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Computer Networks

27th International Conference, CN 2020
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Proceedings

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Preface

Communication is one of the most important parts of the modern world. The field of computer networks constantly delivers new technologies that meet expectations of all services required by various applications, from many years. They are like digital bloodstream of computer systems, highly necessary but invisible unless they are damaged. Most of devices and whole systems are dependent on computer networks services. They become useless or their functionalities would be significantly diminished if the computer networks stopped working. Because the majority of digital facilities are a part of networked systems, the communication technologies are one the most important part of them ensuring their operation. Try to imagine, what personal and professional activities would be in time of COVID-19 lockdown, if we did not have the significant development of networks communication in recent years. Therefore, the prospects in this domain bring inevitable development, and events founded to exchange and disseminate knowledge in this area are important.

It is indispensable to have an in-depth knowledge of how to manage, model, and design networked systems. To the high dynamics and the multiplicity of emerging technologies, it is necessary to constantly expand and exchange knowledge and gain experiences in this field. Conferences are the kind of meetings where independent points of view are presented and where experts, researchers, and users can exchange ideas. This book contains the top proceedings of one such event.

The Computer Networks (CN) conference was established at the Faculty of Automatic Control, Electronics and Computer Science of Silesian University of Technology in Gliwice 25 years ago. Professor Andrzej Grzywak was the main initiator of this event. The 27th edition of the conference took place in 2020, and we hope that more editions will be held in the future. With the increasing popularity of this topic, we are facing the difficult task of dealing with numerous article submissions with twice as much strength.

The innovative solutions and proposals submitted to CN indicates that significant, relative scientific research is discussed. Every year, the number of publications is growing and the scientific quality of works is getting more advanced. The scientific level of the presented works is very high, and as a consequence the reviewing process is very demanding and difficult for the authors. It consists of three independent opinions of well-known scientists from around the world. Computer networks are still the main solution which allows nodes to share resources. This is very important from many points of view, including industrial communication.

Since 2009, conference proceedings have been published by Springer in the CCIS series. All conference issues are indexed by Web of Science and Scopus each year. It is also worth mentioning that the conference has co-sponsors and co-organizers, which include the Computer Networks and Distributed Systems Section of the Informatics Committee of the Polish Academy of Sciences (PAN) as well as IEEE Poland and the International Network for Engineering Education and Research (iNEER).



27th International Science Conference on Computer Networks (CN 2020)

The CN conference has been visible for more than a quarter of a century, giving researchers a chance to meet each other, make new connections, start cooperation, discuss on bothering problems, as well as disseminate their research results. The essential contents presented during the conference are published in significant and well recognized series of proceedings. Over the past 26 years of the conference's history, all important topics related to computer networks area have been discussed at the conference and major breakthroughs in this area have been deliberated. Many collaborative relationships were established, both in local and international scope. Thus, we believe that the event has had a significant contribution to the global pool of achievements in this domain.

Computer networks are still the only communication means for digital systems of all kinds. Thus, recent research and innovative applications are very important for current industrial and social activities. We also expect a high need for this in the future. Computer networks and internal complexity of their operations are usually not shown to their user. But without modern solutions and developments many popular and spectacular amenities of everyday life would be unavailable.

This year, the CN conference faced the non-precedent situation related to both pandemic state and internal regulations changes in Poland. It caused a reduced number of submissions as well as the withdrawal of some works. Despite this, the organizers ran the conference with the best topics among submitted and by including here the best articles related to them. For the current edition, nearly 50 papers were submitted. To maintain the high quality of the CCIS publication, only 34 were selected for further consideration, and 14 among them were carefully selected for publication in this proceedings. Each paper was reviewed by three independent reviewers in a double-blind process. The Technical Program Committee of CN 2020 consisted of 136 scientists from 25 countries and 5 continents. This book collects the research work of scientists from notable research centers. It includes stimulating studies of the wide spectrum of both science and practical-oriented issues regarding the computer networks and communication domain that may interest a wide readership. The content is divided in three parts.

– Computer Networks

This section contains seven papers. All of them refer to the general domain of computer networks and communications problems.

