutions are deployed. Understanding the resulting cross-dependencies between IPv4 and IPv6 hosts will add a significant level of insight into Internet structure and resilience research. In this talk, Minoo Ruohi from TUM presented an active measurement technique to determine whether an IPv4-IPv6 address pair resides on the same physical host. The measurement technique is based on measuring clock skew through TCP timestamps, and introduces new capabilities to classify nonlinear clock skews. in their studies, they achieve 97.7% accuracy on a ground truth data set of 458 hosts and have proved this technique's value by applying it to 371k sibling candidates, of which they classify 80k as siblings. A technical report on this work has been published [3]. Further, the classified siblings as well as additional data and all code from this work have been released for public use [1].

2.8 SWIFT: Predictive Fast Reroute upon Remote BGP Disruptions

Fast rerouting upon network failure is a key requirement when it comes to meet stringent service-level agreements. While current frameworks enable sub-second convergence upon local failures, they do not protect against the much frequent remote failures. In contrast to local failures, learning about a remote failure is fundamentally slower as it involves receiving potentially hundred of thousands of BGP messages. Also, pre-populating backup forwarding rules is impossible as any subset of the prefixes can be impacted.

In this presentation, Laurent Vanbever from the ETH Zurich presented SWIFT, a general fast re- route framework supporting both local and remote failures []. SWIFT is based on two novel techniques. First, SWIFT copes with slow notification by predicting the overall extent of a remote failure out of few control-plane (BGP) messages. Second, SWIFT introduces a new data- plane encoding scheme which enables it to quickly and flexibly update the impacted forwarding entries.

SWIFT have been implemented by the ETH Networked Systems Group (NSG) and its performance benefits have been demonstrated by showing that: i) SWIFT is able to predict the extent of a remote failure with high accuracy (?93%); and ii) SWIFT encoding scheme enables to fast-converge more than 95% of the impacted forwarding entries. Overall, SWIFT reduces the average convergence time from few minutes to few seconds.

2.9 Open Platforms for Cyber-physical systems

2.10 Collaborative intrusion handling using the Blackboard-Pattern

Defending computer networks from ongoing security incidents is a key requirement to ensure service continuity. Handling incidents is a complex process consisting of the three steps: 1) intrusion detection, 2) alert processing and 3) intrusion response. For useful and automated incident handling a

[1] https://github.com/tumi8/siblings

comprehensive view on the process and tightly interleaved single steps are required. Existing solutions for incident handling merely focus on a single step leaving the other steps completely aside. Incompatible and encapsulated partial solutions are the consequence. In this talk Holger Kinkelin proposed an approach on incident handling based on a novel execution model that allows interleaving and collaborative interaction between the incident handling steps using the Blackboard Pattern. Their holistic information model lays the foundation for a conflict free collaboration. The incident handling steps are further segmented into exchangeable functional blocks distributed across the network. To show the applicability of their approach, typical use cases for incident handling systems were identified and tested based on their implementation. This talk was based on a paper published at WISCS associated to ACM CCS 2016 [1].

3. PARALLEL GROUP WORK

The afternoon sessions were used to discuss certain topics in more depth in smaller groups. This section summarises the discussions of each group.

3.1 SDN/NFV Measurements

3.2 SDN++: Applications Perspective

The breakout session entitled SDN++ dealt with SDN from the perspective of how to apply SDN, and how to introduce improvements to SDN (thereby creating SDN++), for better meeting the identified requirements. Participants of the breakout session were Laurent Vanbevier, Artur Hecker, Wolfgang Kellerer, Edwin Cordeiro and Georg Carle, the latter also being the presenter of the results. The method of the working group was first to identify relevant application areas of SDN, then assess to which extent known SDN approaches have shortcomings (i.e., identifying the 'SDN pain areas'), and subsequently identifying promising approaches for improving SDN. The application areas of SDN were (1) establishing means for programmability of the network, which can be used for improving certain network properties, (2) management of advanced cellular networks, in particular 5G networks, for different capabilities such as network slicing, and (3) providing means to add sophisticated control functionality to corporate networks, such as adding flexible access control. Identified weaknesses of existing SDN were the fact that existing SDN southbound interfaces, in particular OpenFlow, operate on a low level of abstraction, which makes programming of the network time-consuming and error prone. Identified areas of improvement and need for further work were specifying suitable high-level interfaces and abstractions. There further is the need to develop tools that are capable of automatically translate high-level specifications to low-level configuration. A complete tool chain is required. This includes measurement tools that are capable of monitoring changes. Network programmability is beneficial for measurement tools. It is expected that SDN management tools will facilitate to deal with the programmability of networks. Furthermore, verification tools will allow to detect and prevent attempts of wrongly programming the network. These tools will form a network operating system, with tools that operate on top of the operating system functions. Another need for improvement is the development of a clear transition path from today's networks to future SDN-based networks. This includes to identify which legacy functionalities from today's networks we assume being able to depend on in SDN deployments.

