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Integrated Sensing and Communications: Toward Dual-Functional Wireless Networks for 6G and Beyond

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Abstract: *As the standardization of 5G solidifies, researchers are speculating what 6G will be. The integration of sensing functionality is emerging as a key feature of the 6G Radio Access Network (RAN), allowing for the exploitation of dense cell infrastructures to construct a perceptive network. In this IEEE Journal on Selected Areas in Communications (JSAC) Special Issue overview, we provide a comprehensive review on the background, range of key applications, and state-of-the-art approaches of Integrated Sensing and Communications (ISAC). We commence by discussing the interplay between sensing and communications (S&C) from a historical point of view, and then consider the multiple facets of ISAC and the resulting performance gains. By introducing both ongoing and potential use cases, we shed light on the industrial progress and standardization activities related to ISAC. We analyze a number of performance tradeoffs between S&C, spanning from information theoretical limits to physical layer performance tradeoffs, and the cross-layer design tradeoffs. Next, we discuss the signal processing aspects of ISAC, namely ISAC waveform design and receive signal processing. As a step further, we provide our vision on the deeper integration between S&C within the framework of perceptive networks, where the two functionalities are expected to mutually assist each other, i.e., via communication-assisted sensing and sensing-assisted communications. Finally, we identify the potential integration of ISAC with other emerging communication technologies, and their positive impacts on the future of wireless networks.*

Keywords: Integrated sensing and communications, 6G, performance tradeoff, waveform design, perceptive network