The first paper is delivered by two research entities: the Institute of Analysis and Scientific Computing, TU Wien, Austria and the Institute of Computer Science and Information Technologies, Lvov Polytechnic National University, Ukraine. It refers to the issue of finding the proper network topology regarding the criteria of bandwidth utilization. The Gomory-Hu algorithm is considered which is modified with taking into account deficient channels. Network topology optimization made by the proposed algorithm guarantees the transmission of the maximum input stream. The presented idea, although based on classical Gomory-Hu algorithm, seems to be very promising. The authors provide also an example showing that the result obtained with the modified algorithm is correct.

The second paper is presented by the representatives of the University of Houston, USA. The authors ponder communication networks used in space. The space technologies become continuously more important last years and communication on this matter is highly relevant to develop the whole branch. Authors examined the segmentation process used by Licklider Transmission Protocol to determine the role of the segment length in the context of transmission delays. They propose the model of the protocol that allows estimating the variable length of data chunk instead of fixed one. This innovative approach is possible because authors provide a relation between bit error rate of a channel and the optimal segment length instead of common practice of using the maximum payload of underlying protocol.

The third paper is prepared by scientists from the Technical University of Liberec, Czech Republic, and refers to the NAT64 and DNS64 mechanisms. The authors specify the problems related to the DNS use in modern network services, especially problems related to default usage of third party DNS resolvers together with the most deployed detection method described by RFC7050. These issues could become real, as the method is not compatible with DoH resolvers. This could even lead to problems which would prevent Internet service providers from disabling IPv4 in their network. Authors suggest how to solve the issues related to RFC7050 and show a possible way how to move information about both NAT64 and DNS64 from local view of top-level domain to operator's global zone, with keeping the security.

The authors of the next paper come from two Polish universities. The first author is from the University of Zielona Góra and the second from Military University of Technology. They touch a brand new technology, namely networks that transmit quantum information. Just like in regular networking one of the most important processes in quantum circuits is packet switching. The authors describe an implementation of a router for a four-qutrit quantum circuit. In general, the quantum router is a solution, working on qubits, and provides spin interactions between quantum units of information. Authors show that the joining of such routers allows for the building of structures which are able to transfer a quantum state to the defined node in a quantum network, achieving high accuracy of information transfer.

The next team is from Silesian University of Technology, Poland, and in their article authors analyze the state of the art in relation to the development of supercomputers

and the important usage of related network technologies. They present the trends available in the domain of high-performance computers. The analysis is focused on system architecture, processors, computing accelerators, energy efficiency, and interconnection ability as well. The authors show that a significant impact on the supercomputer's development depends on many, various elements but the development of new topologies and technologies designed for connecting system nodes is absolutely pivotal.

The next paper has been produced in Germany by researchers from Technical University of Dresden. The aim of the paper is reliable delivery of crowd monitoring data. The authors discuss the dynamic switching between infrastructure network and peer-to-peer communication in a case when the connectivity is lost. The availability of such services is important from the emergency point of view of big events. The authors tested the P2P connection during an experiment they made at a real annual fair on the university campus.

The last paper in this section refers to 5G cellular networks and its author comes from Jagiellonian University, Poland. The development of this technology raises many unreasonable emotions these days, as new technologies usually do, but it is inevitable and finally will bring a positive impact to our networked society. The delivery of a small payload in a short time is requested in 5G and is possible by achieving ultra-reliable and low-latency communication. This is one of the major challenges in this kind of communication. In this paper, the authors provide some important definitions and present a method for reliability enhancement of such type of traffic. They consider the maximization of the reliability enhancement as an optimization problem and they make some relevant simulations to obtain an optimal resource allocation policy. As a result, they achieve significant performance differences between standard methods and the studied one.

– Cybersecurity and Quality of Service

This section contains three papers related to networks security, reliability, and quality of service issues.

This first paper is made by author from the University of Ostrava, Czech Republic. The content of the paper ruminates the well-known and common problem of unwanted emails and anti-spam systems which block one from receiving them. The authors present the interconnection between two significant layers of multi-layer spam detection systems. Such communication is usually a weak point in mutual collaboration between many SMTP servers. Thus, the construction of the feedback interconnection between message content check and greylisting layers is a key, and authors propose an easy way how spam detection can be improved by this. It seems that the proposed method can improve the system's effectiveness because the obtained results prove that the number of detected spam messages is higher in comparison to the other well-known methods. The method is not related to the given IP version and is not connected with the particular implementation so it can be adopted to any multi-level spam detection system.