3.3 QUIC

QUIC is a new UDP-based reliable transport protocol with build-in security and optimized for HTTP/2 that is now under standardization by the IETF. QUIC was originally proposed by Google and has already seen large-scale deployment for Google service and in Chrome. Since September 2016 a new IETF working group reviews the design of QUIC in order to publish a QUIC protocol specification with IETF consensus.

3.4 DDoS Defence beyond Centralization

3.5 Security

The security breakout session covered civil liberties and privacy.

Firstly, the group set its focus and decided not to discuss the topics of trustworthy hardware or civil liberties, but instead to concentrate on SDN security and problems of cloudification

Key results: 1) Customer networks are converging: Customers want less own hardware, and want to be more independent and to lease remote services and equipment rather than owning it. 2) Virtualization (which happens when you cloudify applications) amplifies known problems in traditional fields like security, trust, verifiability or visibility. 3) A special challenge is the cloudification of services that already utilize virtualization in the traditional model, for example sandboxes that analyze malware. For a cloud case, one would end up with nested virtualization, which in turn comes with even new problems concerning performance and visibility of the virtualization to the malware being inspected 4) Encryption of data still leads to the usability of cloud scenarios being reduced to mostly SaaS, because homomorphic encryption is still not there to solve these problems 5) Special problems with end-to-end security, e.g., there is more end-to-end encryption happening, which is good. As a downside however, it makes life harder for people inspecting traffic in the middle If termination of encrypted connections is done in the cloud, there will be an unencrypted last mile as new security issue arising from this scenario.

3.6 IoT

4. POSTERS

Participants were also encouraged to volunteer to bring a poster to provide a perspective into their recent measurement research work.

4.1 The Cost of Security in the SDN Control Plane

In OpenFlow enabled Software Defined Networks (SDNs) network control is carried out remotely via a control connection. In order to deploy OpenFlow in production networks, security of the control connection is crucial. For OpenFlow connections TLS encryption is recommended by the specification. In this work, we analyze the TLS support in the OpenFlow eco-system. In particular, we implemented a performance measurement tool for encrypted OpenFlow connections, as there is non available. Our first results show that security comes at an extra cost and hence further work is needed to design efficient mechanisms taking the security-delay trade-off into account.

Published: R. Durner, W. Kellerer, The cost of Security in the SDN control Plane, ACM CoNEXT 2015 - Student Workshop, Heidelberg, Germany, Dezember 2015.

4.2 THE BALTIKUM TESTBED - Selected Activities in the Baltikum Testbed

The poster showed a high-level overview to the recent activities in the Baltikum Testbed. The testbed which is focussed on performance measurements of x86-based packet processing systems provides an automated, documented, and reproducible experiment workflow. The poster presented several activities, comprising the load generator MoonGen, automated benchmarks of routers and OpenFlow switches, and different performance studies, including an IPsec gateway with NIC-offloading.

Ref: [1] P. Emmerich, S. Gallenmüller, D. Raumer, F. Wohlfart, and G. Carle. MoonGen: A Scriptable High-Speed Packet Generator. In Internet Measurement Conference 2015 (IMC'15), Tokyo, Japan, October 2015. [2] Sebastian Gallenmüller, Paul Emmerich, Florian Wohlfart, Daniel Raumer, and Georg Carle. Comparison of Frameworks for High-Performance Packet IO. In ACM/IEEE Symposium on Architectures for Networking and Communications Systems (ANCS 2015), Oakland, CA, USA, May 2015. [3] Daniel Raumer, Sebastian Gallenmüller, Paul Emmerich, Lukas Märdian, Florian Wohlfart, and Georg Carle. Efficient serving of VPN endpoints on COTS server hardware. In IEEE 5th International Conference on Cloud Networking (CloudNet'16), Pisa, Italy, October 2016. [4] Daniel Raumer, Sebastian Gallenmüller, Florian Wohlfart, Paul Emmerich, Patrick Werneck, and Georg Carle. Revisiting benchmarking methodology for interconnect devices. In Applied Networking Research Workshop 2016 (ANRW '16), Berlin, Germany, 2016.

4.3 Boost Virtual Network Resource Allocation: Using Machine Learning for Optimization

Rapidly and efficiently allocating virtual network resources, i.e., solving the online Virtual Network Embedding (VNE) problem is important in particular for future communication networks. We propose a system using an admission control to improve the performance for the online VNE problem. The admission control implements a Neural Network that classifies virtual network requests based on network representations, which are using graph and network resource features only. Via simulations, we demonstrate that the admission control, i.e., the Neural Network filters virtual network requests that are either infeasible or that need too long for being efficiently processed. Thus, our admission control reduces the overall system runtime, i.e., it improves the overall calculation efficiency for the online VNE problem. Generally, we demonstrate the ability to learn from the history of VNE algorithms. We show that it is possible to learn the behavior of algorithms and how to integrate this knowledge when solving future problem instances.

Reference: [1] A. Blenk, P. Kalmbach, P. van der Smagt, W. Kellerer, Boost Online Virtual Network Embedding: Using Neural Networks for Admission Control, 12th International Conference on Network and Service Management (CNSM), Montreal, Quebec, Canada, Oktober 2016.

