# Special Issue on Age of Information

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Information freshness at the monitoring station is of fundamental importance in the dissemination of time-critical information. Applications that rely on information freshness include networked monitoring, situational awareness and automated control (e.g., tactical networks, sensor networks, airplane/vehicular control, and Cyber-Physical Systems) applications. Other commercial applications include data analytics (e.g., crowdsourcing, financial trading, social networks, and Internet of Things) applications. Age of Information (AoI) is a concept that has recently gained prominence as a performance metric for characterizing information freshness at the receiver. It is interesting to note that improving first-order metrics such as, providing high throughput and / or low delay, that lead to improved performance in traditional data networks, are inadequate when it comes to improving information freshness. Therefore, there is a critical need to re-examine existing metrics and develop new ones for current and future real-time applications.

This special issue received 16 submitted manuscripts, of which eight papers have been accepted for publication. The editors would like to thank the authors of all papers for their submissions and special thanks go to the reviewers for their help in allowing us to complete the reviews and decisions in a timely fashion. The papers in this special issue will report research advances in three main areas, namely Sampling and Transmission Strategies for minimizing AoI, AoI and Networking, and AoI and Energy Efficiency.

**Sampling and Transmission Strategies for Minimizing AoI:** As the title suggests, in this section are presented papers that propose new sampling and transmission strategies to optimize data freshness and thereby minimize the age of information in various scenarios. Firstly, the paper “Sampling for Data Freshness Optimization: Non-linear Age Functions” by Yin Sun and Benjamin Cyr presents a randomized threshold sampling strategy over a non-linear age function in order to improve the freshness of the received data samples at the remote receiver. Next, by considering a rate-limited link, the paper “When to Preempt? Age of Information Minimization under Link Capacity Constraint” by Wang *et. al.* presents transmission strategy that decides intelligently whether to skip the new arrival or switch to transmitting it, as each update could take multiple time slots to complete its transmission. The manuscript titled “Minimizing Age of Information with Soft Updates” by Melih Bastopcu and Sennur Ulukus introduces the concept of soft updates, where updates generated by the source start taking effect right away, but gradually over time, as opposed to instantaneously, which is most commonly found in the literature. Finally, the paper “Age of Information Performance of Multiaccess Strategies with Packet Management” by Antzela Kosta *et. al.* considers the notion of packet management in a multiaccess channel, where N source nodes communicate with a common receiver. As part of packet management, the source nodes are provided the capability of replacing unserved packets in the transmission queue when newer packets arrive. The AoI performance is investigated under both scheduled and random access.

**AoI and Networking:** This part contains two papers that propose age minimization strategies where the source and destination nodes are connected over a network. Firstly, the paper "Age of Information in Multihop Multicast Networks" by Buyukates *et. al.* studies how age performance of a network changes with growing network size. Specifically, the paper studies the scalability of age in multihop multicast networks using the idea of stopping threshold. The manuscript "Fundamental Bounds on the Age of Information in Multi-Hop Global Status Update Networks" by Farazi *et. al.* analyzes age of information in a multihop network when each node in the network is both a source and a monitor, and more importantly receives fresh updates from all other nodes in the network. The paper specifically analyzes lower bounds for peak and average age of information in terms of graph theoretic properties such as the connected dominating number.

**AoI and Energy Efficiency:** The last section focusses on proposals to improve information freshness where sources are constrained by energy such as being equipped with a finite battery that can be replenished via energy harvesting. To begin with, the paper "Optimal Status Updating with a Finite-Battery Energy Harvesting Source" by Bacinoglu *et. al.* explores optimal threshold policies for generation and transmission of updates such that the time-average expected age penalty is minimized, where the threshold is a non-increasing function of the instantaneous battery level. It should be noted that since each update consumes a certain amount of the harvested energy, choosing the right threshold is key to minimizing the age penalty. Numerical analysis shows significant improvement in age can be attained when battery capacity is increased from one update transmission's worth to two. Then, the paper "Age of Information of Two-way Data Exchanging System With Power-Splitting" by Cheng Hu and Yunquan Dong considers two way communication between an access point and a smart device over a block fading channel where the smart device is also able to harvest energy from the access point. The access point splits its transmit power into two parts: one part for its own data transmission to the smart device, and the remaining for energy transfer, so as to perform both actions simultaneously. The paper analyzes how the power-splitting ratio affects the weighted-sum average AoI and weighted-sum data rate of the system, and in particular, obtains the optimal power-splitting ratio for this system.

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