

# On Freshness of Information in Future Networks and Intelligent Systems

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**Abstract:** The combination of tactile internet and machine-to-machine communications has facilitated a wide range of low-latency cyber-physical applications, including fleet management, virtual/augmented reality (VR/AR), and industrial automation, among many others. These applications typically rely on a constant flow of new information, such as measurements captured by numerous sensors within the system, to support making informed decisions. While the latency of these messages is typically in the order of a few milliseconds, the latency itself often fails to provide an insight into the relevance of the information for the decision-making process of these applications. To address this concern, a novel metric known as the 'Age of Information' (AoI) has emerged, aiming to measure the freshness of data. The AoI is defined as the time elapsed since the latest useful piece of information reached its intended destination, generated at its source (e.g., a sensor). Moreover, AoI is closely tied to the significance of collected data in real-time applications. The underlying assumption is that the more recent the information was generated, the greater its importance in influencing the decision-making process of these applications. This contrasts with latency, which merely measures the time taken for data to travel from source to destination. As such, AoI metric is emerging as a valuable tool in future networks for evaluating the freshness and significance of data in various in real-time applications.

In this lecture, we will discuss the origin of the AoI metric, how it is measured, and what its impact will be on future networks and intelligent systems. We will also demonstrate, using a system of multiple sensors, how to design a smart Medium Access Control (MAC) scheme capable of minimizing AoI within the system.