The authors of the second article come from Otto-Friedrich-University Bamberg, Germany, and V. A. Trapeznikov Institute of Control Sciences, Russian Academy of

Sciences, Russia. They consider an analysis of transport reliability in fog computing approach. The network function virtualization paradigm in an IoT scenario together with a software-defined networks stack and multipath communication between its clients and servers are used. The authors analyze the reliability of the redundant transport system. The used communication channels are error-prone simulated by random failures described by general Markov-modulated Poisson processes. They found that the steady-state distribution of the restoration model can be effectively calculated by a semi convergent iterative aggregation-disaggregation method for block matrices. As the result of the presented analysis authors compute the associated reliability function and hazard rate. The obtained effects seem to be useful for future generations of these kinds of networks.

The authors of the last paper in this section are from Gdańsk University of Technology, Poland. Both are from the Faculty of Electronics, Telecommunications and Informatics. They propose a new approach to network bandwidth distribution which can ensure so-called fairness to end-users. In some services where the high competition exists between users, e.g., multimedia transfer, the fairness assurance in the assignment of limited resources to a potentially large set of users competing for them is highly requested. The authors define fairness in terms of quality of experience for satisfied users and quality of service for unsatisfied users. Such an algorithm of fair bandwidth distribution can be one of the most desired supports for service providers, because its aim is minimizing the number of end-user service terminations. The proposed algorithm works much better than others commonly used, and as the result the number of resignations was almost four times lower than that of other algorithms.

– Queueing Theory and Queueing Networks

This section contains four papers. The chapter refers to the theory of queues and queueing network models. In such models the time characteristics of all tasks at each network node is given by the response time of a queueing network.

Authors of the first paper in this section are from Petrozavodsk State University and the Institute of Applied Mathematical Research of the Karelian research centre of RAS, Russia. They talk about the implementation of failure rate functions to compare queueing processes for exponential, Pareto, and exponential-Pareto mixture distribution of service times. They use the failure rate and stochastic comparison techniques together with coupling of random variables to establish some monotonicity properties of the model. The obtained results can be useful for the estimation of the performance measures of a wide class of queueing systems.

The second paper comes from Poland. The authors are from the Institute of Computer Science, Cardinal Stefan Wyszyński University in Warsaw and from the Institute of Information Technology, Warsaw University of Life Sciences – SGGW. The authors report theoretical investigations on modified M/G/1/inf queueing model. They study this model with non-homogeneous customers, an unreliable server and a service time distribution which depends on a volume characteristic of the jobs. They extend their previous work and try to follow a purely transform-oriented analysis approach for M/G/1 models. The results show that the method of an additional event

can be used in the case of complicated models. The queueing model may be relevant in virtualized computer systems.

The third paper is a result of research from USA, the University of California San Diego and California State University Northridge. The paper presents an infinite-server queue model with transient analysis and nonhomogeneous arrival processes. The paper is built on the previous defined mathematical models and presents a detailed analysis of the presented model. The authors obtained the basic differential equations for joint probability generating functions for a number of busy servers and served customers for transient and stationary random environments. The results seem to be suitable for network performance evaluation, as well as for designing the optimal strategies for managing resources of various networked systems and subsystems where the considered model can be used.

The last paper is a result of international cooperation. The authors are from, Shri Mata Vaishno Devi University, India, and the Polish Academy of Science as well as Silesian University of Technology, Poland. The authors consider cloud services which are provided by virtual machines. They presented a simple queueing model for processing tasks in computational clouds. The research is based on transient analysis of the performance parameters. The numerical examples are presented to illustrate its utility by considering the effects of reneging and feedback on the queueing delay, probability of task rejection, and the probability of immediate service.

On behalf of the Program and Organizing Committee of the CN conference, we would like to express our gratitude to all authors for sharing their research results and for their assistance in producing this volume, which we believe is a reliable reference in the computer networks domain.

We also want to thank the members of the Technical Program Committee and all reviewers for their involvement and participation in the reviewing process.

If you would like to help us make the CN conference better, please send us your opinions and suggestions at cn@polsl.pl.

May 2020

Piotr Gaj
Wojciech Gumiński
Andrzej Kwiecień

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CN 2020 was organized by the Faculty of Automatic Control, Electronics and Computer Science, Silesian University of Technology (SUT) and supported by the Committee on Informatics of the Polish Academy of Sciences (PAN), the Section of Computer Networks and Distributed Systems in technical co-operation with the IEEE, and consulting support of the iNEER organization.

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