4.4 HyperFlex: Towards Flexible, Reliable and Dynamic SDN Virtualization Layer

The virtualization of Software Defined Networks (SDN) allows multiple tenants to share a physical SDN infrastructure, where each tenant can bring its own controller for a flexible control of its virtual SDN network (vSDN). In order to virtualize SDN networks, a network hypervisor is deployed between the physical infrastructure and the tenants' controllers. We present, HyperFlex, a flexible, reliable and dynamic SDN virtualization layer. HyperFlex achieves the flexibility of deploying hypervisor functions as software or alternatively using available processing capabilities of network nodes. It also provides resources isolation for the control plane of vSDNs. Additionally, HyperFlex supports the dynamic migration of network hypervisor instances on run time. These features are key steps towards vigorous slicing in 5G.

References: [1] A. Blenk, A. Basta, M. Reisslein, and W. Kellerer, "Survey on Network Virtualization Hypervisors for Software Defined Networking," IEEE Communications Surveys & Tutorials, pp. 1–32, 2015. [2] A. Blenk, A. Basta, and W. Kellerer, "HyperFlex: An SDN virtualization architecture with flexible hypervisor function allocation," in Proc. IFIP/IEEE Conf. IM, pp. 397–405, 2015. [3] A. Basta, A. Blenk, H. Belhaj Hassine, and W. Kellerer, "Towards a dynamic SDN virtualization layer: Control path migration protocol," in Proc. ManSDN/NFV Workshop (CNSM), 2015. [4] A. Blenk, A. Basta, J. Zerwas, M. Reisslein, and W. Kellerer, "Control plane latency with sdn network hypervisors: The cost of virtualization," IEEE Transactions on Network and Service Management, pp. 360–380, 2016. [5] A. Basta, A. Blenk, Y.-T. Lai, and W. Kellerer, "HyperFlex: Demonstrating control-plane isolation for virtual software-defined networks," in Proc. IFIP/IEEE Conf. IM, pp. 1163–1164., 2015.

4.5 SafeCloud

The poster gives an overview of the cloud security activities of the SafeCloud project. Safe cloud usage for the user requires privacy and in SafeCloud a variety of privacy-enhanced services are developed. This includes cryptographic databases and

secure multiparty computation. Security and resilience mechanisms add diverse and censorship-resistant storage, multipath and route monitoring.

Reference: safecloud-project.eu

4.6 sKnock: Scalable Secure Port Knocking

Port-knocking is the concept of hiding remote services behind a firewall which allows access to the services' listening ports only after the client has successfully authenticated to the firewall. This helps in preventing scanners from learning what services are currently available on a host and also serves as a defense against zero-day attacks. Existing port-knocking implementations are not scalable in service provider deployments due to their usage of shared secrets. Here, we introduce an implementation of port-knocking based on x509 certificates aimed towards being highly scalable.

Reference: Daniel Sel, Sree Harsha Totakura, Georg Carle, "sKnock: Scalable Port-Knocking for Masses ," in Workshop on Mobility and Cloud Security & Privacy, Budapest, Hungary, Sep. 2016.

4.7 BMBF Project SarDiNe

The BMBF project SarDiNe is motivated by the advent of the virtualization of complete enterprise networks. Software defined networks (SDN) tremendously ease the creation and management of virtual networks which leads to new challenges in security policy enforcement. Traditionally, networks were separated physically and security was mainly enforced by firewalls placed at gateway positions between the physical networks. With highly dynamic virtual networks it remains unclear where to place firewalls, especially if higher security measures like filtering on the application layer are needed.

In SarDiNe we propose to virtualize firewall functionality as well and dynamically place it on commodity hardware managed by cloud techniques and spread across the network. Then, the SDN is used to dynamically reroute traffic via these virtual network functions (VNF). This approach promises a scalable and cost-efficient security solution applyable in many different setups. As main use case we elaborate a bring-your-own-device (BYOD) scenario. Also, we are interested in exploiting the SDN to provide parts of the filtering functionality in its fast switching hardware. The result is a hybrid VNF-SDN firewall which aims at a cost reduction in terms of computation resources needed for scaling and latency imposed by the rerouting.

4.8 Securebox

TBA

4.9 StackMap

TBA

5. CONCLUSIONS AND NEXT STEPS

Collected feedback. Mirja: good chance to talk to people, topics are a bit too diverse;

Dirk: good to have an overview and bring opinions to the companies, to have deeper discussion for certain topics;

Vaihbav: junior to talk on first day, senior on second day;

Joerg: less presentations

Lars: break out session are good, longer break session, dedicated session for PhD students;

invite more industrial participants

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6. REFERENCES

[1] N. Herold, H. Kinkelin, and G. Carle. Collaborative incident handling based on the blackboard-pattern. *Proceedings of the 2016 ACM on Workshop on Information Sharing and Collaborative Security*, pp. 25–34, Vienna, Austria, 2016.

[2] Munich Internet Research Retreat 2016: Materials. https://www.cm.in.tum.de/en/mir.

[3] Q. Scheitle, O. Gasser, M. Rouhi, and G. Carle. Large-Scale Classification of IPv4-IPv6 Siblings with Nonlinear Clock Skew. Technical report, 2016.