

10492 Executive Summary

Information-Centric Networking

— Dagstuhl Seminar —

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1 Motivation

Information-Centric Networking (ICN) is one of the significant directions of current networking research. In ICN, the principal paradigm is not end-to-end communication between hosts - as it is in the current Internet architecture. Instead, the increasing amount of content that must be distributed requires alternatives: Architectures that work with information objects as a first-class abstraction; focusing on the properties of such objects and receivers' interests to achieve efficient and reliable distribution of such objects. Such architectures make in-network storage, multiparty communication through replication, and interaction models such as publish-subscribe generally available for all kinds of applications, without having to resort to dedicated systems such as peer-to-peer overlays and proprietary content-distribution networks.

The ICN approach is currently being explored by a number of research projects, both in Europe (4WARD, SAIL, PSIRP) and in the US (DONA, CCN). The Delay Tolerant Networking (DTN) community has developed a message-oriented architecture that has been used along with ICN addressing and routing concepts. While these approaches differ with respect to their specific architecture, they share some assumptions, objectives and certain structuring architectural properties. In general, the aim is to develop network architectures that are better suited for content distribution, the currently prevailing usage of communication networks, and that better cope with disruptions in the communication service. The basic idea of ICN still leaves room for many variations. The Dagstuhl ICN seminar was intended as a catalyst for these variations and as a forum for discussing the following research topics:

- The relationship of networking architecture innovation vs. so-called over-the-top approaches in the application layer

- The support of an Internet of Things and Services by an ICN architecture
- How to migrate towards an information-centric architecture, and whether and how to use it as a migration enabler for, e.g., an IPv4/IPv6 technology step
- The role of and needs for naming and addressing and name resolution systems, along with the necessary security aspects of a naming scheme; a fundamental dichotomy between flat and hierarchical naming schemes needs to be resolved
- Efficiency and robustness of ICN data dissemination vs. specific content distribution overlay solutions
- The desirability of using specific transport protocols for ICN vs. the use of standard protocols like TCP or disruption tolerant protocols like the DTN Bundle protocol
- The integration and placement of caches inside a network
- Can the introduction of a new ICN architecture enable new types of applications that were too complex to create/operate/deploy/maintain in traditional networks?

2 Organization of the seminar

The seminar was organized as a 2.5 days seminar that provided room for presentation of approaches, results so far, as well as presentation and discussion of new ideas and selected specific topics.

The seminar was structured in 4 main blocks:

1. Presentation of on-going research activities
2. In-depth presentations and discussion of *naming, security, and routing and resolution* for ICN (Group Discussion 1)
3. In-depth presentations and discussion of *resource management and transport, ICN APIs and ICN hour glass waists, and deployments aspects, business models and incentives* for ICN (Group Discussion 2)
4. Discussion of seminar results and next steps

The seminar started, in the first block, with a set of presentations of on-going research activities:

- Teemu Koponen: DONA (Data-Oriented Networking Architecture)
- Jim Thornton: NDN (Named-Data Networking)
- Bengt Ahlgren: NetInf (Network of Information) in the 4WARD project
- George Xylomenos: PURSUIT project

The seminar then addressed important specific ICN topics such as naming, security, routing and resolution. For that, a set of discussion starter presentation set the scene by summarizing important issues and by providing new ideas:

- Christian Dannewitz: Naming and Security in Information-centric Networking

- Kevin Fall: Discussion on Information Centric Networking with a Security Focus
- Jarno Rajahalme: What’s in a Data Name?
- Jussi Kangasharju: Naming and Search in Information-Centric Networks

These topics were then discussed in smaller groups (Group Discussion, part A), and the results of these discussions were presented and discussed in a plenary session.

In the second block of specific ICN topics discussion, several discussion starter presentations on resource management, congestion control, and ICN in challenged networks have been given:

- Van Jacobsen: Congestion Control and Transport in ICN
- Sara Oueslati: Ideas on Traffic Management in CCN
- Volker Hilt: Energy Consumption of Content-Centric Networks
- Joerg Ott: Delay-tolerant Networking: Elements of ICN
- Stephen Farrell: ICNing DTN
- Armando Caro: Content Based Networking in DTNs
- Christian Esteve Rothenberg: Compact Forwarding in Content-Oriented Networks
- Henrik Lundqvist: Deployment of Information Centric Networking from a Mobile Operator Perspective: Service Program Mobility
- Antonio Carzaniga: Content-Based Publish/Subscribe Networking and Information-Centric Networking

Aspects of these presentations were then discussed in *dedicated* groups on *resource management and transport, ICN APIs and the ICN hour glass waist, and deployment aspects, business models, and incentives.*

The seminar was wrapped up by a discussion of common concepts, future research topics and next steps for the ICN community.

3 Outcome of the seminar

The seminar delivered a comprehensive analysis of the state of the art in information-centric networking, progress on specific technical issues such as scalable addressing and content distribution, a better understanding of the legal requirements and application developer needs. It also touched upon possible next steps in research and helped to form an ICN community. The seminar has led to the organization of a SIGCOMM workshop⁷ on the same topic that is co-organized by seminar organizers and participants.

⁷ <http://www.neclab.eu/icn-2011/>