Special Issue "A Festschrift in Honor of Prof. Anthony Ephremides' 80th Birthday: A Journey from Age of Information to Semantics of Information"

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Age of Information (AoI) is an end-to-end metric that can capture one semantic property known as the timeliness of information, which is essential in status-updating systems. Semantics of Information (SoI) captures properties of information that relate to the "goal" and "purpose" of information, which is to improve the performance of systems using the information. As a new paradigm shift toward 6G communications systems, SoI will create systems that generate, process, and transmit only a small fraction of information. Thus, they consume less energy and channel resources without sacrificing their effectiveness.

This special issue honors Prof. Anthony Ephremides' contribution to the area and celebrates his 80th birthday. Prof. Ephremides is among the very first who foresaw the implications of the Age of Information as a paradigm shift in communication networks and advocated for a more general theory, the semantics of information based on rigorous foundations.

The editors would like to thank the authors of all papers for their submissions. In addition, special thanks go to the reviewers for their help in allowing us to complete the reviews and decisions on time. The papers in this special issue will report research advances in the semantics of information. More specifically, seven accepted papers deal with the age of information, and three investigate semantics beyond the age of information.

Age of Information: In this part we present the papers that considered AoI. The paper "Fresh-CSMA: A Distributed Protocol for Minimizing Age of Information" by Tripathi, Jones, and Modiano considers the design of distributed scheduling algorithms that minimize age of information (AoI) in single-hop wireless networks. The paper "Age-Optimal Multi-Flow Status Updating with Errors: A Sample-Path Approach" by Sun and Kompella studies an age of information minimization problem in continuous-time and discrete-time status updating systems that involve multiple packet flows, multiple servers, and transmission errors; and four scheduling policies are proposed. The paper "AoI Analysis and Optimization in Systems with Computations-Intensive Updates" by Vilni, Moltafet, Leinonen, and Codreanu considers a computation-intensive status update system with a data pre-processing server and a transmit server. The paper "Fresh Multiple Access: A Unified Framework Based on Large Models and Mean-Field Approximations" by Hui, Wei, and Chen builds a unified framework based on large models and mean-field approximations. Freshness-oriented multiple access is studied, focusing on Age of Incorrect Informatioin (AoII) and peak AoII scenarios. The paper "Timely and Covert Communications under Deep Learning-Based Eavesdropping and Jamming Effects" by Costa and Sagduyu explores the concept of timeliness in covert communications when faced with eavesdropping and jamming. Time-sensitive information is transmitted

through a wireless channel between a transmitter and a receiver, while an adversary seeks to detect the communication attempts with a deep learning-based classifier. The paper "Age of Information Games Between Power Constrained Schedulers and Adversaries" by Banerjee, Ulukus, and Ephremides considers AoI games in a cellular network with multiple users, one base station (BS), multiple channels, and one adversary. The paper "On the Age of Information of Processor Sharing Systems" by Gandarias, Doncel, and Assaad examines the AoI of a source sending status updates to a monitor through a queue operating under the processor sharing discipline.

Semantics beyond Age of Information: Here we present the three papers that consider SoI beyond AoI. The paper "State-aware Real-time Tracking and Remote Reconstruction of a Markov Source" by Salimnejad, Kountouris, and Pappas considers the real-time remote tracking and reconstruction of a two-state Markov process. A state-aware randomized stationary sampling and transmission policy is proposed which accounts for the importance of different states of the information source, and their impact on the goal of the communication process. The paper "Sampling for Remote Estimation of an Ornstein-Uhlenbeck Process through Channel with Unknown Delay Statistics" by Chen, Tang, Wang, Yang, and Tassiulas considers the sampling of an Ornstein-Uhlenbeck process through a channel for remote estimation to minimize the mean square error at the estimator under a sampling frequency constraint. The paper "Control-Aware Scheduling over Multi-hop Networks" by Kutsevol, Ayan, and Kellerer demonstrates the benefits of the application-oriented design of networking algorithms for control. The transmission scheduling over a multi-hop network that connects the WNCS components is considered.

Nikolaos Pappas received a B.Sc. degree in Computer Science, a B.Sc. degree in Mathematics, an M.Sc. degree in Computer Science, and a Ph.D. degree in Computer science from the University of Crete, Greece, in 2005, 2012, 2007, and 2012, respectively. From 2005 to 2012, he was a Graduate Research Assistant with the Telecommunications and Networks Laboratory, Institute of Computer Science, Foundation for Research and Technology—Hellas, Heraklion, Greece, and a Visiting Scholar with the Institute of Systems Research, University of Maryland at College Park, College Park, MD, USA. From 2012 to 2014, he was a Postdoctoral Researcher with the Department of Telecommunications, CentraleSupelec, Gif-sur-Yvette, France. He is currently an Associate Professor at the Department of Computer and Information Science at Linköping University, Linköping, Sweden. His main research interests include the field of wireless communication networks with an emphasis on semantics-aware communications, energy harvesting networks, network-level cooperation, age of information, and stochastic geometry. Dr. Pappas has served as the Symposium Co-Chair of the IEEE International Conference on Communications in 2022 and the IEEE Wireless Communications and Networking Conference in 2022. He is Area Editor of the IEEE OPEN JOURNAL OF THE COMMUNICATIONS SOCIETY and an Expert Editor for invited papers of the IEEE COMMUNICATIONS LETTERS. He is an Editor of the IEEE TRANSACTIONS ON MACHINE LEARNING IN COMMUNICATIONS AND NETWORKING and the IEEE/KICS JOURNAL OF COMMUNICATIONS AND NETWORKS. He is a Guest Editor of the IEEE NETWORK on "Tactile Internet for

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Yin Sun received his B.Eng. and Ph.D. degrees in Electronic Engineering from Tsinghua University, in 2006 and 2011, respectively. He was a Postdoctoral Scholar and Research Associate at the Ohio State University from 2011-2017 and an Assistant Professor in the Department of Electrical and Computer Engineering at Auburn University from 2017-2023. He is currently the Godbold Associate Professor in the Department of Electrical and Computer Engineering at Auburn University, Alabama. His research interests include Wireless Networks, Machine Learning, Semantic Communications, Age of Information, Information Theory, and Robotic Control. He is also interested in applying AI and Machine Learning techniques in Agricultural, Food, and Nutrition Sciences. He has served as an Associate Editor of the IEEE Transactions on Network Science and Engineering, an Editor of the Journal of Communications and Networks, an Editor of the IEEE Transactions on Green Communications and Networking, a Guest Editor of five special journal issues, and an Organizing Committee Member of several conferences. He founded the Age of Information (AoI) Workshop in 2018 and the Modeling and Optimization in Semantic Communications (MOSC) Workshop in 2023. His articles received the Best Student Paper Award of the IEEE/IFIP WiOpt 2013, Best Paper Award of the IEEE/IFIP WiOpt 2019, runner-up for the Best Paper Award of ACM MobiHoc 2020, and 2021 Journal of Communications and Networks (JCN) Best Paper Award. He co-authored a monograph Age of Information: A New Metric for Information Freshness. He received the Auburn Author Award of 2020, the National Science Foundation (NSF) CAREER Award in 2023, and was named a Ginn Faculty Achievement Fellow in 2023. He is a Senior Member of the IEEE and a Member of the ACM.