IFIP Advances in Information and Communication Technology 600

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IFIP – The International Federation for Information Processing

IFIP was founded in 1960 under the auspices of UNESCO, following the first World Computer Congress held in Paris the previous year. A federation for societies working in information processing, IFIP's aim is two-fold: to support information processing in the countries of its members and to encourage technology transfer to developing nations. As its mission statement clearly states:

> *IFIP is the global non-profit federation of societies of ICT professionals that aims at achieving a worldwide professional and socially responsible development and application of information and communication technologies.*

IFIP is a non-profit-making organization, run almost solely by 2500 volunteers. It operates through a number of technical committees and working groups, which organize events and publications. IFIP's events range from large international open conferences to working conferences and local seminars.

The flagship event is the IFIP World Computer Congress, at which both invited and contributed papers are presented. Contributed papers are rigorously refereed and the rejection rate is high.

As with the Congress, participation in the open conferences is open to all and papers may be invited or submitted. Again, submitted papers are stringently refereed.

The working conferences are structured differently. They are usually run by a working group and attendance is generally smaller and occasionally by invitation only. Their purpose is to create an atmosphere conducive to innovation and development. Refereeing is also rigorous and papers are subjected to extensive group discussion.

Publications arising from IFIP events vary. The papers presented at the IFIP World Computer Congress and at open conferences are published as conference proceedings, while the results of the working conferences are often published as collections of selected and edited papers.

IFIP distinguishes three types of institutional membership: Country Representative Members, Members at Large, and Associate Members. The type of organization that can apply for membership is a wide variety and includes national or international societies of individual computer scientists/ICT professionals, associations or federations of such societies, government institutions/government related organizations, national or international research institutes or consortia, universities, academies of sciences, companies, national or international associations or federations of companies.

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Advancing Research in Information and Communication Technology

IFIP's Exciting First 60+ Years, Views from the Technical Committees and Working Groups

Springer

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Foreword

IFIP — the International Federation for Information Processing —was founded in 1960 following the first World Computer Congress, and under the auspices of UNESCO. Its aim was to support and advance the work of the then-fledgling societies dealing with information processing (which we now refer to as information and communication technology, or ICT) and the nascent computing industry. Computer Science, or Computing as a discipline of science, was also in its infancy.

Today, IFIP is the global federation of ICT societies and associations committed to advancing scientific progress and the professional and socially-responsible application of technology based on scientific progress. IFIP's members are national, regional, and international ICT societies. In turn, their members are ICT scientists, researchers, academics, educators, professionals, practitioners, and policy-makers, who are focused on developing and advancing ICT foundational knowledge and expertise; promoting digital equity; educating and enhancing public understanding of technology and its potential (both for good and, occasionally, ill); and increasing professionalism and professional standards.

Along with its member societies, IFIP is a strong advocate for ICT equality and works closely with UNESCO, the United Nations, ITU, and many other international bodies to promote understanding of issues related to technology. We aim to collaborate on solutions to help in the achievement of the United Nations Sustainable Development Goals (SDGs).

IFIP also seeks to raise awareness and understanding amongst the wider community about where technology is headed, how it can enhance the quality of all our lives, and how to ensure that all people have equal access and equal opportunity.

In both science and research, IFIP is uniquely placed to achieve these outcomes through its global network of 13 Technical Committees and more than 130 Working Groups, which bring together experts in different fields to share and enhance their knowledge, and to focus attention on key areas related to science and technology.

IFIP member societies, and their individual members, have access to the largest network of technical expertise in the world. This enables them to make valuable connections, grow their knowledge and skills, and contribute to the development of global insights and standards for ICT and ICT professionals.

Most of the more than 100 events IFIP organizes every year are based on the work of IFIP Technical Committees and Working Groups and bring together international experts on various ICT-related topics, to share the latest scientific findings, discuss the ICT-related technological and societal developments, and reflect on the latest issues of relevance to the ICT profession.

Given this breadth and depth of competence we welcome the survey of current findings, summary of the state of the art, and discussions in Technical Committees and their Working Groups that are contained in this volume of Advancing ICT Research, and which document the wide range of scientific activities within IFIP. The final

chapter of this volume deserves special attention— it is the current Code of Ethics which IFIP has adopted for itself.

Please join us as we celebrate IFIP's 60th anniversary with a range of online and blended events addressing all aspects of ICT and enjoy this volume of ICT achievements.

Mike Hinchey
IFIP President (2016–2022)

Preface

Soon after IFIP was founded, it established Technical Committees (TCs) and related Working Groups (WGs) to foster exchange and development with regard to the scientific and technical aspects of information processing. IFIP TCs are as diverse as the different aspects of information processing, but they share the following aims:

- To establish and maintain liaison with national and international organizations with allied interests and to foster cooperative action, collaborative research, and information exchange.
- To identify subjects and priorities for research, to stimulate theoretical work on fundamental issues and to foster fundamental research which will underpin future development.
- To provide a forum for professionals with a view to promoting the study, collection, exchange, and dissemination of ideas, information, and research findings and thereby to promote the state of the art.
- To seek and use the most effective ways of disseminating information about IFIP's work including the organization of conferences, workshops, and symposia and the timely production of relevant publications.
- To have special regard for the needs of developing countries and to seek practicable ways of working with them.
- To encourage communication and to promote interaction between users, practitioners, and researchers.
- To foster interdisciplinary work and – in particular – to collaborate with other Technical Committees and Working Groups.

