

# Is the Management of the Future Internet Ignored? A Report on ManFI 2009

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**Abstract** This report summarizes the presentations and discussions at the 1st IFIP/IEEE International Workshop on Management of the Future Internet (ManFI 2009). This report provides a broad, high-level view of key requirements, challenges, strategies and R&D results associated with the current state-of-the-field in Future Internet management.

**Keywords** Future Internet · Network management · Architectures · Automation

## 1 Introduction

Acting on the rising popularity of Future Internet (FI) research, the first IFIP/IEEE International Workshop on Management of the Future Internet (ManFI 2009) was intended as a forum to bundle those FI activities and provide up-to-date results that focus on the management aspects of the FI. The workshop took place on June 5, 2009, at Hofstra University, Long Island, NY, USA, in conjunction with the 11th IFIP/IEEE International Symposium on Integrated Network Management (IM 2009). ManFI 2009 was organized by POSTECH Korea and Universität der Bundeswehr München Germany, and co-sponsored by the IST Network of Excellence for the Management of Internet Technologies and Complex Services (EMANICS), which is sponsored by the European Commission.

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Recently, researchers in the networking area around the world have been investigating ways to solve the major problems that exist in the current Internet. This design activity is referred to the “Future Internet”, which has become a very hot topic, especially in the US, Europe, Japan and Korea. Network management is a very important area; however, it was not one of the original design goals of the current Internet. Rather, it emerged as a “necessary means” to enable functionality provided by the Internet to grow. As a result, managing the current Internet is still very cumbersome and difficult. The purpose of this workshop is to encourage researchers to include manageability at the *beginning* of architecting the Future Internet.

The ManFI 2009 program featured two keynote addresses and presentation of eight full and four short papers. It concluded with a panel session. All submitted papers were reviewed by at least three members of the technical program committee.

## 2 Keynote Addresses

John Strassner (Chairman of the Autonomic Communications Forum, director of autonomic research at the Telecommunications Software and Systems Group, and Professor at POSTECH) delivered the first keynote on the state of the art in network management for the Future Internet. He discussed shortcomings of the current Internet and its management problems and then compared the three approaches to the Future Internet: incremental, evolutionary, and revolutionary. Within those categories, he gave an extensive overview of current initiatives and projects from Europe, the US and Asia. These included the GENI [1] and FIND [2] programs of the US; the Situated Autonomic Computing [3], 4WARD [4], Autonomic Internet (AutoI) [5]; and Internets of the Future [6] of Europe; and the Future Internet Forum [7] of Asia. John pointed out that new network architectures are designed following an information-centric approach, which leads to new key management requirements, such as security and trustworthiness in a distributed environment and the need to involve management functionality at modeling and design phases. Key problems include the lack of a scalable knowledge representation that can be used to unite management data from heterogeneous devices and technologies, the lack of support for translating needs to different constituencies, and a brief look into how Future Internet architectures could be designed to overcome these problems.

Marcus Brunner (Network Laboratories, NEC Europe Ltd.) dedicated his keynote to the European Future Internet research perspectives and more specifically to the in-network management approach of the 4WARD project. He pointed out that today’s approach to Internet management as an add-on does not work well for self-management, and is thus not sufficient for future management needs. Self-management functions need to be designed as an integral part of new network components, and the in-network management approach will enable self-management to be implemented with reduced integration costs and shortened service deployment cycles.

### 3 Technical Paper Sessions

Out of all submissions, we chose eight contributions for presentation as full technical papers. In the morning paper session, four papers dealing with Future Internet management challenges and paradigms were presented. The afternoon session featured four papers dealing with selected management aspects of the Future Internet. In addition, four short papers were chosen for poster-style presentations.

