

Review

A Comprehensive Exploration of 6G Wireless Communication Technologies

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Abstract: As the telecommunications landscape braces for the post-5G era, this paper embarks on delineating the foundational pillars and pioneering visions that define the trajectory toward 6G wireless communication systems. Recognizing the insatiable demand for higher data rates, enhanced connectivity, and broader network coverage, we unravel the evolution from the existing 5G infrastructure to the nascent 6G framework, setting the stage for transformative advancements anticipated in the 2030s. Our discourse navigates through the intricate architecture of 6G, highlighting the paradigm shifts toward superconvergence, non-IP-based networking protocols, and information-centric networks, all underpinned by a robust 360-degree cybersecurity and privacy-by-engineering design. Delving into the core of 6G, we articulate a systematic exploration of the key technologies earmarked to revolutionize wireless communication including terahertz (THz) waves, optical wireless technology, and dynamic spectrum management while elucidating the intricate trade-offs necessitated by the integration of such innovations. This paper not only lays out a comprehensive 6G vision accentuated by high security, affordability, and intelligence but also charts the course for addressing the pivotal challenges of spectrum efficiency, energy consumption, and the seamless integration of emerging technologies. In this study, our goal is to enrich the existing discussions and research efforts by providing comprehensive insights into the development of 6G technology, ultimately supporting the creation of a thoroughly connected future world that meets evolving demands.

Keywords: 6G wireless communication; terahertz (THz) waves; optical wireless technology; dynamic spectrum management; non-IP-based networking protocols; cybersecurity; quantum communications; artificial intelligence (AI); network architecture; spectrum efficiency; energy consumption; reconfigurable intelligent surfaces; holographic communication; blockchain technology; tactile Internet



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1. Introduction

To lay the groundwork for our 6G vision, we first offer background information spanning the development of network technologies from the first to the fourth generation, detail the advancements achieved with 5G, and discuss the research efforts aimed at achieving 6G (see Figure 1).

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