Considering these aims and the corresponding activities and competencies of the IFIP TCs, it seems natural that they were invited to contribute high quality ICT Research publications with insights from the breadth of their entire work on a global/worldwide scale. Consequently, the editors of this book were lucky enough to receive 17 contributions from nine TCs and several of their WGs. These contributions describe the scientific, technical, and further work in the TCs and WGs and in many cases also assess the consequences of the work's results. They will help IFIP and their readers to explore the developments of IFIP and the profession now and over the next 60 years. The contributions are arranged per TC and conclude with the chapter on the IFIP code of ethics and conduct as a joint IFIP endeavour and achievement.

The WGs of TC 1 "Foundations of Computer Science" contributed two chapters focussing on complexity and signal flow theory:

- "Hot Current Topics of Descriptional Complexity" reflects the work of WG 1.2 "Descriptional Complexity" aiming for powerful yet operational descriptions of information and the algorithms that process it.
- "A Survey of Compositional Signal Flow Theory" is a joint contribution by WG 1.3 "Foundations of System Specification" and WG 1.8 "Concurrency Theory" and

illustrates the use of special graphical models to advance the description of signal flow graphs and make it easier to understand the corresponding signal flows.

The WGs of TC 2 "Software: Theory and Practice" also contributed two chapters concentrating on essentials of software engineering such as algorithms and data management:

- "Algorithmics" contributed by WG 2.1 "Algorithmic Languages and Calculi" describes the WG's contributions to the rigorous and reliable design of computer programs of all kinds, which basically is "Algorithmics".
- WG 2.6 "Database" contributed "Advances in Data Management in the Big Data Era", sharing its expertise in recent advancements in data integration, metadata management, data quality, and graph management, as well as data stream and fog computing,

TC 3 "Education" contributed the chapter "Computers and education – recognising opportunities and managing challenges". It considers the shifting focus of TC 3's concerns for computing and education over the past 60 years, the reasons for those shifts, and the challenges that educators have faced in developing appropriate uses of computers in their practices. The chapter explores the roles and influences of TC 3 activities, including an overview of important TC 3 visions and declarations that highlighted contemporary and future issues, and the status of an evolving declaration focusing on future sustainability and computing. The chapter concludes with an overview of the impact of TC 3, and signposts next steps in its ongoing journey.

The WGs of TC 5 "Information Technology Applications" provided six chapters showing the importance and diversity of applications of information processing:

- WG 5.4 "Computer Aided Innovation" contributed "Computing Inventive Activities in an Industrial Context – New Scientific Challenges and Orientations". This chapter is based on WG 5.4's activities in studying the computerization innovation in industrial environments and puts them in relation to the rebirth of artificial intelligence and the 4.0 paradigm in manufacturing and industry in general.
- WG 5.5 "Cooperation Infrastructure for Virtual Enterprises and Electronic Business (COVE)" contributed "The Evolution Path to Collaborative Networks 4.0". Hence, this chapter starts with a classification of collaborative networks, continues with a history of four generations of collaborative networks, and leads to a reflection of ongoing developments, trends, challenges, and expectations. It turns out that collaborative networks have been evolving in 24 sub-dimensions. The set of trends and challenges that are mentioned and exemplified in relation to each of the sub-dimensions also constitute the elements of a research agenda for the coming years in this area.
- WG 5.7 "Advances in Production Management Systems" contributed a chapter in line with its name but adding the subtitle "Issues, Trends, and Vision Towards 2030". Based on more than 42 years of experience this chapter reviews past, current, and future issues and trends to establish a coherent vision and research agenda for the WG 5.7 and its international community. The chapter covers a wide range of production aspects and resources required to design, engineer, and manage the next generation of sustainable and smart production systems.

- WG 5.8 "Enterprise Interoperability" contributed a state-of-the-art view on methods and approaches for interoperable enterprise systems. It includes the WG view on the state of the art in enterprise modelling, enterprise engineering, enterprise architectures, enterprise integration, and enterprise interoperability. A brief history of these topics, with special attention to the work developed by WG 5.8 former and current members follows. With respect to application, references to production systems and the manufacturing enterprise are made. The chapter closes with a brief look into very recent developments in the domain of enterprise interoperability.
- WG 5.12 "Architectures for Enterprise Integration" like WG 5.7 combined its chapter's title from its name and a subtitle, in this case "Twenty-five Years of the GERAM Framework". With GERAM being the "Generalised Enterprise Reference Architecture and Methodology" published in 1994, this chapter is about the use of systems thinking and systems theory in enterprise architecture and about how it is possible to reconcile and understand, based on a single overarching framework, the interplay of two major enterprise change endeavours: enterprise engineering (i.e. deliberate change) and evolutionary, organic change. The chapter also demonstrates how such change processes can be illustrated by employing systems thinking to construct dynamic business models. Finally, the chapter attempts to plot the way GERAM, as a framework to think about the creation and evolution of complex socio-technical systems of systems, will continue to contribute to society in the context of future challenges and emerging opportunities.
- WG 5.15 "Information Technology in Disaster Risk Reduction (ITDRR)" contributed "Synthesis of a Composite Imitation Model of the Cognitive Structure of the Ergatic System Operator Based on Conceptual Pattern Technology". To reduce the risk of disasters one wants to support the human operators of ergatic systems and hence study their cognitive structures. Thus, this chapter reports how for the purpose of studying the cognitive structures of human operators of ergatic systems, an IT system has been developed for the conceptual synthesis of relevant simulation models (cognitive structures) based on the use of conceptual modelling.