Accepted papers represented the latest results in research and development in the management of the Future Internet, and covered topics including architectural aspects of the management of the Future Internet, shortcomings of current management of the Internet, surveys of Future Internet research activities and how they approach management, automation of management functionality, and more. In the following, we provide a brief overview of the contributions of each paper and the discussions that evolved:

- Sung-Su Kim (POSTECH, Korea) presented “Towards Management of the Future Internet”. He summarized representative programs from Europe (4WARD, AutoI, and ANA [8]) and the US (CONMan [9] and DMNGI [10]), and discussed their common design requirements such as architecture, protocol, market aspects, and automation of management functionality. He also pointed out that none of these projects addressed new management techniques or ways of representing management data, and pointed out why these were needed for the FI.
- Brendan Jennings (Waterford Institute of Technology, Ireland) presented “Challenges for Federated, Autonomic Network Management in the Future Internet”. This paper described the Federated Autonomic Management of End-to-end systems (FAME) project [11], and pointed out that new management systems will need to support federation of behavior. Difficulties in achieving this vision include negotiation and delegation of governance, common knowledge, end-to-end service level monitoring, translating business requirements to network implementation, and coordination of service-aware distributed management.
- Javier Rubio-Loyola (Universitat Politècnica de Catalunya, Spain) presented “A Viewpoint of the Network Management Paradigm for Future Internet Networks”. He described the autonomic management approach taken by the European AutoI project, and focused on the context-awareness to trigger autonomic behavior to adapt the system to changes in the environment. Functional layers are used to simplify the management of networks. He used a ubiquitous multimedia streaming service for illustrating these principles.
- Thomas Magedanz (Fraunhofer Institute for Open Communication Systems, Germany) et al. discussed “Service-Oriented Testbed Infrastructures and Cross-Domain Federation for Future Internet Research”. They suggested an approach called the Network Domain Federation (NDF) that discusses the architecture of the federated testbed of the PanLab II European project [12]. Different combinations of services and resources are provided by federating different testbeds using an innovative object-oriented approach. The architecture has been implemented using standard protocols like SPML, HTTP, and SIP.

- Marcelo Yannuzzi presented “Understanding IPv4 Prefix De-aggregation: Challenges for Routing Scalability”. A characterization of the IP prefix de-aggregation factor has been analyzed, and the management requirements were shown as applied to the LISP testbed. LISP is a solution for routing table size problems, and their overlay-based approach can satisfy the proposals for LISP. Finally, they will use the results from this study to understand how to better migrate existing IPv4 networks to IPv6.
- Amélie Medem (LIP6 Laboratory, France) presented “Troubleminer: Mining Network Trouble Tickets”. Text processing techniques are used to mine the textual description of trouble tickets automatically, which generates vectors of keywords. Based on those vectors, an n-ary tree is constructed for classifying the trouble tickets. Experiments have been carried out with the datasets from the Abilene and Switchlan networks. One of the findings is that more than half of all trouble tickets correspond to maintenance activities.
- Martín Serrano (Waterford Institute of Technology, Ireland) presented “A Formal Approach for the Inference Plane Supporting Integrated Management Tasks in the Future Internet”. This paper started by reviewing the Knowledge Plane of Clark et al. [13], and then explained the motivation for extending this work into the Inference Plane by Strassner et al. [14]. He explained how the Inference Plane could accommodate business-aware service management, and then showed how the Ontology for Support and Management (OSM) project could be used to define and manage many of the semantic structures required to formalize and represent knowledge. This in turn can facilitate interoperability between management systems by enriching their information or data models with associated semantics.
- Jeroen Famaey (Ghent University, Belgium) presented “Dynamic QoE Optimisation for Streaming Content in Large-Scale Future Networks”. He focused on the description of a set of algorithms aiming at optimizing the process of streaming multimedia content in a scalable and fully distributed end-to-end architecture. The algorithms help select the most appropriate content servers and codecs (plugins), considering bandwidth limitations and maximizing QoE. Experimental results based on simulations have been used to assess the approach.

The high volume of very interesting discussions and feedback to the presenters emphasized the forward-looking character of this workshop. For example, many of the workshop participants asked diverse questions, ranging from implementation experience to experimental methodology to open speculation concerning future work and alternatives.

#### 4 Short Paper Session

Four selected short papers were presented as posters:

- Ewan Sutherland (University of Namur, Belgium) presented “The Internet tipping point: driving the transition to a new architecture?” The focus of this paper was to find a guide for future design and implementation by learning from

past experience. The effect of changes that the clean-slate approach will cause was analyzed and discussed in detail.

