Learning from the Past: Implications for the Future Internet and its Management?

Edited by

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─── **Abstract** ───

This report documents the program and the outcomes of Dagstuhl Seminar 11042 "Learning from the Past: Implications for the Future Internet and its Management?". The discussion centered around the question if by analyzing the past - especially why certain technologies did or did not succeed - it is possible to reason about the Future Internet, the challenges and especially the management aspect. Valuable observations have been identified during the discussions. A scientific publication that summarizes the key findings is under preparation.

1   Executive Summary

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The attendees of the seminar discussed a hot topic of various research initiatives, namely the Future Internet, and its management. Can we make assumptions for the Future Internet if we question ourselves how the present Internet needs to be re-engineered by analyzing its current major limitations? Although discussions like the clean-slate vs. evolutionary approach are taking place, and are certainly vision-based, an alternative approach to investigate why certain decisions failed or succeeded seems to be promising as well.

Looking back, we recognize that the Internet architecture and protocols are, in theory, defined by about 5000 RFCs ("standards"), but in practice depend on a much smaller number of core assumptions, protocols and technologies. The Internet is largely defined by a modest set of protocols with numerous extensions and modifications: IPv4 and IPv6 at the network layer, UDP and TCP at the transport layer, and a handful of standardized and a large number of proprietary application protocols, for applications from email and file transfer to

gaming. Along with these data-delivering protocols, control plane protocols such as BGP, configuration protocols such as DHCP and management protocols such as SNMP are needed to keep the Internet running.

Many of these protocols are now at least a decade, in some cases three decades, old. Some have aged gracefully; others clearly have reached the end of their useful lifetime. Also, numerous other protocols and architectures have been proposed in the literature and many were even standardized over the past decades, but most have had very limited or no practical impact. Unfortunately, the design of new protocols is still largely based on folklore and ideas passed on informally during discussions at conferences, IETF standardization meetings and PhD seminars. It is relatively easy to stuff all ideas accumulated into a new protocol, but it seems much harder to destil the lessons learned into future designs, so that we do not loose some of the core properties that have made the Internet successful. Not only in the design of protocols, the same is true also for the development of management approaches. Although it seems that we have recognized that the management of the Future Internet needs to be addressed in the design phase, it is largely ignored so far, maybe because we do not know how to approach it.

Therefore, learning from the past would give us valuable insights for the design of the Future Internet, and its management. The goal of the seminar was to discuss these questions and identify the key findings.

2   Table of Contents

3   Overview of Talks

The seminar investigated core network architectural issues and core protocols as well as management approaches, to define precisely what made design decisions succeed against their competitors at the time of design, and which choices have turned out to be prescient and where we are reaching the end of the extensibility. The discussion was motivated by the following talks:

- Georg Carle, TU München
  Network Management for Measuring, Processing, and Reacting
- Gabi Dreo Rodosek, Universität der Bundeswehr München
  Learning from the Past: KISS principle for the Future Internet, and Self-Management
- Olivier Festor, INRIA - Nancy Grand Est
  A Biased Focus on 20 Years Research in Network Management
- Sape J. Mullender, Alcatel-Lucent Bell Labs - Antwerpen
  New Protocols for Accessing Services, Files, Content and more
- Aiko Pras, University of Twente
  Learning from the past - why OSI failed
- Danny Raz, Technion - Haifa
  Networking and Computation Resources: Can They Mix?
- Ramin Sadre, University of Twente
  Is The Future Unpredictable?
- Peter Schoo, Fraunhofer Institut SIT, München
  Management in FI needs increasingly more and better means for anomaly detection
- Henning Schulzrinne, Columbia University
  What did we learn? Random thoughts on protocol design
- Burkhard Stiller, Universität Zürich
  Communications + Management/Operations + Security* != Communications, Management/Operations, Security*
- Hermann de Meer, Universität Passau
  Problems in cross layer optimizations contrasted to E2E communications

4   Lessons Learnt resp. the Key Findings Identified

In the following the key findings of the seminar during the discussions are summarized:
1. We need a better understanding of design trade-offs.
2. New applications can change traffic characteristics in a few months. In the past decade several applications dramatically changed the way how the Internet is used. Nobody has actually foreseen the success of P2P networks, and especially Youtube and Facebook. Thus, the question is whether it is possible to design a Future Internet without having any ideas what the "next big things" could be. If thus the traffic changes are unpredictable, then we need to establish a fast and stable infrastructure without any assumptions on the traffic.
3. The waterfall model does not work in practice in communications, for sure, software is not a "one-time instance", changes will occur for some time. Thus, versions are needed, and for protocols we may arrive at the same iterative refinement approach.

4. The use of formal specifications in case of OSI was rather harmful than it helped. OSI failed because nobody needed it, and options have been considered to be harmful.
5. Implementations from the beginning are necessary. However, with first to the market means to loose quality.
6. Full decoupling of planes (management, user, control) is good in an "old-style telco world", however, it will not work in the Future Internet.
7. There is no future for a centralized management (in most cases). It is necessary to move the research effort towards self-management approaches.
8. Future protocols should have built-in management possibilities (Management-by-Design).
9. The focus of management must concentrate on algorithms to automate it, the supporting data and data feeding will follow afterwards.
10. Effective management is the management that disappears or is invisible, respectively.
11. The need for self-configuration in access networks, programmable nodes (measurement is an important case on layer 3).
12. Fundamentally new protocols and approaches are needed that are additionally suitable for addressing replicated objects, which are mutable, as well as trust.
13. Assumptions for DiffServ/IntServ changed, there is no need anymore for end-to-end Quality-of-Service (QoS), except for Label Switched Paths.
14. There is no need for Network Address Translation anymore due to IPv6.
15. IP addresses are unsuitable for the mobility aspect. Mobile IP has failed.

5   Conclusions

All discussions have shown that a lot of various concepts that have been developed are nowadays, or will be in the near future, more or less obsolete due to the enormous amount of bandwidth being available in network backbones or migration to IPv6. These insights of those discussions have shown very interesting combinations of effects and consequences as well as mechanisms and their implementation alternatives. Based on these observations a scientific paper is under preparation.

Participants

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