TC 6 "Communication Systems" and especially WG 6.6 "Management of Networks and Distributed Systems" contributed "Blockchains and Distributed Ledgers Uncovered: Clarifications, Achievements, and Open Issues". WG 6.6 has investigated blockchains in various aspects; hence, this contribution summarizes and clarifies key characteristics of blockchains and the related approach of distributed ledgers. The value of both is outlined in combination with selected and exemplified application domains. In addition, a set of open issues is discussed, as they possibly hinder practical operation, e.g. excessive expectations, missing interoperability, wrong scalability promises, or out-of-scope trust assumptions. Then the state of the art is clarified and current, as well as necessary, research steps to follow are outlined.

TC 7 "System Modelling and Optimization" contributed a historical note on its activities over the last 53 years describing how the eight WGs of TC 7 and the related events evolved and what this means for the future, as modelling and optimization remain important in various applications. Examples are reinforcement learning and quality learning, adequate methods and sufficiently efficient implementations to address large scale data problems, and, most recently, the modelling of pandemics.

TC 8 "Information Systems" contributed "The Future of Information Systems in a Post-COVID World by TC8 (Information Systems)". The article highlights the accomplishments of TC 8 and its working groups over its 50 year history and envisages strategies for the future. It begins with an overall view of the diverse and changing roles of the Information Systems field, then moves forward to foresee environmental sustainability and digital glocalization in a post-COVID-19 world. Next the article describes the achievements of TC 8, the establishment of its ten WGs, and what TC 8 and its WGs have to offer in the future. Lastly, the article identifies the individual working groups of TC 8 to detail their activities as important conduits of research and practice in the field of IS over the past 50 years, then imagine the roles of the TC8 working groups in a post-COVID landscape.

TC 9 "ICT and Society" contributed "The Impact of Human Choice and Computers and Technical Committee 9 on ICTs and Society: A Critical Sociotechnical Tale". This article recounts the history of the Human Choice and Computers (HCC) conference series, and of TC 9 itself. It documents a textual analysis of the proceedings of the HCC conferences and biographical detail concerning the key players involved. It shows that not only has there been a marked focus, over more than four decades, on a critical and sociotechnical approach to understanding the relationship between ICTs and society but that HCC and TC 9 may be regarded as the original and continuing home of the critical academic voice in ICT.

TC 11 "Security and Privacy Protection in Information Processing Systems" contributed "Information Security and Privacy – Challenges and Outlook". This chapter examines the role of TC 11 and its 14 WGs in the ever-changing and evolving domain of fast-developing technologies that are not always matched with a commensurate focus on security and privacy matters. The discussion provides an outline of key issues in information security when viewed from technical, organizational, and human perspectives, which collectively represent the breadth of areas within which TC 11 and its WGs are seeking to make contributions. So, the chapter documents the challenges involved in achieving and maintaining security and privacy, alongside insights into the ways that they are being tackled within IFIP activities.

The concluding chapter of this book is dedicated to the IFIP Code of Ethics and Conduct that the IFIP General Assembly adopted on September 24, 2020. It also includes a section on the creation of this code. This section describes the work on the code that TC 9 had already initiated in 1988 and that involved IFIP as a whole and its member societies. In addition, there is a prologue by the IFIP Task and Finish Group on the development, the nature, the structure, the status, and the benefits of the code. The code itself consists of sections on professional responsibilities, professional leadership principles, and compliance with the code. As such it is offered to member societies and any other interested parties.

Besides giving valuable insights into important and upcoming topics of information processing, all the contributions show the rich diversity of the international work being done in IFIP and how it represents the global research and application of information processing. They also document the essential role of IFIP as a platform for this work.

Especially in these challenging times caused by the COVID-19 pandemic, we are honoured to bring you this collection and express our appreciation to all the contributors who supported making IFIP AICT 600 a success. There is a long list of people who volunteered their time and energy to put together the chapters and who deserve acknowledgement.

We hope you find AICT 600 interesting, stimulating, and inspiring for your future work regardless of the challenging times in which IFIP is celebrating its 60th anniversary.

May 2021

Michael Goedicke
Erich Neuhold
Kai Rannenberg

Contents

TC 9: ICT and Society

TC 11: Security and Privacy Protection in Information Processing Systems

IFIP General