- Miguel Lopes (University of Minho, Portugal) presented “Automated Network Services Configuration Management”. The presented framework works in cooperation with an automated and distributed monitoring system that together build an automated network service replication mechanism enabling to work with independent software and hardware implementations.
- Spiros Spirou (Intracom Telecom, Greece) presented “Economic Traffic Management”. He proposed an autonomous and cooperative traffic management and explained how various actors in several scenarios expressed their goals and incentives. Economics-inspired methods were applied, and rules for local interactions of actors that maximized incentives were described for achieving global traffic management.
- Feng Liu (Ludwig-Maximilians-Universität München, Germany) presented “The Role of AI Planning in the Management of Future Internet”. He proposed to apply the hierarchical task network (HTN) planning approach to facilitate the task decomposition operation and knowledge representation, which are important building blocks of Future Internet management. He explained his approach by comparing it with traditional planning.

## **5 Panel: Why is Managing the Future Internet Being Ignored?**

The last session of the ManFI 2009 workshop was dedicated to a panel session with the theme “Why is Managing the Future Internet Being Ignored?” Chaired by James Won-Ki Hong (POSTECH, Korea), the four panelists Joan Serrat (Universitat Politècnica de Catalunya, Spain), Lisandro Zambenedetti Granville (UFRGS, Brazil), Spiros Spirou (Intracom Telecom, Greece), and Yoshiaki Kiriha (NiCT, Japan) debated a wide range of topics with each other and the participants of the workshop.

Joan started the discussion by stating his opinion that management of the Future Internet is not being ignored but, instead, is being re-thought. The limitations of the current Internet have created a pressing need for new approaches. Joan stated that a new Internet should rely on autonomic communications principles with embedded self-management capabilities.

Lisandro focused on the importance of network virtualization on different layers. He related important management questions to technology and business aspects. Two popular examples were “How can one manage physical/virtual routers?” and “What’s the cost of managing network virtualization?” He also indicated the importance to interact with other communities dealing with similar issues.

Yoshiaki presented the role of future management technologies from activities in Japan, where the FI is motivated by the networking community; consequently, it is called New Generation Network (NWGN) [15]. It is envisioned that societal and business changes will transform society from a competitive to a collaborative society. Five future network-oriented research goals have been formulated: delivery of added value delivery for different stakeholders, creation and management of trusted heterogeneous networks, global sensor clouds that provide complex behavior

from aggregating simple entities, realizing network autonomicity, and transforming approaches to consider “green” networks.

Spiros gave some figures on Future Internet management funding by the European Union, which led to comparisons with other regions. In Europe, FI management has only been included in project funding recently, which shows the increasing importance of continuing research in management, while the US and Japan have no funding devoted to FI management.

The discussions then covered a large range of topics, including e.g. the design philosophy behind the Future Internet and business cases for virtualization. Another major issue in FI management will be security, which like management, must be designed in from the start and which is difficult to do in a fashion so that is accepted by all stakeholders. This lack of acceptance is caused by many diverse factors, ranging from the current view of many companies that network management is a cost (as opposed to profit) center, which discourages industry from investing in its research.

## 6 Concluding Remarks

All technical papers were published with the papers from the other IM 2009 workshops by IEEE:

IFIP/IEEE International Symposium on Integrated Network Management Workshop Proceedings.

June 1-5, 2009, Hofstra University, NY, USA.

IEEE Catalog Number: CFP0958G-CDR.

ISBN: 978-1-4244-3924-9.

Further, the workshop materials (e.g., program and presentations) are available online at: <http://www.manfi.org/2009>.

Many contributed to the success of the ManFI 2009 workshop. We would like to thank the authors and all speakers for presenting their work, sharing ideas and the openness for discussions. We gratefully acknowledge the work of the technical program committee members in the process of selecting the best papers and the IM 2009 workshop chairs for their organizational support. Many thanks go to all workshop participants, who helped to make ManFI 2009 a rich and pleasant first event in – hopefully – a series of workshops on management of the Future Internet.

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**Iris Hochstatter** received her diploma in computer science from Ludwig-Maximilians-Universität München. She pursued graduate studies in technology management at the Center for Digital Technology and Management and the University of California at Berkeley. Since 2007, she is a research assistant at the department of computer science of the Universität der Bundeswehr München and a member of the European Network of Excellence EMANICS. Her research interests include ubiquitous computing, context-awareness, Future Internet, and network management.

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